

for a greener tomorrow



# Environmental Topics 2015

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# Environment – Environmental Topics

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## ▶ **New Energy Potential — A Wireless Sensor Powered by Small Vibrations**

Updated Mar 2014

- ▶ Changing Vibrations into Electricity with the Use of a Spring
- ▶ Storing Electricity a Little at a Time for Bulk Use
- ▶ Endless Possibilities of Wireless Sensors that Utilize Vibration Power Generation
- ▶ Comments from the Developer

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## ▶ **Plastic Recycling Comes of Age**

- ▶ Defining a Recycling-based Society
- ▶ Hyper Cycle Systems: Reclaiming Resources
- ▶ Green Cycle Systems: Refining Old Plastics
- ▶ Breakthroughs Shaping the Future

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## ▶ **Tapping into Hidden Deposits of Rare Earth Elements Found in Cities**

Updated Mar 2014

- ▶ Why Should Rare Earth Elements Be Recycled?
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- ▶ When Will Rare Earth Recycling Start to Become Widespread?

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## ▶ **Kyoto Works Becomes Home to a Family of Ducks**

Published Apr 2013

June 2012. Kyoto works, one of our factories discovered a duck was building a nest. In the beginning of July, 7 cute chicks were hatched. Parent duck and chicks moved to paddy field nearby with our staff watching over them.

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## ▶ **Water for Life, Water for Industry**

Updated Mar 2014

- ▶ Water As Precious, Reliable and Delicious
- ▶ Microbubbles Revolutionize Industrial
- ▶ Ozone Generation Improves Water Treatment
- ▶ Membrane Separation Advances Water Recycling

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## ▶ **Archives**

- ▶ Dialog on Environmental Management
- ▶ A New Dimension in Eco Air Conditioning
- ▶ Intelligent Ways to Save Energy and Reduce CO2 from Production
- ▶ Coordinated Regional Waste Recycling (Kyushu Region)
- ▶ Exchanging Ideas with Experts (Respecting Biodiversity)
- ▶ Innovative Products and Production
- ▶ Rebuilding and Developing Automotive Equipment
- ▶ Towards Zero Emissions

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## ▀ Mitsubishi Electric Group Environmental Sustainability Report

Each year Mitsubishi Electric produces a printed "Environmental Sustainability Report" that provides an overview of the major topics found in the [Environmental Report](#) and [Environmental Topics](#) sections of this website.

- ▀ Latest Issue:  
Environmental Sustainability Report 2015 (PDF:  
1.72MB) 
- ▀ Back Issues

# Environment – New Energy Potential — A Wireless Sensor Powered by Small Vibrations

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## Eliminates the Need for Wiring and Battery Replacement by Measuring and Transmitting Data Using Vibration-Generated Electric Power

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In 2012, Mitsubishi Electric Engineering Co., Ltd. developed a sensing system that generates electric power via the minor vibrations that occur generally to wirelessly transmit data collected using a sensor. Up to now, the small vibrations that occur generally have attracted little or no interest. This innovative system that takes full advantage of vibrations enables the measurement and transmission of data in locations where securing a power source and the changing of batteries is difficult.

Updated Mar 2014

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  - More Than Just a Novelty, a Technology that Is Genuinely Useful
  - Aspiring to Fast-Track Market Introduction of an Initial Practical Application

# Environment – Changing Vibrations into Electricity with the Use of a Spring

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## Shifting Priorities to the Use of Vibrations to Generate Electric Power

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When standing on a bridge, it is not uncommon to feel the structure sway as vehicles drive by. In this regard, we encounter a variety of vibrations as we go about our daily business. For the most part, vibrations have been considered unnecessary. If anything, vibrations are something that we could do without. Mitsubishi Electric Engineering Co., Ltd. (MEE), on the other hand, has shifted its priority on vibrations, which are generally considered a nuisance, to a more positive focus. The company sees vibrations as an energy source.

Electromagnetic induction is the basic principle and premise underpinning the conversion of vibrations into electric energy. It refers to the phenomenon when electricity is generated by moving a magnet inside a coil. How then can electromagnetic induction be used to generate electricity from vibrations? The answer lies in the originality of this technology and its development. In reality, a spring plays the role of a power generating unit. Springs, which fulfill several functions including the absorption of shock in a variety of devices, are not only characterized by their ability to extend and contract. Springs also sway when placed in contact with other items that sway, a phenomenon that is referred to as sympathetic vibration. Springs that are in a constant state of sympathetic vibration are fragile. The general consensus, therefore, has been to minimize the sympathetic vibration of machinery as much as possible. MEE, on the other hand, looked toward using this phenomenon to amplify vibrations.

The vibration amplification spring was developed as a result of this approach. This spring exhibits sensitive sympathetic vibration toward external oscillations. Thanks largely to proprietary research into the quality of materials and configuration, there is no danger of the spring breaking despite vibrating continuously for lengthy periods. The vibration amplification spring is used to encircle a magnet and moved fastidiously in an upward and downward motion. This in turn creates electromagnetic induction resulting in electricity. This is the mechanism for vibration power generation utilizing sensor movements.



# Environment – Storing Electricity a Little at a Time for Bulk Use

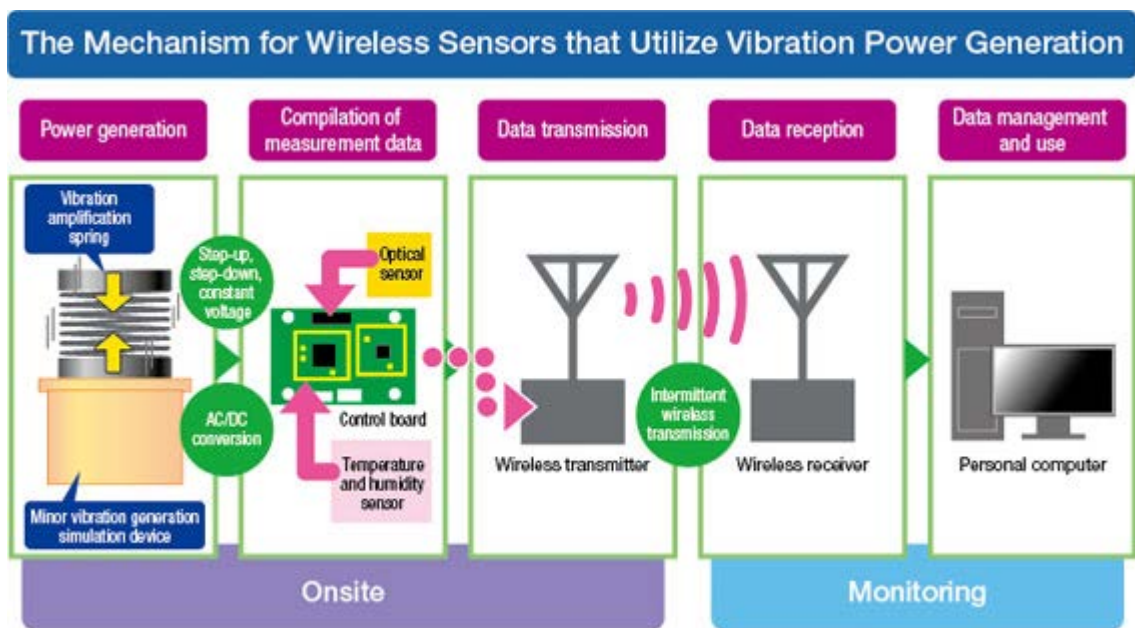
## A sensor System that Combines Vibration Power Generation with Capacitors

The sources of energy for vibration power generation are found in the minor vibrations that occur during daily life. These include vibrations attributable to such structures and facilities as roads and factories. For this reason, the electric power generated cannot be regarded as substantial. In an initial test case, the energy generated in one second was sufficient to power only a single light bulb.

To address this concern, MEE devised a structure that is capable of utilizing at regular time intervals the small amounts of electric energy generated that have been stored in capacitors. While the amount of usable electric power remains limited, it is sufficient to power various types of energy-efficient sensors and wireless radios. Recognizing that actual conditions for use for the most part entail measuring and monitoring at such regular intervals as once every few minutes or once every few hours, considerable potential exists for the practical application of this store-and-use method.

In a second test case\*, steps are being taken to measure and transmit temperature, humidity and luminance data at 10-second intervals. This frequency can be set freely in accordance with the level of vibration and the purpose of electric power use. For example, power generated is currently six times the amount used on a once-a-minute basis, and 360 times the amount used on a once-an-hour basis. This creates opportunities for increasingly energy-efficient sensors as well as more complex sensors.

\* Based on vibrations of approximately 10Hz.



# Environment – Endless Possibilities of Wireless Sensors that Utilize Vibration Power Generation

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## Bridges, Railways, Tunnels, Construction Sites: Active Wherever Vibrations Can Be Found

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There are many locations and instances where vibrations occur on a constant basis. In addition to bridges, locations include railways, the areas under elevated structures of roads, inside tunnels, constructions sites, and areas around large-scale machinery at factories. Each of these locations and instances are a potential source of energy for wireless sensors that utilize vibration power generation. By designing optimal vibration amplification springs that match the level of vibration at each location, steps can be taken to further enhance power generation efficiency. Larger or conversely smaller springs can be designed depending on the place of installation.

Currently, sensors are used to measure and monitor temperature, humidity and luminance. Looking ahead, potential exists for various other applications including noise, odor, transparency, pressure, velocity, obstacles and event vibrations themselves which serve as a source for electric energy. At the same, the area receiving vibrations (the power generating portion) and the area setting the sensor in motion can be separate. For example, the power generated by the vibrations of engines and motors can be used to measure wheel and roof data.

The potential of wireless sensors that utilize vibration power generation is indeed endless, particularly when considering the many possible combinations of the various options available. A significant number of companies from a wide range of industries together with various government agencies have shown a keen interest in this technology. Several joint studies have already commenced with an eye toward commercialization. While weak in nature, vibrations as a source of energy exist in every possible location. The day when the full potential of this new technology is realized may be closer than we think.

Wireless Sensors that Utilize Vibration Power Generation can be Used in any Number of the Following Places



## Environment – Comments from the Developer

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### More Than Just a Novelty, a Technology that Is Genuinely Useful

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**Hiromori Nomura**  
Assistant Manager  
Communications System  
Design Section,  
Communications  
Equipment Engineering  
Department A  
Mitsubishi Electric  
Engineering Co., Ltd.

The initial spark for this idea came from a particular exhibition. Looking at the sympathetic vibration of the spring portion of a device on display the thought came to me: "Can this be used to generate electricity?" I bounced this idea off of some colleagues, but there were doubts as to whether this could really work. Having generated a certain amount of voltage using a prototype, however, I embarked on a process of trial and error with the cooperation of experts in the fields of electromagnetic induction and material technology. Little by little, we were able to enhance performance. Today, a large number of researchers and engineers are finding this proposal both unique and interesting. While I find this recognition gratifying, I am convinced that the role of a developer is not to merely put forward ideas that people consider a novelty, but to create technologies that are genuinely useful.

### Aspiring to Fast-Track Market Introduction of an Initial Practical Application

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**Hiroyuki Yonezawa**  
Manager  
Communications System  
Design Section,  
Communications  
Equipment Engineering  
Department A  
Mitsubishi Electric  
Engineering Co., Ltd.

Wireless sensors that utilize vibration power generation represent a new technology that complements efforts to develop environmentally friendly sensors. Following presentations and announcements during an environmental exhibition held in December 2012, a significant number of companies have responded favorably and are currently promoting joint research into securing commercial application. In addition to measuring vibration data at actual usage sites and customizing optimal power generation mechanisms in accordance with this data, we are looking at designs for both the power generation and measuring components that are capable of minimizing energy consumption. Our goals are to realize an initial practical application as quickly as possible. By introducing a concrete example of this new technology to the market, we anticipate increased awareness by society as a whole and a sudden surge in applications across a broad spectrum of fields.

# Environment – Plastic Recycling Comes of Age

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## A Model Business for a Sustainable Future

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Japan's Home Appliance Recycling Law, enacted in 1998 and enforced since 2001, compelled the country's manufacturers to set up systems and confront head-on the challenge of transforming the nation into a recycling-based society.

Mitsubishi Electric responded by establishing in 1999 its first recycling operation, Hyper Cycle Systems. The initial goal was the clean and efficient treatment of recovered materials and any resulting waste, yet within a few short years the company realized the operation was a seed that could be cultivated into the creation of a completely new industry—sustainable recycling.

Today, Hyper Cycle Systems is that and much more: it is Japan's leading light in home appliance recycling. It boasts cutting-edge technologies, machinery and automated processes custom-developed by Mitsubishi Electric for the recovery of reusable metal, glass and plastic materials on a mass scale—and all in a modern, unexpectedly clean facility with intelligent air purification and air-quality monitoring systems.

It is joined by Green Cycle Systems, Japan's first large-scale, high-purity plastic recycling center. Established by Mitsubishi Electric in 2010, Green Cycle Systems takes the shredded mixed plastic chips recovered by Hyper Cycle Systems and separates them into reusable plastic on a scale of unprecedented magnitude. The combined output of these two enterprises has increased Mitsubishi Electric's rate of recycled, industrial-grade plastic from 6% to a paradigm-shifting 70%.

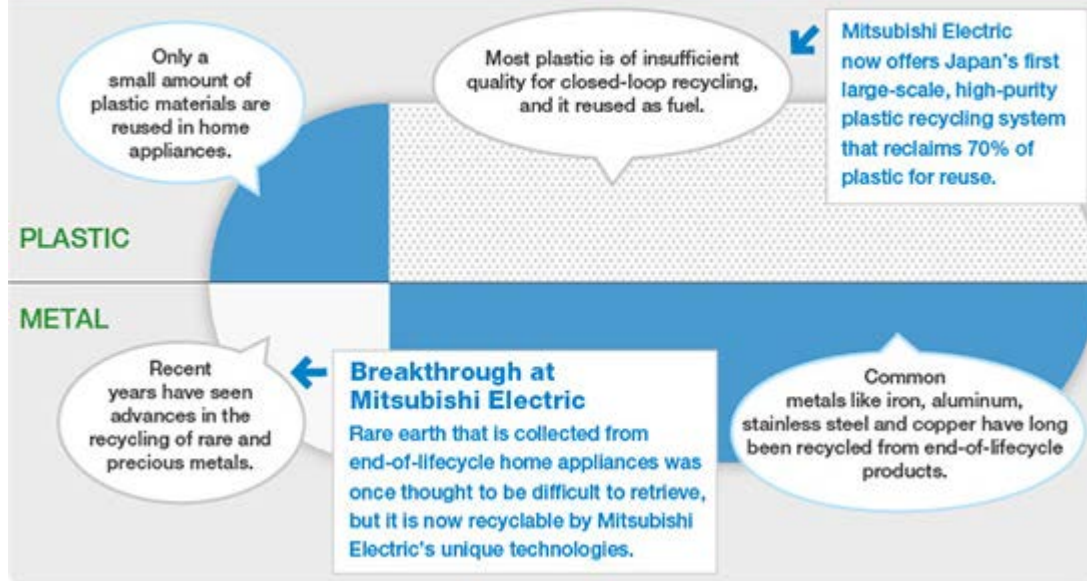
This unprecedented economy-of-scale indicates that plastic recycling has come of age as a viable eco-business, while positioning Mitsubishi Electric at the forefront of recycling in Japan, and indeed the world. It is compelling evidence of sustainability at work—a completely new, sustainable recycling industry expected to thrive indefinitely, as a mission-critical business for a recycling-based society. It is a model for other companies to follow too, in the development of other sustainable businesses capable of producing industrial-grade materials from old, end-of-lifecycle products.

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  - Building on a Legacy of Best Practices

## Current State of Home Appliance Recycling



# Environment – Defining a Recycling-based Society

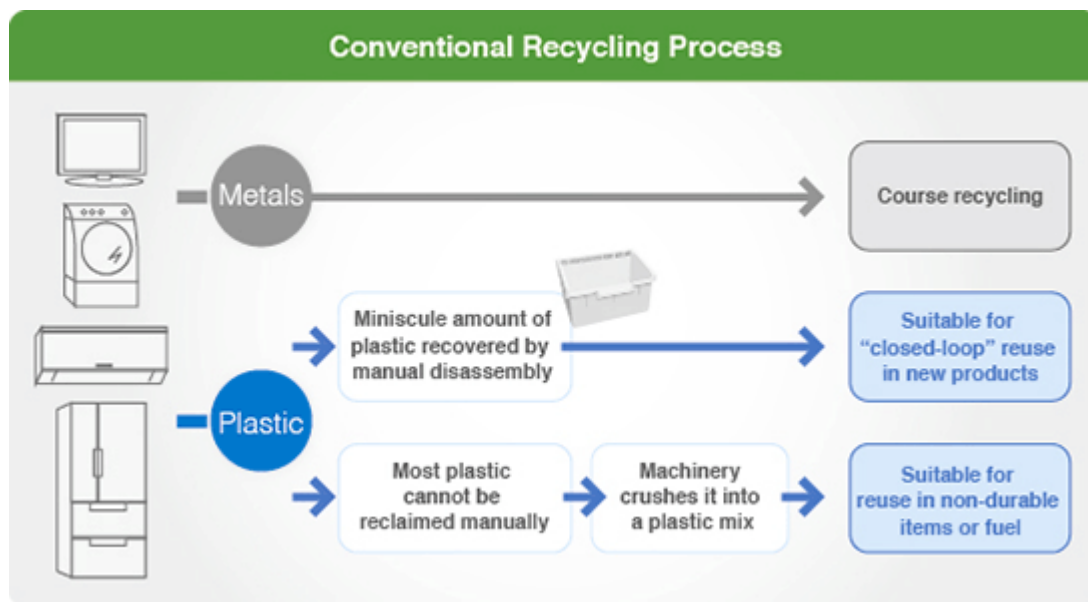
## The Challenges of Plastic Recycling

Metals from used or end-of-lifecycle products have long been recovered for industrial reuse to some extent. Unlike metals, however, plastic recycling requires a much higher degree of costly manual processing, and even then the quality of most of the resulting materials is suitable only for new non-durable everyday items, toys, trinkets, and landfills.

The reason is because of the purity of the plastic recovered. Modern home appliances are composed of a variety of plastics that, when recovered, must be completely separated from each other one by one. The separated plastics also include plastics of varied levels of deterioration due to many years of existence.

Many recyclers simply extract the metals and grind all of the plastics together into chips, then hand them over to external specialists. Mitsubishi Electric, however, set out to become the number one specialist in the field. Persistent research and development into new types of automated plastic separation and processing technologies and equipment have paid off in breakthrough proprietary systems that have ushered in the age of large-scale recycling of high-purity plastic.

Mitsubishi Electric is literally defining the age of sustainable recycling in Japan, defying conventional wisdom, and demonstrating that a recycling-based society is an obtainable goal. While building on its expertise in plastic recycling, the company will also continue seeking new methods for more efficient recovery of rare metals, in order to realize its ultimate goal of complete recycling of all materials from old products.



## Creating an Industrial-grade Recycled Materials Business

Soon after Mitsubishi Electric established Hyper Cycle Systems just over a decade ago, management became convinced that the key to transforming Japan into a sustainable, recycling-based society would be the practical—and therefore profitable—recovery of high-purity plastics that can be reused in the manufacture of new products capable of meeting the standards of durability and safety consumers demand.

From an industrial perspective, Mitsubishi Electric perceives a recycling-based society as one where recycled materials are a manufacturing company's veins, which flow into its arteries of new products. This view calls for a completely new type of "sustainable recycling" industry, one where materials reclaimed from old products are processed into new, industrial-grade "raw materials."

This new field specializes in extracting the maximum amount of marketable materials. It also provides further benefits to society by offsetting the enormous consumption of petroleum and other resources, as well as negative environmental impact, of mass manufacturing new products from completely new materials.

## The 70% Tipping Point

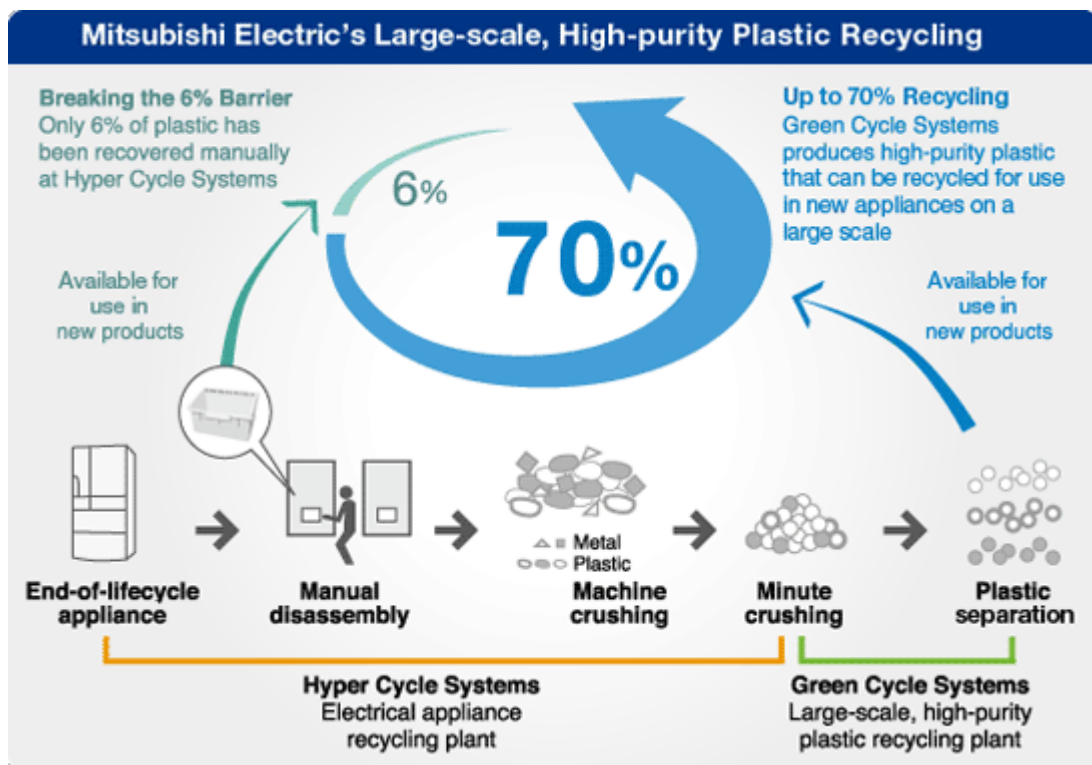
Mitsubishi Electric's mission to make plastic recycling practical and profitable called for fresh ideas and unprecedented technology-based solutions. From the outset, Hyper Cycle Systems was a working laboratory at which engineers and technicians across a variety of Mitsubishi Electric Group concerns convened to collaborate, experiment and tinker, and prove concepts through trial and error.

While developing technologies and establishing the best practices for recovering as many materials from old products as possible, and with highest levels of purity, they placed extreme emphasis on rapid development of machinery and techniques designed to defy the existing limitations preventing more than a miniscule 6% plastic-recovery rate.

Proprietary technologies for separating different plastics by specific gravity and by electrostatic properties succeeded in recovery of the three main types of plastic used in home appliances—polypropylene (PP), polystyrene (PS) and acrylonitrile-butadiene-styrene (ABS)—at purity levels exceeding 99%.

Experimental industrial processes to improve efficiency and profitability, combined with chemical engineering to reinforce the durability of recovered plastics, demonstrated impressive increases in the recycling rate along the way, until ultimately a 70% rate of recovery of industrial-grade plastics created a tipping point.

It set the stage for the opening of Green Cycle Systems in 2010, Japan's first large-scale high-purity plastic recycling concern, which represents a major step forward in Mitsubishi Electric's goal to establish a completely new, sustainable recycling industry.



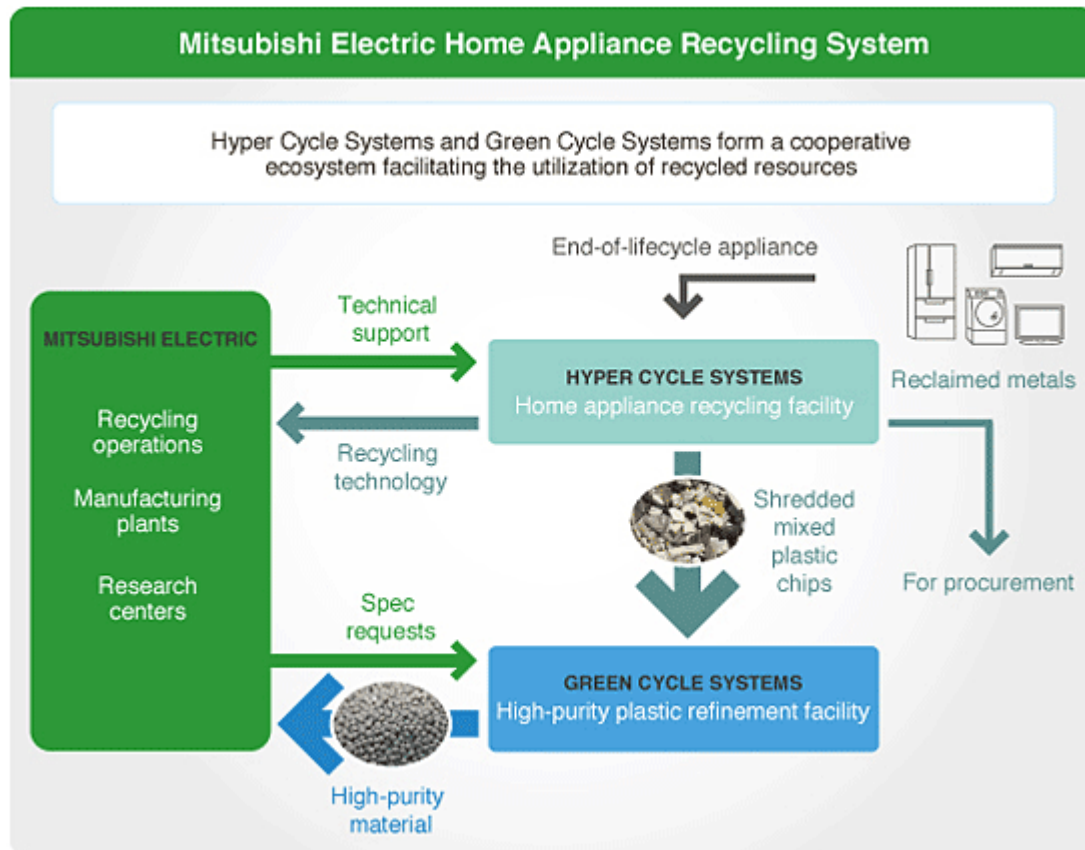


## Sustainability at Work

The collective workforce of Hyper Cycle Systems and Green Cycle Systems forms the living embodiment of Mitsubishi Electric's original guiding principle to create a workplace that everyone would be proud of. Everyone includes the local communities in which the company's recycling centers operate.

An open corporate culture encourages visitors to observe "sustainable recycling" first-hand. They note the clean and comfortable work environment made possible by advanced Mitsubishi Electric building systems technology that keeps air quality safe. They inquire about the high-tech machinery and automated processes that Mitsubishi Electric's factory automation technologies bring to bear.

In addition, they learn that great successes are possible when like minds collaborate to shatter preconceived notions. Most of all, they take pride in knowing that a recycling-based society is one with new opportunities for the next generation of architects of a sustainable tomorrow.



# Environment – Hyper Cycle Systems: Reclaiming Resources from End-of-lifecycle Products

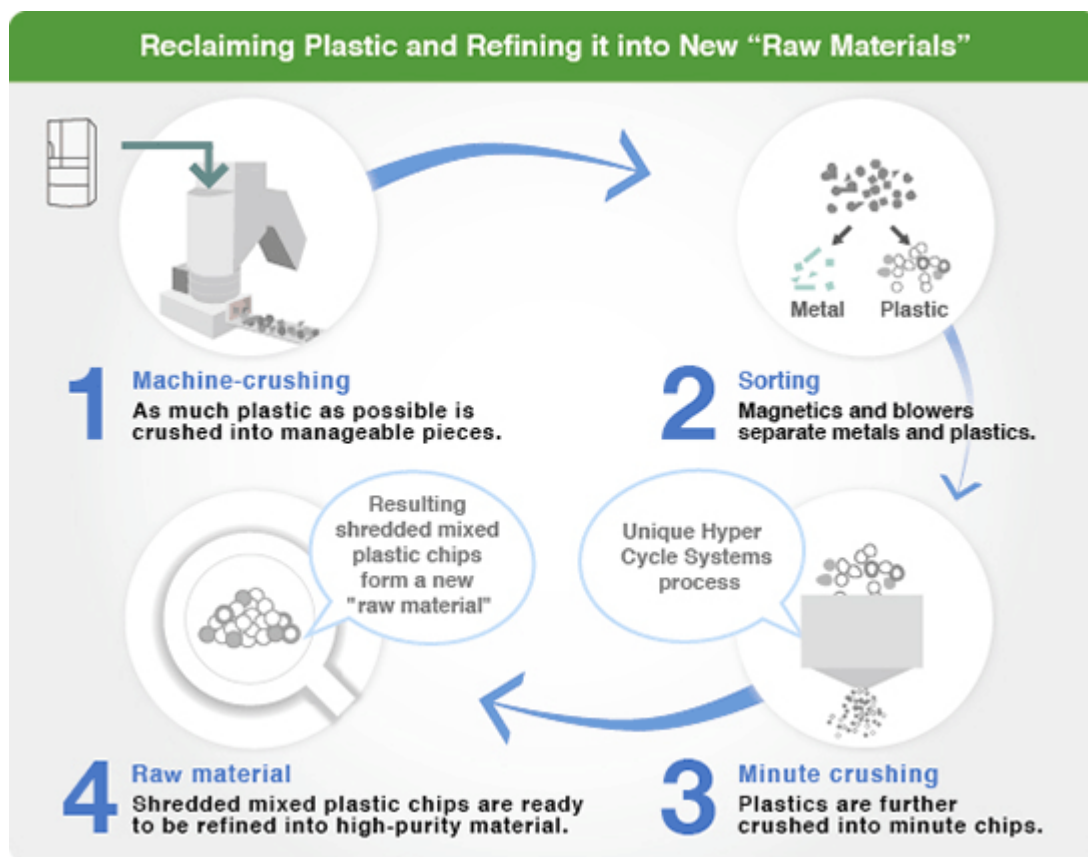
## Genesis of a Sustainable Recycling Industry

Hyper Cycle Systems Corporation, which began operations in April, 1999 to comply with the enactment of Japan's Home Appliance Recycling Law, is the foundry of a new, sustainable recycling industry, crafting the production technologies and systems for producing pure, industrial-grade materials from the metal and plastic materials reclaimed from old electrical appliances.



Hyper Cycle Systems Corporation

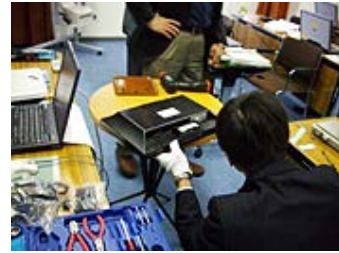
Plastic taken from end-of-lifecycle products by manual labor consists of about 6 % of all recycled plastics Hyper Cycle Systems deals with annually. The remainder includes metal and plastic fragments. Green Cycle Systems uses automated processes to separate the metals from so-called plastic excess.




## Supporting the Next Generation of Eco-Product Designers

Each year, Mitsubishi Electric organizes a program consisting of educational seminars at Hyper Cycle Systems whereby the present and future designers of electrical products can learn first-hand the issues related to designing for a sustainable future.

They spend time at the actual product disassembly and other production lines for hands-on experience, and attend seminars structured to instill in them the concept of "environment-compatible planning." The future of both recycling and better new-product manufacturing is literally in their hands.



▶ Hyper Cycle Systems Corporation website   
(Japanese only)

# Environment – Green Cycle Systems: Refining Old Plastics into Industrial-grade Materials

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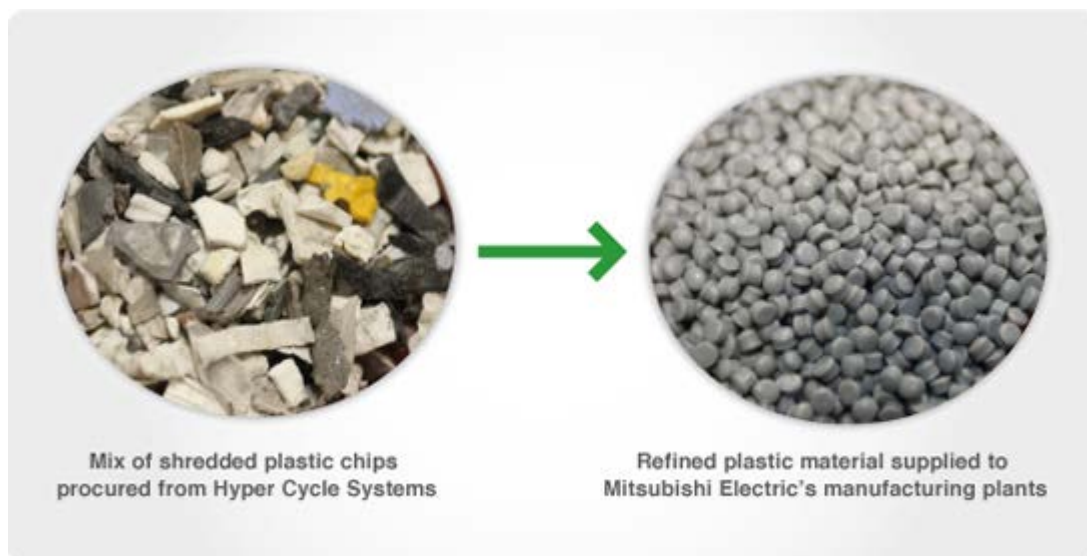
## Japan's First Large-scale, High-purity Plastic Recycling Company

Green Cycle Systems Corporation, which commenced operations in April, 2010, processes shredded mixed plastic chips received from Hyper Cycle Systems Corporation into plastic material pure enough to meet the safety and quality standards of new electrical appliances.



Green Cycle Systems Corporation

The fruit of more than a decade of efforts by Mitsubishi Electric to create a new, sustainable recycling industry from scratch, Green Cycle Systems applies automated processes to optimize recovery of reusable "raw materials" on a scale of 6,400 tons out of 10,000 tons of shredded mixed plastic chips per year. Together with Hyper Cycle Systems, combined output amounts to a 70% recycling ratio of high-purity plastic materials recovered.



## Innovative Plastic Separation Technology

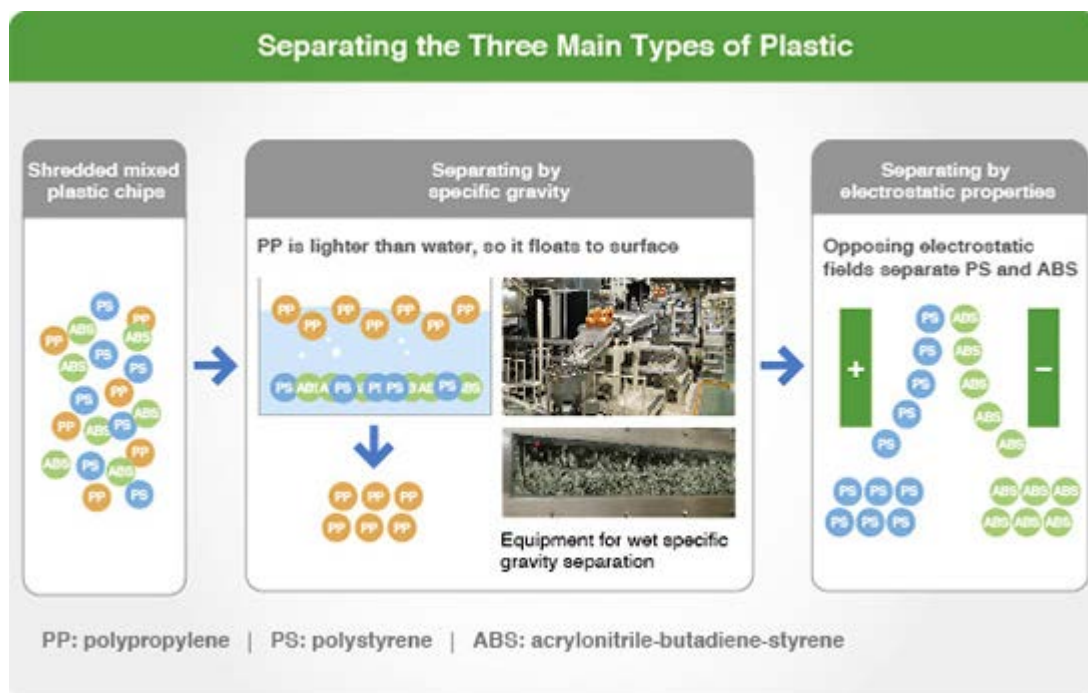
The mix of shredded plastic chips Green Cycle Systems receives from Hyper Cycle Systems primarily consists of the three main types of plastic used in home appliances: polypropylene (PP), polystyrene (PS) and acrylonitrile-butadiene-styrene (ABS). By using automated plastic separation equipment developed by Mitsubishi Electric, these are precisely extracted and processed on a large scale, and at purity levels exceeding 99%.

This high degree of purity is made possible by proprietary technologies for separating different plastics by specific gravity and by electrostatic properties, and by separating plastics containing banned substances using computer-controlled x-ray detection devices mapped to multiple air jets capable of pinpoint accuracy.

Recovering high-purity PP, PS and ABS is an enormous challenge, and from the beginning there were no road maps to follow. Numerous specialists at Hyper Cycle Systems and Mitsubishi Electric's R&D and technology centers, as well as manufacturing operations throughout Japan, were assembled to create the automated machinery and innovative processes required for a new, sustainable recycling industry. Their breakthroughs in technology eliminated each stumbling block one by one.

The first innovation was a wet specific gravity separator for PP, or polypropylene. PP is light compared to PS and ABS, which are roughly equivalent in size and weight. PP is also lighter than water, so it floats. Applying water processing, or wet specific gravity separation equipment, PP rises to the water's surface, where it is easily recovered.

ABS and PS, which are heavier than water, cannot be isolated in this way, so the next innovation was technology that exploits their different electrostatic properties. When PS and ABS are subjected to agitation, the resulting friction generates static electricity. PS responds to a negative charge and ABS a positive charge. Therefore, applying a voltage to positive and negative electrodes is an efficient way to channel the two plastics away from each other.



## Eliminating Banned Substances and Ensuring Material Quality

Two other critical innovations were a computer-controlled system to ferret out plastics containing hazardous substances, and an optimum formula of additives to ensure an end-product up to industrial specifications.

Within the recovered plastics are chips from old appliances containing brominated flame retardants subsequently banned from use in new products by the EU's RoHS Directive. (RoHS prevents the use of six specific hazardous substances: lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls and polybrominated diphenyl ether).

When subjected to X-rays, plastic chips containing bromine appear darker. Therefore, Mitsubishi Electric developed a novel solution whereby the chips are spread on a conveyer, and an X-ray scanning device detects the impure ones as they pass, then instantly instructs individually synchronized air jets to blow them aside. This revolutionary X-ray analysis separation technology was awarded the 2010 Environmental Prize, supported by Japan's Environmental Ministry and other industrial concerns.

Although Mitsubishi Electric succeeded in separating and recovering the three main plastics in their original states, they still suffer from deterioration in material quality due to oxidation over time, preventing their use in new products. Antioxidants help, but suffer from a limited lifespan.

To solve the problem, Mitsubishi Electric quantified the remaining lifespan of collected plastic and devised a recipe with the optimal formulation of antioxidant and metal deactivator additives, and succeeded in "quality prescription" for producing new material with quality equivalent to new plastic.



X-ray analysis separation equipment for eliminating plastic containing bromine

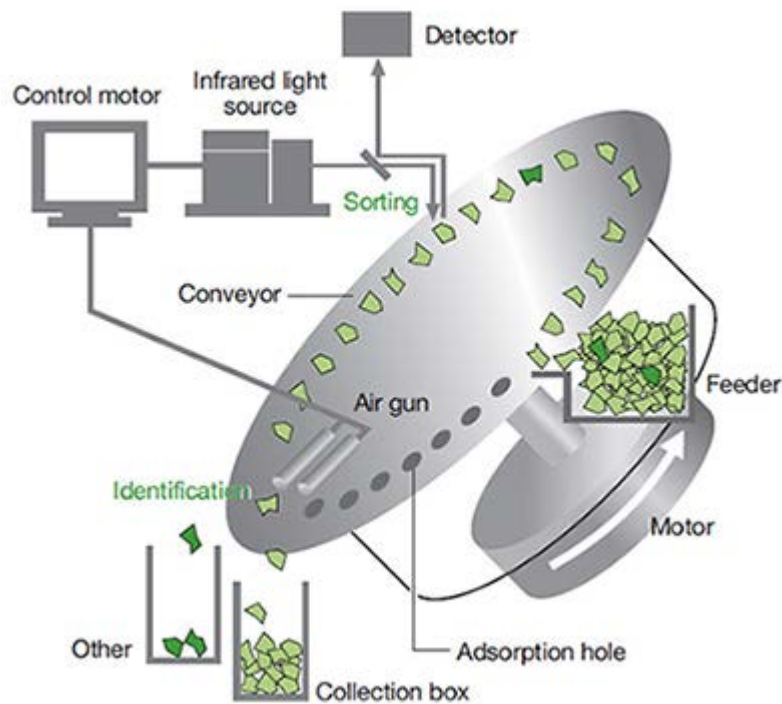


Award-winning technology where X-rays detect plastic chips containing flame retardant, and instantly instruct 124 individual air jets to blow them aside

## New Technology to Increase the Efficiency of Plastic Recycling

The Mitsubishi Electric Group announced details of a newly developed high-purity plastic recycling identification technology in February 2013. With this technology, it is now possible to prescreen plastics and to conduct purity control inspections after removing pieces of plastic that contain restricted-use materials. Plastics contain coloring agents and additives that hinder rigorous screening. Using a high-purity plastic identification device, long-wavelength mid-infrared light is reflected off mixed plastic shards. By analyzing these reflections, various types of plastic can be identified with an accuracy of 99%, irrespective of pigmentation or additives. It only takes the very short time of approximately one second to identify the type of plastic. In utilizing this technology, it is possible to prescreen the ratio of various types of plastic that should be processed at plants, thereby improving recycling efficiency.


### Illustration of High-Precision Plastic Identification System



#### Note

Development of this technology was undertaken by Mitsubishi Electric with a grant supporting businesses that develop and commercialize industrial technologies from the Ministry of Economy, Trade and Industry (Japan) in fiscal 2011 (to be used to verify resource recycling systems and develop advanced plastics identification and recycling technologies).



Green Cycle Systems Corporation website  (Japanese only)

# Environment – Breakthroughs Shaping the Future

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## Building on a Legacy of Best Practices

In 2012, the Mitsubishi Electric Group led the successful launch of Japan's first large-scale, high-purity plastic recycling system. In recycling materials including metals, Mitsubishi Electric Group is pursuing a policy of "greater efficiency and advancement in all aspects," but we think we can do more. One of our key pursuits is rare metals recycling.

However, there are still many more breakthroughs to come, as Mitsubishi Electric presses ahead, leveraging its technological advantages in the discovery of more efficient ways to reclaim valuable rare metals.

The ideas, attitudes and best industrial practices responsible for rapid breakthroughs in plastic recycling also fuel the company's efforts in this area, strengthening Mitsubishi Electric's leadership role in its ongoing quest for a sustainable future.

### 🔍 Tapping into Hidden Deposits of Rare Earth Elements Found in Cities

#### Staying Focused on the Challenges Ahead

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**Mr. Takashi Hishi**  
Executive Corporate Adviser  
(as of 2011)  
Hyper Cycle Systems  
Corporation

From the very start, the idea of creating a completely new industry from the profitable recovery and processing of end-of-lifecycle products has been a powerful motivating force for us at Hyper Cycle Systems. It fueled our determination to first and foremost make our facilities pleasant and inspiring places to work, as well as crucibles of innovation.

If our goal is mass-scale production of industrial-grade materials of the highest quality, only a clean and healthy work environment can ensure optimum productivity levels at any given time. As the health, safety and comfort of our people come first, our first major challenge was to eliminate dust kicked up from the disassembly of old products. This critical step requires intensive manual labor.

We did that by properly partitioning workspaces and installing high-tech dust elimination and air conditioning equipment specially developed by Mitsubishi Electric's building systems engineers. We also encouraged an open-minded environment where good ideas can come from anyone. This has led to a proactive, initiative-taking culture.

I think that our advances in materials separation technology, combined with the chemical processes used by Green Cycle Systems to create greater yields in the quality and quantity of industrial-grade recycled plastic resources, demonstrates that we have established firm fundamentals for a successful recycled materials business.

Materials recovered from old products are valuable resources of benefit to society. We look at a mountain of old electrical appliances and see a "city mine," and view ourselves as the miners entrusted with the painstaking work of extracting the precious ore from it.

But we're really still just in the era of discovery of what might be possible. We hope in five or ten years Hyper Cycle Systems and Mitsubishi Electric will be viewed as the nucleus of a completely new type of recycled materials industry.



## For the Benefit of the Entire Industry

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**Mr. Satoshi Matsuda**  
President  
Green Cycle Systems  
Corporation

Green Cycle Systems produces a commodity that comes from the waste plastic we receive from the product lines of a number of electrical appliance manufacturers. Currently, Green Cycle Systems is looking to strengthen ties with cooperative companies to become a material center of home appliances recycling factories. We are expanding our capability by collecting materials from many recycling factories.

Mitsubishi Electric's attitudes towards recycling have always reflected the company's views on what it feels are in the best interests of the industry at large, so Green Cycle Systems doesn't intend to confine its sales to only Mitsubishi Electric Group factories. We want to extend the company's "closed-loop recycling" concept to all home appliance makers in the industry, with our recycling centers at the heart, of it.

Our larger aim is to expand the scale of recycling in Japan, so we encourage other recyclers to make use of Green Cycle Systems' unique expertise in large-scale, high-purity plastic recycling. Right now the facility has ample capacity to refine much more raw plastic materials than it receives from Hyper Cycle Systems. And once we achieve full operation, which we expect to happen as quickly as possible, then we will develop as a bearer of new industry that can contribute to society with a low-carbon footprint and recycling-oriented base. I truly believe this is essential for the betterment of the industry and for Japanese society at large, in the future.

# Environment – Tapping into Hidden Deposits of Rare Earth Elements Found in Cities

## Recycling Rare Earth Magnets from Air Conditioners

The stable procurement of rare earth metals has become one of the most pressing tasks facing industry today. In 2012, the Mitsubishi Electric Group developed a system that can efficiently recover rare earth magnets used in the compressors of household room air conditioners and began recycling this precious commodity. Below, we will answer the who, what, when, where, why and how of it to discover the importance of rare earth recycling and the future potential it offers.

The Mitsubishi Electric Group collects rare earth magnets that contain neodymium (Nd) and dysprosium (Dy).

Updated Mar 2014

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- ▶ Why Should Rare Earth Elements Be Recycled?
  - There Are Not Enough Rare Earth Elements for Cutting-Edge Industries
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  - Recovering Rare Earth Magnets From End-of-Lifecycle Room Air Conditioners
- ▶ How Are Rare Earth Magnets Being Recycled?
  - Newly Developed Automatic Dismantling Equipment Removes and Recovers Rare Earth Magnets in Just 30 Seconds
- ▶ Where Are Rare Earth Magnets Being Recovered From?
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- ▶ Who Is Involved in the Rare Earth Recycling Business?
  - This Business Involves not Only Mitsubishi Electric Group Companies, but Magnet Manufacturers as well
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  - Over the Next Couple of Decades, as Part of Initiatives Aimed at Achieving Japan's National Target of Being 50% Self-Sufficient in terms of Rare Earth Elements by the Year 2030

# Environment – Why Should Rare Earth Elements Be Recycled?

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## There Are Not Enough Rare Earth Elements for Cutting-Edge Industries

The term "rare earth" refers to a set of 17 chemical elements in the periodic table considered particularly rare compared to other metals found on earth. Today, most of these elements have become essential raw materials for cutting-edge products and applications such as electric vehicles, high-performance home appliances, computers and smart phones. As such, demand for rare earth elements is expected to increase considerably going forward.

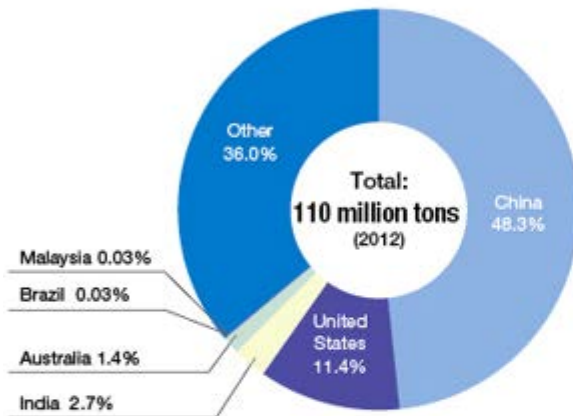
However, a majority of the earth's rare earth resources are not produced in Japan, meaning companies there have to rely entirely on imports. On top of this, supply has been exposed to constant instability. Amidst this, the world's largest rare earth producer, China, launched export restrictions on these materials, causing prices to soar around the world.

As a result, today Japanese industry is faced with the important tasks of finding another supply source for rare earth elements other than China, developing alternative materials, and recycling, which involves recovering and reusing rare earth elements found in end-of-lifecycle products.



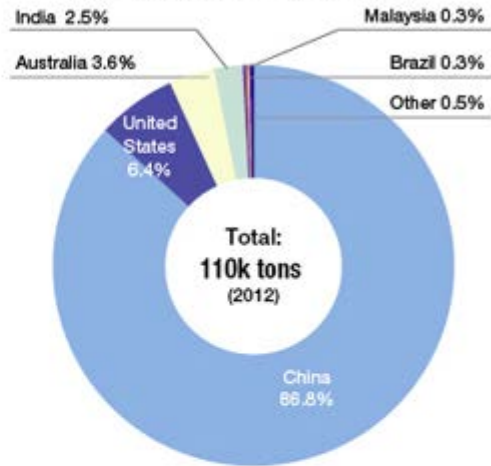
## Key Data on Rare Earth Elements and Challenges Facing Japan

### Rare Earth Reserves



Source : Mineral Commodity Summaries 2013

### Rare Earth Production Volume



Source : Mineral Commodity Summaries 2013

China has the most reserves and produces the most rare earth elements.  
Rare earth elements are not produced in Japan



### Challenges Facing Japan

Secure overseas resources

Develop alternative materials

Recycle

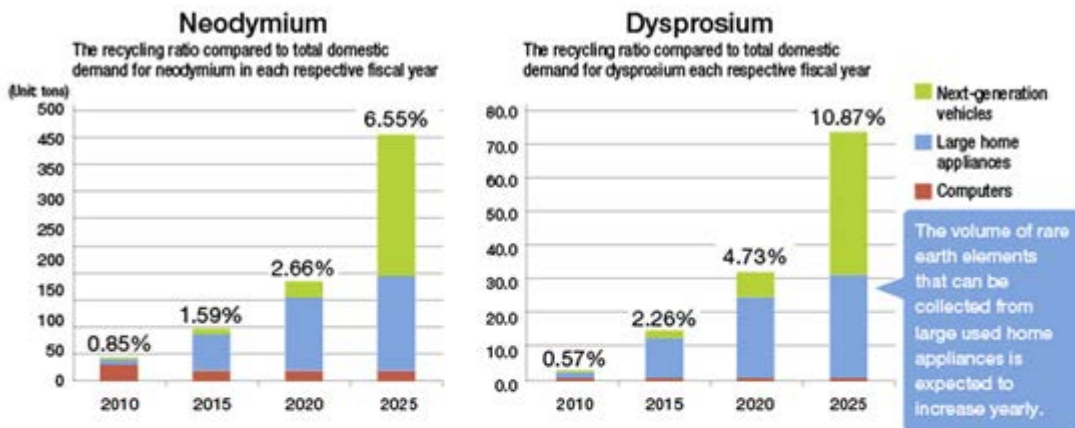
# Environment – What is the Mitsubishi Electric Group Doing to Recycle Rare Earth Elements?

## Recovering Rare Earth Magnets From End-of-Lifecycle Room Air Conditioners

The Mitsubishi Electric Group initiated the full-scale launch of its rare earth recycling business in April 2012. Mitsubishi Electric has been engaged in recycling business activities at its Group company, Hyper Cycle Systems Corporation (HCS), focusing mainly on the four home appliances of televisions, refrigerators, washing machines and air conditioners. In particular, since 2010 the Group company Green Cycle Systems Corporation (GCS) has been collecting compressors that are removed from air conditioners. GCS has installed automatic dismantling equipment on its existing compressor disassembly and recovery line and is engaged in the recovery of rare earth magnets. Among end-of-lifecycle home appliances, air conditioners have the most potential with regard to the recovery of rare earth elements, due to the volume of rare earth elements used and the amount remaining after the end of the product's life.

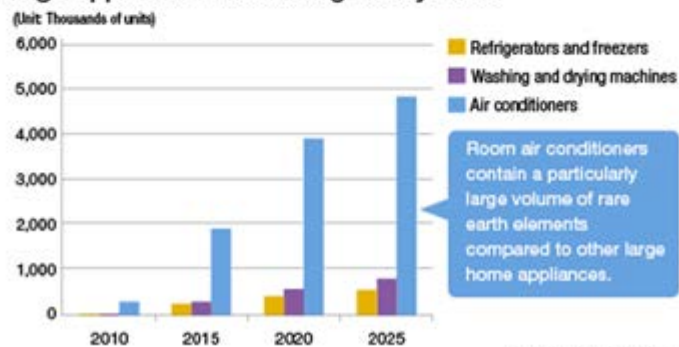
### Potential Volume of Rare Earth Elements Obtainable through Recycling\*

\* The volume of rare earth elements recoverable in a one-year period if all of the rare earth elements found in applicable products could be extracted after all products were disposed



### Expected Disposal of Products Containing Rare Earth Elements

#### Large appliances containing neodymium



Source : Ministry of Economy, Trade and Industry

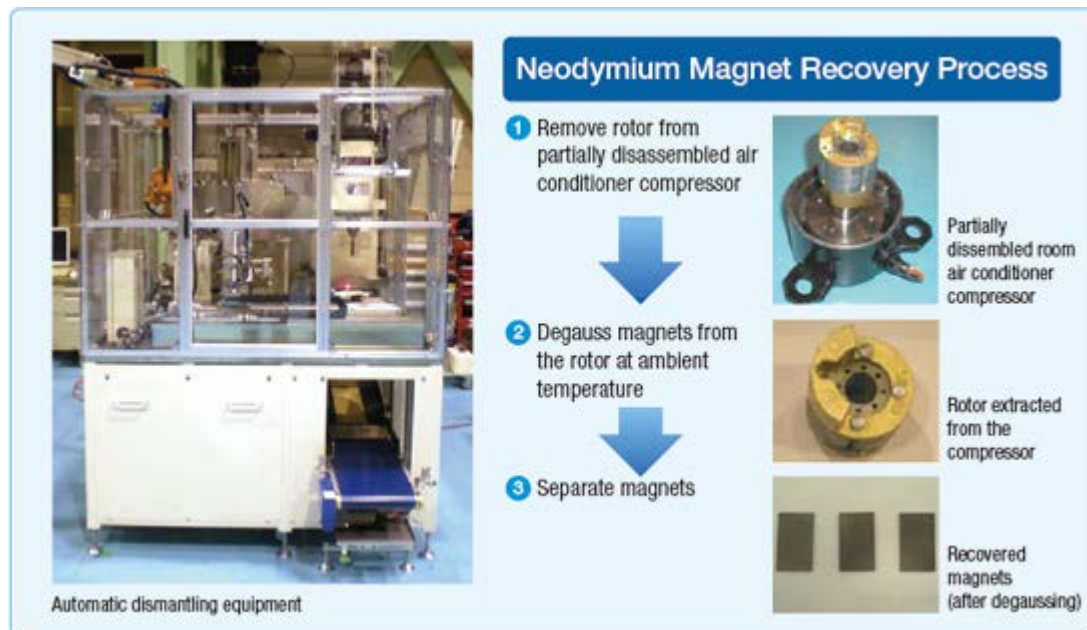
# Environment – How Are Rare Earth Magnets Being Recycled?

## Newly Developed Automatic Dismantling Equipment Removes and Recovers Rare Earth Magnets in Just 30 Seconds

Room air conditioners have great potential as an untapped deposit of rare earth elements, but the difficulty of removing the rare earth elements from these units for recycling has stood as a major barrier. This is because rare earth magnets used in air conditioners are found inside components used in compressor rotors attached to the surrounding component with a rather powerful magnetic force. On top of this, rotors are made in a variety of shapes and sizes, making it near impossible to establish a standard method for disassembling the rotor to remove the rare earth magnets inside.

Mitsubishi Electric has resolved this issue with proprietary technologies that have enabled the development of automatic dismantling equipment that uses a resonance damping demagnetization method. This equipment can automatically dismantle, sort and remove the rare earth magnets used in compressors at a pace of one air conditioning unit every 30 seconds. We have also created a database on the shapes and sizes of rotors to establish settings for this equipment to easily modify its operations for each rotor type. This has enabled us to recover rare earth magnets where it was once not possible.

\* The development of this equipment was made possible with assistance from the Ministry of Economy, Trade and Industry's program to support businesses that introduce industrial facilities that use rare earth metals.

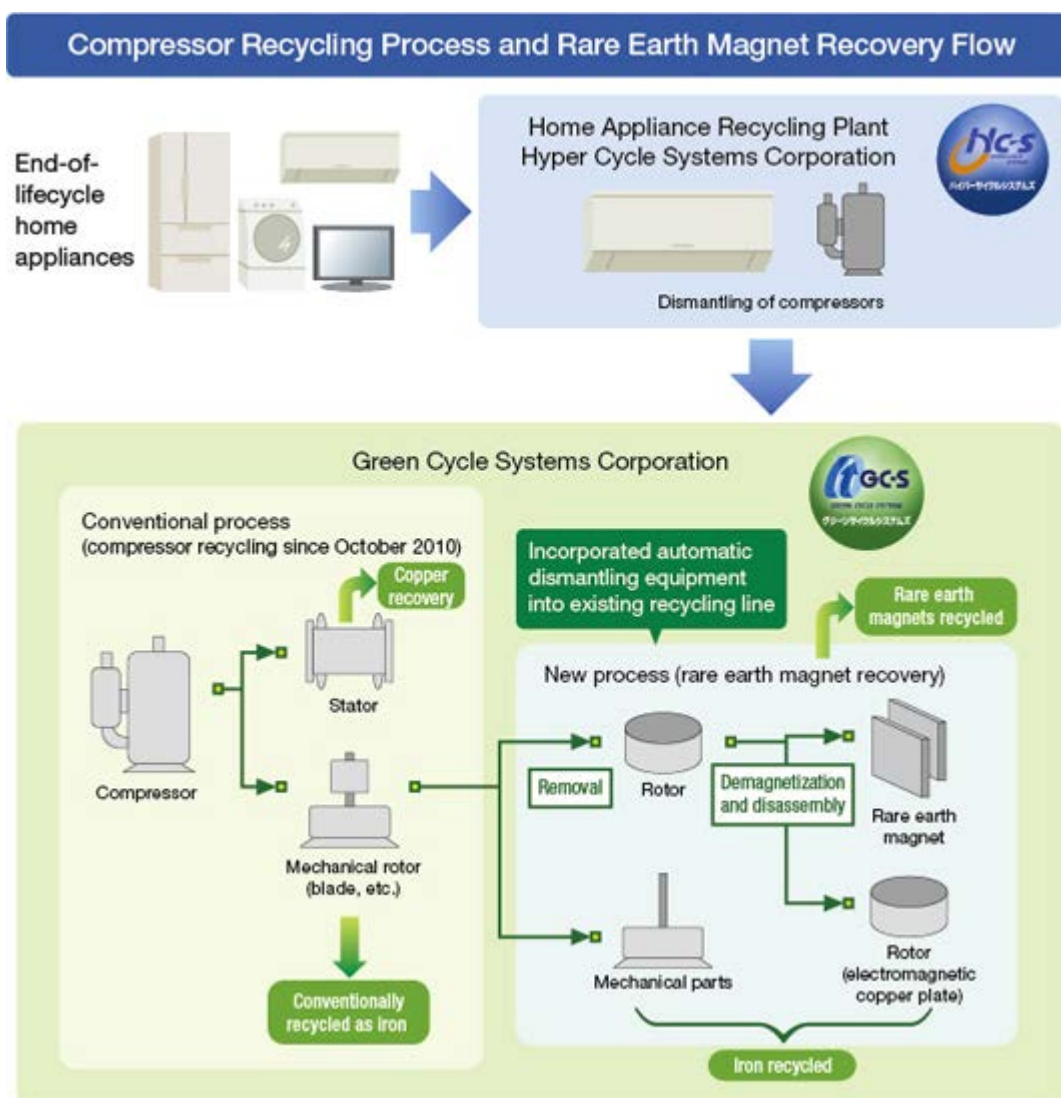


# Environment – Where Are Rare Earth Magnets Being Recovered From?

## An Efficient Recovery System has been Built into an Existing Recycling Line

Mitsubishi Electric's subsidiary Green Cycle Systems Corporation (GCS) has been charged with the rare earth magnet recovery process. GCS has been operating Japan's first large-scale, high-purity plastic recycling system business since April 2010. GCS installed the newly developed automatic dismantling equipment on its existing compressor disassembly and recovery line in order to build a seamless recovery system for rare earth magnets.

End-of-lifecycle room air conditioners collected from the market first arrive at the home appliance recycling plant of Mitsubishi Electric subsidiary Hyper Cycle Systems Corporation (HCS) where they are dismantled. HCS sends the removed compressors to GCS, which then recovers the rare earth magnets inside on its dedicated recycling line. These compressors are not only made by Mitsubishi Electric, but a host of other major manufacturers, meaning there are many different shapes and sizes to handle. As a result, we have created a database of compressor types to establish the most optimal method of dismantling and recovering the rare earth magnets from each individual type.

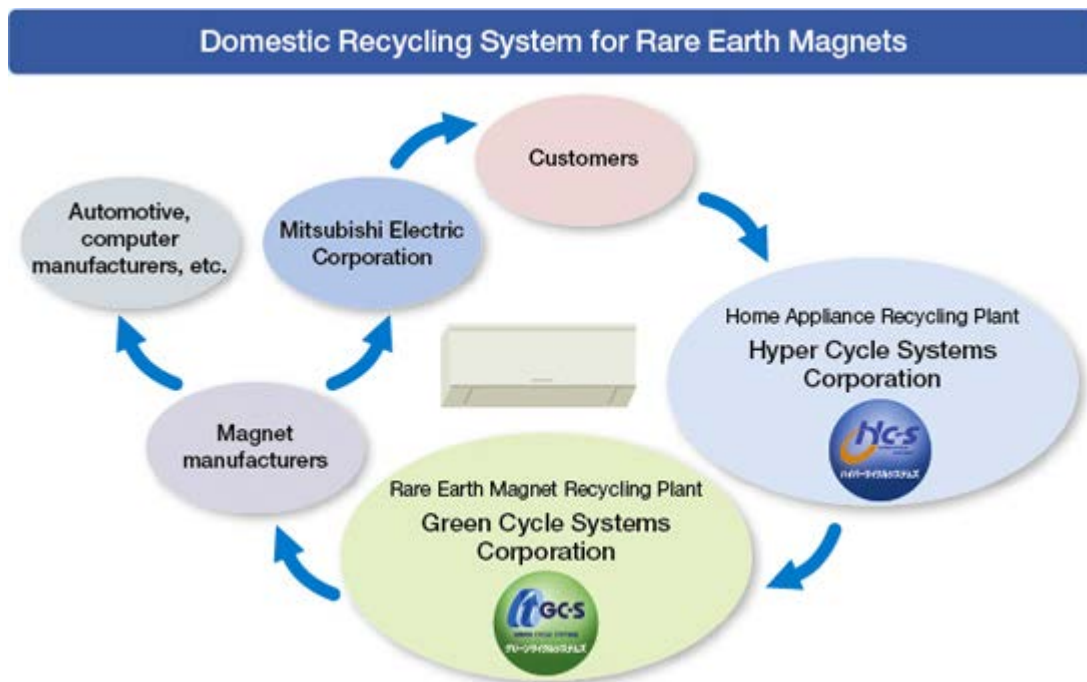


## Environment – Who Is Involved in the Rare Earth Recycling Business?

### This Business Involves not Only Mitsubishi Electric Group Companies, but Magnet Manufacturers as well

Rare earth recycling requires not only efficient recovery processes, but also a framework for fully utilizing these recycled materials in society. As such, the Mitsubishi Electric Group is working with magnet manufacturers with technologies for reusing rare earth magnets to establish a recycling system that expands beyond the confines of the group.

Presently, Green Cycle Systems Corporation (GCS) supplies all of the rare earth magnets (neodymium and dysprosium) it recovers to magnet manufacturers located in Japan. There, rare earth elements are reused to make powerful magnets that are used in a wide range of components found in cutting-edge products, such as home appliances, electric vehicles and computers.





## Environment – When Will Rare Earth Recycling Start to Become Widespread?

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### Over the Next Couple of Decades, as Part of Initiatives Aimed at Achieving Japan's National Target of Being 50% Self-Sufficient in terms of Rare Earth Elements by the Year 2030

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Today, Japan's rare metal and rare earth self-sufficiency rate stands at near zero percent. As a result, the Government of Japan has established a national target to raise this rate to 50% by the year 2030. The Mitsubishi Electric Group plans on strengthening and expanding its initiatives in order to help Japan achieve this target.

Green Cycle Systems Corporation (GCS) has already begun receiving end-of-lifecycle products that contain rare earth magnets not only from Hyper Cycle Systems Corporation, but also from other recycling plants outside the Mitsubishi Electric Group since 2012.

Recovered rare earth magnets are also reused in Mitsubishi Electric products by way of magnet manufacturers. As with large-scale, high-purity plastic recycling, we plan on taking the lead in establishing a resource recycling system. Furthermore, we will work to develop new technologies for creating recovery equipment that can remove rare earth resources from the hard disk drives of end-of-lifecycle laptop computers and other products.

As an important member of Japan's manufacturing industry, the Mitsubishi Electric Group stands fully committed to expanding its rare metal and rare earth recycling initiatives going forward.

# Environment – Kyoto Works Becomes Home to a Family of Ducks

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June 2012. Kyoto Works, one of our factories which manufactures liquid-crystal televisions, discovered a duck building a nest on the factory site. At the beginning of July, seven cute little chicks were hatched. The mother duck and chicks moved to a nearby paddy field with our staff watching over them. Still now, the ducks can be seen swimming peacefully.

Published Apr 2013

## Photo Diary of the Mother Duck at Kyoto Works

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### June 1

What a guard patrolling the site found was not a stranger but a mother duck. She was in the bushes sitting on her eggs.



### June 25

The mother duck sitting on her eggs. Our employees watched over her day and night, checking her condition and on the lookout for predators.



### July 3

Finally, seven young chicks were hatched. They peeped and wobbled. A fence was set up around the nest to prevent the chicks from going out onto the road.



### July 4

The mother and chicks moved to the waterfront. One chick fell into the ditch! An employee watching over them immediately rescued it and all the ducks arrived safely at the paddy field.



Employees were happy and relieved to see them swimming vigorously. All employees are looking forward to seeing the grown-up chicks return to build their own nests.



#### Photo Diary of Mother Duck at Kyoto Works

▶ Watch video 

[3 minutes]

## Message from Kyoto Works

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### **I feel like I am a father to the ducks! I hope to watch over them growing up.**

After receiving the surprising news about the duck, we spent a month hoping she would be okay and able to hatch her chicks safely. In fact, we took turns watching over the whole process from the egg-laying and hatching to fledgling periods. All our hard work was rewarded when we watched the chicks wobbling along after their mother. According to an expert, ducks sometimes make nests in environments close to humans to avoid predators such as cats and crows. An area of natural habitat and a place close to the water are also vital for them. We will make efforts to maintain a duck-friendly environment at Kyoto Works.

Akihiko Nakamura  
Manager, General Affairs Section  
Kyoto Works  
Mitsubishi Electric

# Environment – Water for Life, Water for Industry

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## A Fresh Approach to Water as a Renewable Resource

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Access to clean and reliable sources of water is increasingly a major global issue, and Mitsubishi Electric has much to offer the world in the way of new and fresh approaches to the usage and recycling of water in industrial applications. An abundant and stable supply of clean water is a basic need of society, and Mitsubishi Electric is at the forefront of cutting-edge, sustainable technologies developed specifically to ensure that this precious natural resource is not wasted.

Mitsubishi Electric is one of Japan's leaders in the development and implementation of systems for wastewater treatment in manufacturing, water purification for public consumption, and more effective industrial cleaning processes such as microbubble technology that removes oil and other deposits without detergents or hazardous chemicals, and ozone generation technology that purifies water without chlorine. Membrane separation technology is also being put to use in high-grade industrial applications in Mitsubishi Electric's own manufacturing operations.

The goal is 100% recycling of water to eliminate unnecessary wastewater, encourage water conservation and promote cost-savings. Such initiatives are a part of Mitsubishi Electric's efforts to strengthen its corporate constitution and contribute to society as a leading green company.

Updated Mar 2014

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- Water As Precious, Reliable and Delicious
- Microbubbles Revolutionize Industrial Processes
- Ozone Generation Improves Water Treatment
- Membrane Separation Advances Water Recycling

## Environment – Water As Precious, Reliable and Delicious

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Mitsubishi Electric's basic approach to water is to develop and implement technologies that ensure existing water resources are optimized using non-toxic purification and recycling processes. The company itself seeks to recycle and reuse water as opposed to draining it away, furnish manufacturing plants with efficient — and more effective — water-based industrial cleaning processes, and purify water so cleanly that it is consistently delicious to the taste.

Major water processing companies in Japan have relied on Mitsubishi Electric's ozone generation equipment for sewage treatment and better tasting tap water since the 1960s. This technology, which treats water with ozone instead of chlorine, is also now available outside Japan.

Newly developed microbubble technology in use at Mitsubishi Electric factories in Japan has reduced water consumption significantly, while preventing toxic substances from being discharged in wastewater drainage. Mitsubishi Electric's implementation of membrane separation technology is another practical water recycling solution with the added benefits of space savings and reduced CO<sub>2</sub> emissions through its use.

### Ensuring Sustainable Water Resources

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**Yasuhiro Tanimura**  
Senior Manager of Environmental  
Technology & Systems  
Department  
Advanced Technology R&D  
Center

#### Water Reclamation and Non-contamination of Water Resources

In terms of the technologies Mitsubishi Electric develops to furnish society with reliable, safe and secure water resources, the company is committed to parallel courses of action. One places a premium on reclamation of water using proven non-toxic technologies Mitsubishi Electric has developed over the decades, such as ozone generation. The second seeks to introduce new water-based cleaning technologies for industry, such as microbubble technology, which has important implications for environmental preservation.

#### Legacy of Water Purification Technology Development

Mitsubishi Electric has a long tradition of developing purification equipment and technologies to optimize water resources and reduce wastewater in its own industrial processes. The company was working on the development of technology for water treatment using ozone prior to other companies, and started selling its ozone generators as far back as 1968. Research and development into the improvement of ozone generation efficiency was implemented at water treatment plants.

The livelihood of society depends on a reliable supply of fresh water for individual and industrial consumption. Mitsubishi Electric plays an important role in helping municipal governments tackle water and sewage treatment issues. The company's standard for success has always been the guarantee of safe and delicious, fresh drinking water. The results speak for themselves. Now Mitsubishi Electric furnishes ozone generator equipment to around 40% of water and sewage treatment facilities in Japan.

#### Reducing Water Contamination

Mitsubishi Electric's approach to industrial wastewater treatment seeks to avoid the usage of detergents. One solution is Mitsubishi Electric's microbubble technology, which can clean machine parts as well as pipework without detergent. Extremely minute bubbles scour surfaces clean, and the system is extremely efficient in its usage of water resources. Several of Mitsubishi Electric's manufacturing facilities have already adopted microbubble cleaning technology.

In Japan, Mitsubishi Electric has also introduced an electric residential heat-pump boiler system in the Japanese market, which uses microbubbles to keep its water-circulation pipes clean. This type of application can contribute to a vast reduction in the environmental impact of wastewater generated by domestic households.

## Innovating New Water Technologies



**Shinji Nakashima, Dr. Eng**  
Structural Technology  
Department  
Manufacturing Engineering  
Center

### Putting State-of-the-art Technology to Practical Use

Mitsubishi Electric factories all over Japan come to the Manufacturing Engineering Center seeking ways to improve productivity and reduce the environmental burden resulting from manufacturing operations. We provide technical support. This requires the development of innovative technologies that are then put to practical use in the plant. For example, considerable success was achieved in securing higher levels of water efficiency by utilizing microbubble cleaning technology in place of conventional alkali solvents on the metal coating line at Fukuyama Works. In addition, at Gunma Works and Shizuoka Works, a shower-style method of cleaning has been introduced that employs a stream of microbubbles to wash large parts that are difficult to soak in a water cistern.

### Innovative Just-in-time Cleaning

Microbubble technology continues to be a focus. We have been working on implementing it on the production line for industrial cleaning applications. Formerly parts and products were gathered in one place and then cleaned in batches in a large "bath." This was an inefficient process simply because of the waiting period involved. The new process is much more efficient, and doesn't require line stoppage. In the new process, a robot arm picks up each item on the production line, immerses it in a microbubble tank, and then places it on a drying line. In this way, each item is cleaned at the moment it needs it — just-in-time cleaning. This system is garnering much attention from our factories throughout Japan.

### Reexamining Existing Technologies

Microbubble technology is an example of taking an existing technology and working on ways to make it practical on the production line. Exploring new ideas and fusing new technologies and processes with it have improved microbubble performance and brought about profound benefits. It's important that we safeguard this and other technology that supports the industry by improving productivity and contributes to society through reduced environmental burden. The knowledge of the skilled veterans who make highly effective water treatment and other improved methods possible must be safeguarded, as well, as they approach retirement.

# Environment – Microbubbles Revolutionize Industrial Processes

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## High-density Microbubble Cleaning Process

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Mitsubishi Electric's award-winning microbubble cleaning process and system applies high-density, microscopic bubbles 1/100th the size of normal bubbles, which permeate water and then slowly rise to its surface, and which have adsorption properties that make impurities in the water cling to them, to provide better results at significantly less cost. Microbubbles reach grease even on various-sized and complex-shaped instruments, and scour them uniformly.

The high density of microbubbles, which are 0.1 millimeter in diameter, are especially well suited to ferreting out oily grime in the water. This is because of their highly adsorptive properties. Microscopic oil and other impurities in the water naturally attach to microbubbles, float to the water's surface, and then are drained into an overflow bath. This is an efficient way to extract impurities from water, and where applied has reduced Mitsubishi Electric's running costs significantly.

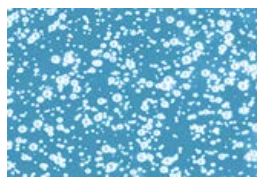
## Maintaining Microbubble Density

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Mitsubishi Electric's research into the oil-adsorption properties of microbubbles began in response to the need for technologies that could remove oil and other impurities without chemical detergents, using only water. It was thought that a breakthrough involving the use of microbubbles would help provide a dramatic reduction in the environmental burden caused by industrial wastewater drainage.

The key challenge behind making the technology practically useful was figuring out how to sustain the density of the microscopic bubbles. Microbubble consistency creates the adsorption effect that lifts impurities to the water's surface. Bubbles naturally combine with each other to form larger bubbles, which decreases cleaning effectiveness over time.

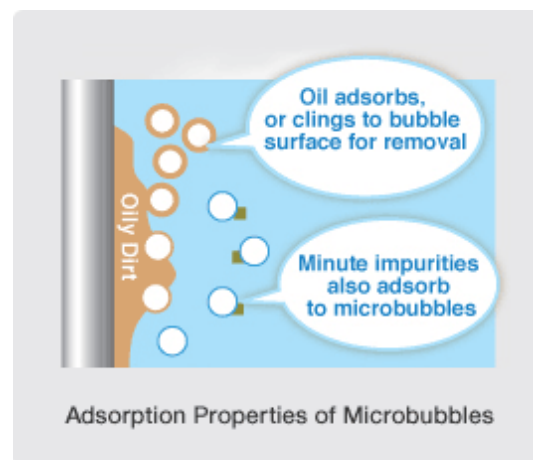
Mitsubishi Electric's breakthrough came through discovery of a safe substance\* that, when only a miniscule amount is added to the water, ensures proper microbubble density for optimum performance.



Microbubbles  
(0.1 millimeter in diameter, less than 100 microns)



Normal bubble  
(about 10 millimeters in diameter)



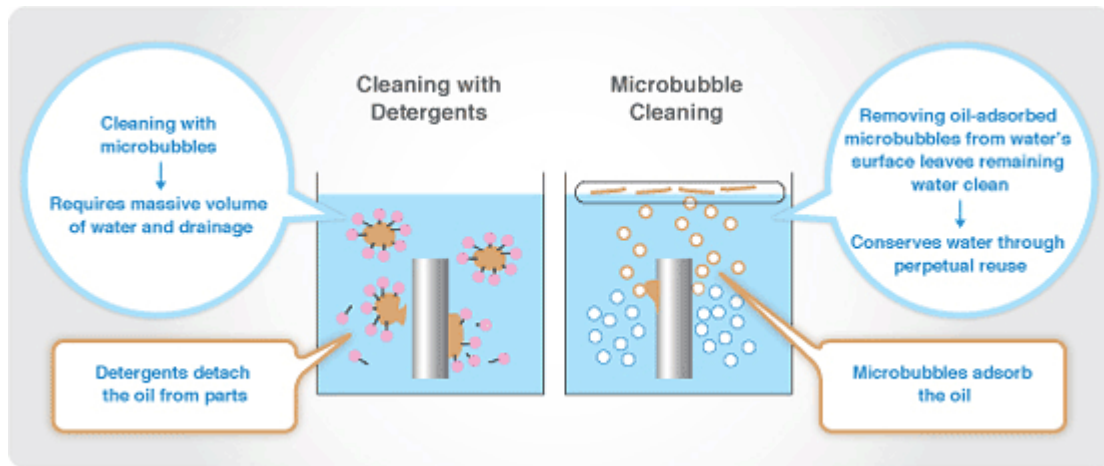
\* The substance is not applied to some products.



## Microbubbles for Industrial Processes

Mitsubishi Electric has been applying the microbubble cleaning system to its own operations since 2006, for product production processes as well as the cleaning of greasy machine parts. Substantial positive effects are being observed at the company's factories, as well as at affiliated companies.

The biggest benefit has been a reduction in the environmental burden caused by wastewater. The microbubble process is so effective at bringing oil and other impurities to the water's surface that the water can be used for cleaning many times, thus slashing water consumption considerably. In contrast, use of chemical agents require the input of enormous volumes of fresh water to be effective, plus processing for compliance with environmental regulations before it can be discharged as wastewater.



### Microbubbles in Manufacturing: Zero Wastewater Solution

Mitsubishi Electric's Green Cycle Systems, Japan's first large-scale, high-purity plastic recycling operation, relies on water as an integral catalyst for its plastic separation process. In order for plastic extracted from end-of-lifecycle home appliances to be reused in new products, various types of plastic must first be separated from each other and refined individually for reuse as new raw materials.

Water is used to separate polypropylene (PP) from the other two main types of plastics used in home appliances, polystyrene (PS) and acrylonitrile-butadiene-styrene (ABS). PP is lighter than PS and ABS, and being buoyant it floats to the water's surface where it can be recovered. After the separation procedure, microbubbles adsorb any leftover dirt or plastic particles and lift them to the surface too, where they are removed. The resulting water is pure enough for reuse.

Allowing for evaporation, about 99% of water for sorting plastics at Green Cycle Systems is recycled on a continuous basis, thus slashing water consumption as well as volume of wastewater drainage.



Green Cycle Systems Corporation. Japan's first large-scale, high-purity plastic recycling operation, turns plastic from end-of-lifecycle electrical appliances into new plastic material that can be reused in new home appliances.



Water process for separating a mixture of shredded plastic pieces. Some types sink and others float to the water's surface. This water is recycled perpetually in the process.



**Kazuyoshi Yabuuchi**  
Engineer and Staff  
Manufacturing Engineering  
Center

### Advantages of Water Recycling

My work at Mitsubishi Electric's production technology center involves the development of parts and equipment for production trials and testing, including the water recycling system, wet specific gravity separation equipment at Green Cycle Systems. Trial and effort has been a way of life for everyone involved in the development of water recycling technology that can be applied on a practical level. The proprietary system we developed for water recycling is unique in many ways, and it is truly a pleasure to see it applied after overcoming so many challenges.

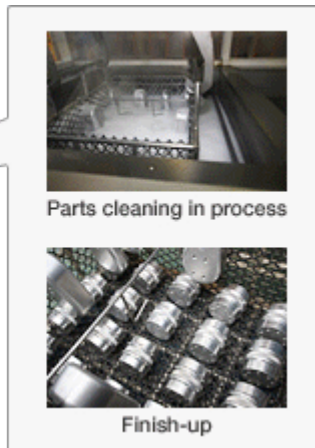
➤ **Environmental Topics: Plastic Recycling Comes of Age**

### Microbubbles in Manufacturing: Parts Cleaning without Chemicals

The Mitsubishi Electric Transmission and Distribution Systems Center employs microbubble cleaning technology as an integral part of its metal plating operation. It's a rigorous process, which starts with the washing of oil from parts, then masking, metal plating and removal of the masking, then finishing up with a thorough quality assurance check. Previously a degreaser was used to clean off the oil, requiring the consumption of an enormous volume of water. Microbubbles require less than one-tenth that amount, and generate only a fraction of the wastewater, thus lowering running costs and decreasing environmental burden.



Microbubble cleaning equipment



- ▶ Membrane Separation Advances Water Recycling



**Hiroshi Kuroki**  
Advanced Water Treatment  
Technology Group,  
Environmental Technology  
& Systems Department  
Advanced Technology R&D  
Center

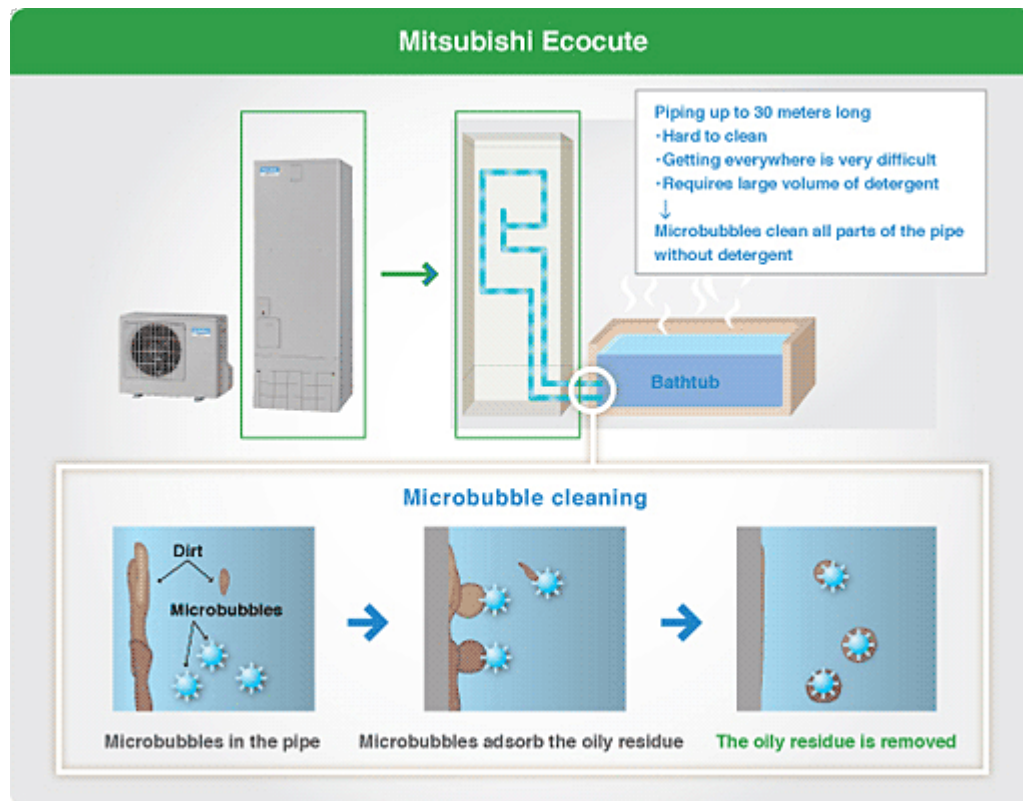
### Advantages of Microbubble Cleaning Equipment

Great skill is required when determining the best application of microbubble technology. When it comes to the cleaning of parts, because there are so many different shapes involved, and some with complicated make-up and areas difficult to access, detailed adjustments are required. Traditionally a great volume of water has been required for the cleaning process, but at Transmission and Distribution Systems Center microbubble technology has drastically reduced that, while also dramatically reducing the time required for cleaning to as little as 1/4 to 1/5 that of previous processes.

### Microbubbles at Home: Automatic Pipe Self-cleaning

Mitsubishi Electric's popular brand of natural refrigerant (CO<sub>2</sub>) heat-pump type hot water supply system in Japan, the "Mitsubishi Ecocute," relies on microbubble technology for self-cleaning of sebaceous material that builds up naturally in its piping. Japanese bathing culture requires that one first wash and rinse outside of the bathtub to clean the body, then submerge in the tub of clean hot water to soak, relax and physically rejuvenate. Since the water doesn't become fouled with soap and grime, the same water is often used by several family members consecutively. But in this process the water tends to collect sebaceous material.

The Ecocute system keeps the water at optimum bathing temperature by circulating it through a heat-pump type water heater via piping as long as 30 meters. As such, sebaceous material in the water is prone to sticking to the inside of the pipes, especially at intricate crooks and bends. Microbubbles can adsorb this oily material. By equipping Ecocute with a microbubble self-cleaning mechanism that is triggered when the bathtub plug is pulled, the pipes are automatically cleaned and the resulting effluence is drained away.



## Microbubbles on the Line

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**Satoshi Ueyama**  
Manufacturing Engineering  
Development Group,  
Production Control  
Department  
Shizuoka Works

As an engineer working on the development of microbubble technology for many years, I was happy to see it in actual use when I was transferred to air conditioner manufacturing at Shizuoka Works two years ago. I feel blessed to have seen the successful adoption of the system on the factory line. I was deeply moved by the speed at which all stakeholders on the line embraced the technology. This reinforces my commitment to seeing the technology leveraged for use in broader applications, and in all parts of the world. I believe that the people and products using microbubble processes, as well as the end-users of the products themselves, are all inextricably linked in the way that society benefits from microbubble technology.

# Environment – Ozone Generation Improves Water Treatment

## Purifying Water Efficiently, without Chlorine

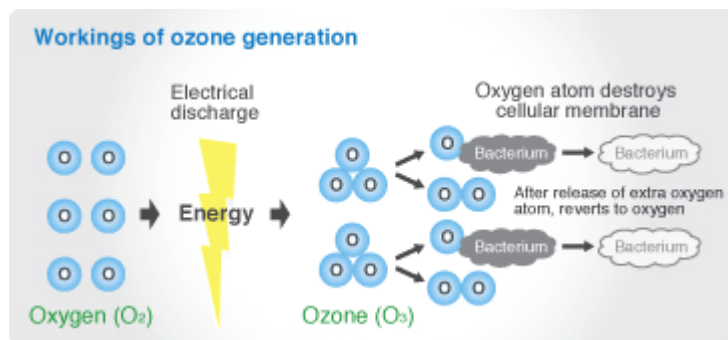
Mitsubishi Electric's positive contributions to the quality of Japan's drinking water, cleaner domestic wastewater, and commercial usage of recycled water resources are significant and longstanding. A key reason is the company's early research, in the 1960s, into the water disinfection, de-coloration, deodorization and purification properties of ozone gas.

Mitsubishi Electric creates ozone ( $O_3$ ) using electrical discharge to add an extra oxygen molecule to  $O_2$ . When air (oxygen, or  $O_2$ ) is passed through a discharge space, a portion of the oxygen is converted into ozone, which disinfects water more effectively than chlorine. What's more, Mitsubishi Electric's unique high-density ozone generation method, with its narrower discharge gap, produces high concentrations of ozone with minimal electricity, making the ozone generator highly energy-efficient, and also more compact.

## Mitsubishi Electric Ozone Generator

In 1968 Mitsubishi Electric introduced its ozone generator product in the Japanese market, and it is now in use by municipalities nationwide, with proven results in improved tap water quality. A compact version for small communities has also been introduced in the United States.

Ozone's anti-bacterial and oxidation qualities are more effective than chlorine, and it can also be applied to deodorization and bleaching of water through degradation of substances that cause odor and coloration. And unlike disinfection and oxidation using chemicals such as chlorine, ozone itself breaks down after treatment and reverts to oxygen, which also serves to prevent environmental pollution.



## Global Applications of the Ozone Generator

Mitsubishi Electric has to date provided more than 1700 ozone generator systems to waterworks concerns in Japan, comprising a 40% share of the ozone generator market. The company's ozone generator product received the coveted 21st Century Invention Prize, awarded by the Japan Institute of Invention and Innovation.

Long proven in practical application at waterworks facilities as well as commercial aquariums and manufacturing concerns in Japan, the ozone generator's disinfecting and deodorizing properties have also been applied to agricultural drainage and wastewater processing facilities.

In all, Mitsubishi Electric's ozone technology is ideal for purifying and sterilizing water, sewage and pool water; sterilizing food products and containers; treating industrial wastewater, oxidation and cleaning in semiconductor manufacturing; and deodorizing and preventing infectious diseases in hospitals. Moreover, the ozone generator contributes to energy as well as space savings.

These and other qualities position Mitsubishi Electric's ozone generator as a critical technology for the world by supplying a reliable and safe method for water treatment and purification for the benefit of local communities worldwide.

### Ozone Generator in Action: Tastier Tap Water in Osaka

Osaka is a teeming metropolis in Japan, with more than 2.6 million residents and numerous industrial concerns. Its primary source of water is the Yodagawa River, fed by Lake Biwa, which in the 1970s suffered from a breakout in moldy odors caused by eutrophication, or an overabundance of minerals and nutrients that starve the water of oxygen.

Osaka's Murano Water Purification Plant, one of the largest in Japan, set up a sophisticated water purification system at that time to deal with the problem. The Murano system included biological, ozone and granular activated carbon treatment processes in addition to standard chlorinated water treatment methods, housed in a ground-level treatment plant, plus two multi-story facilities.

By the 1990s, although water quality had much improved, Osaka tap water was characterized by a strong smell of chlorine. Mitsubishi Electric's ozone water treatment equipment was installed at one of two multi-story facilities in 1994, and then in 1998 one of Japan's largest ozone treatment facilities, also provided by Mitsubishi Electric, was installed at the ground-level treatment plant. This had the effect of dramatically improving overall water quality. In fact, Osaka water today is known for being refreshing to drink straight out of the tap.



Murano Water Purification Plant



Ozone generation equipment

## Ozone Generator in Action: Recycled Water at Olympic Park in Beijing

In 2006, while planning for the 2008 Olympic Games, the City of Beijing was considering a major overhaul of the city's wastewater treatment system. Part of the City's plans for the Olympics included an Olympic Park that utilized recycled water, but at the time, the water quality resulting from existing treatment systems was unsatisfactory. In response, Mitsubishi Electric proposed the use of the company's ozone generator technology for wastewater treatment, to deliver superior performance in de-coloring and deodorizing water. Mitsubishi Electric's proposal was accepted, and in May 2008, a system was installed in the Beijing's Qinghe Wastewater Treatment Plant, in time for the Beijing Olympics, held in the summer. Olympic Park, located nearby the various Olympic venues, featured an artificial lake filled with recycled water purified by Mitsubishi Electric's ozone generators, to much acclaim.

Since the Olympics, Mitsubishi Electric has contributed to the Wastewater Reuse Project, the aim of which is to improve the overall water environment in Beijing City. Sewage water within the city is now being purified by Mitsubishi Electric's ozone generator. This assistance has also enabled recycled water to be directed toward industrial and agricultural reuse.



Qinghe Wastewater Treatment Plant and Mitsubishi Electric's ozone generator

# Environment – Membrane Separation Advances Water Recycling

## A Practical Water Recycling Solution

Mitsubishi Electric's membrane separation method of recycling water for mission-critical industrial processes offers the merits of space and energy savings, direct control of water purity, relatively low operating cost, and best of all, no toxic chemical processing.

When the Mitsubishi Electric Transmission and Distribution Systems Center, which develops and produces devices that ensure a stable supply of high voltage and electrical current, implemented a major refurbishing of its facilities after 35 years of operation, it turned to membrane separation technology for a new wastewater treatment system as a practical solution to achieve its goal of transforming from 30% utilization of recycled water to 100%.

Previously, after washing performed during the process, the water was detoxified and some was reused in the toilet system, while the rest was discharged as wastewater. The decision to implement a new system provided an opportunity to strive for 100% recycling of water used in the metal plating process. In 2010 the new water treatment system for the metal plating operation and water recycling facility came on line, achieving the goal through 70% reuse of water in the metal plating process, and 30% reused in the toilet system.



Mitsubishi Electric Transmission and Distribution Systems Center, ensuring exacting standards of quality for one of the world's most reliable power distribution systems. Its products are in use globally.

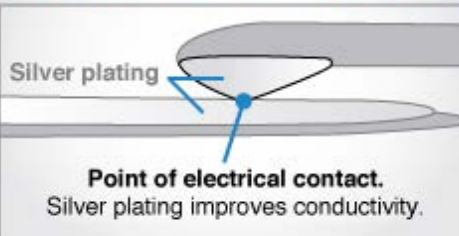


Power transformer



Switchgear

Metal plating is applied to these components



Water recycling equipment for new metal plating process



## Water Quality is Product Quality

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**Masahiko Yokoyama**  
Manager  
Machining Parts Manufacturing  
Sec.  
Switchgear Dept.  
Transmission & Distribution  
Systems Center

It can be said that water gives life to our products. In my role overseeing the implementation of the new system at the Transmission and Distribution Systems Center, I must ensure that recycled water can deliver on that promise.

Our chief aims for the renewal included to mitigate environmental risks, recycle wastewater and implement a 24-hour metal plating operation. To lower environmental risk and make 24-hour operation possible, locating the new facility next to the metal factory was vital. Microfiltration technology allowed us to remove heavy metals in the water in order to keep environmental risk low on a 24-hour basis, while benefitting from space-savings. Reverse osmosis technology was a highly cost effective solution for recycling of the water.

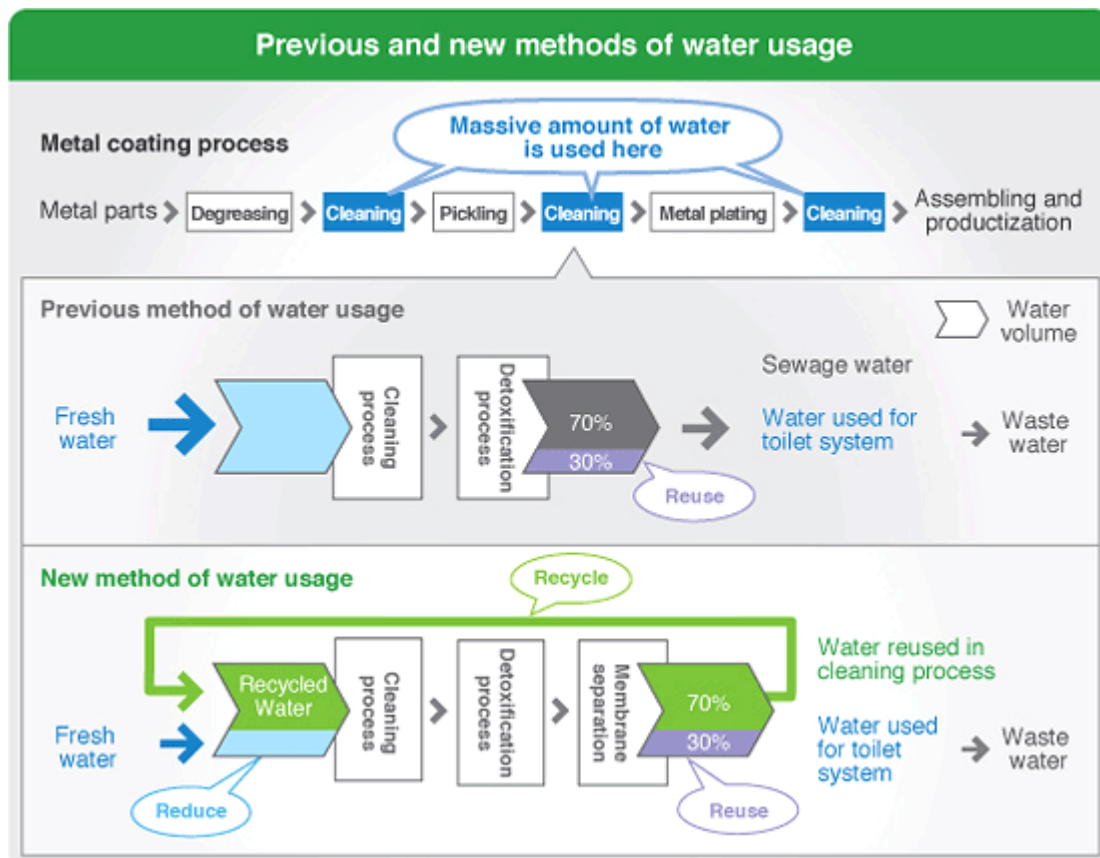
We also had to stabilize fluctuations in concentration levels in drainage water, resolve which pH was optimum for detoxification, and control the degree of fluorine in the water. We have accrued much knowhow and determined the best machinery and practices required for superior operational results, ensured safety and environmental benefit. My goal from now is to make this factory number one in these areas among Mitsubishi Electric's 24 factories in Japan.

## Membrane Separation in the Factory

A membrane separation system was installed at a metal plating facility at Mitsubishi Electric Transmission and Distribution Systems Center in 2010. It economized on limited available space and realized the goal of transforming from 30% recycling of the water used for the process to 100%. The compact size of the equipment allowed for most efficient positioning, adjacent to the metal plating operation itself. The amount of required piping was reduced from 600 to 70 meters, or by some 90%.

Previously 45m<sup>3</sup> of water per hour was required for cleaning during the metal plating operation. After membrane separation technology was introduced, an annual total of some 100,000 m<sup>3</sup> of water is able to be reused. This volume is approximately equivalent to 500,000 bathtubs.

After installing the new system, water consumption was drastically reduced. As much as 70% of the water is now recycled back into the production process. The remaining 30%, which contains soluble acids and alkalis, is detoxified and reused in the plant's toilet system.

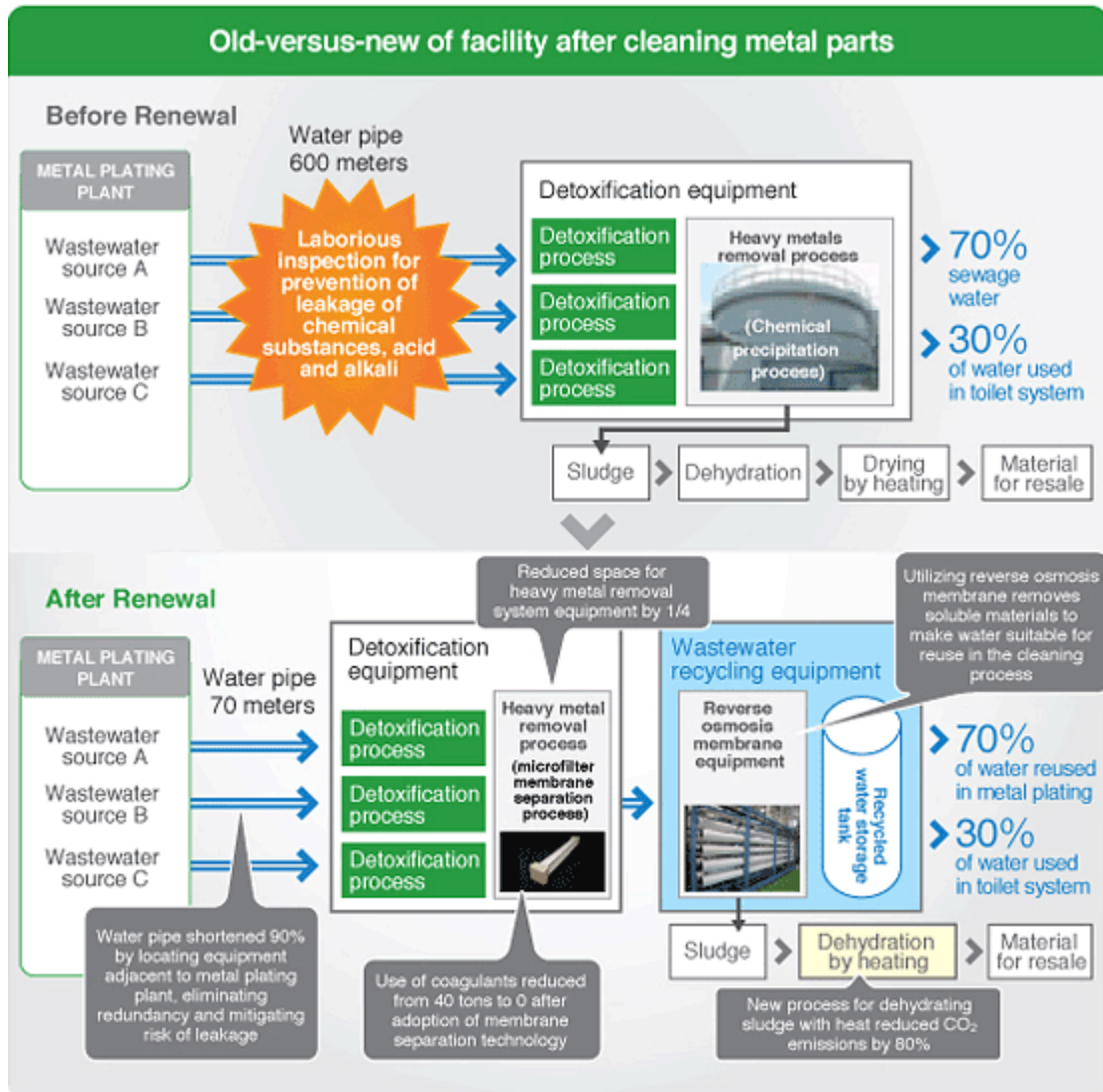


## Microfiltration and Reverse Osmosis

New microfiltration and reverse osmosis (RO) systems permit recycling of the water used in the metal plating washing process. The previous process for water treatment called for storing the used water in a tank after its pH level was optimum for detoxification. The sludge containing heavy metals was then removed.

Now the water used in the metal plating process is treated using microfiltration technology, which uses a membrane to remove all substances over 0.5 microns. The microfiltration equipment saves on facility space by one-fourth, permitting it to be located in a facility adjacent to the metal plating factory. This location has reduced the length of the water supply pipe from 600 to 70 meters. It also made for easier monitoring of the equipment.

Reverse osmosis (RO) is used to improve purity, by detoxifying water from which heavy metals have been removed. Substances larger than 0.1 nanometer, like salts and other soluble substances that adversely affect metal plating quality, are also thoroughly removed. These were previously impossible to filter from the water.



Water detoxification equipment at metal plating facility. Vat at left is for heavy metals; vat at right holds water containing fluorine.



Water detoxified by microfiltration. It is further filtered by reverse osmosis (RO), which eliminates impurities like soluble salt. The water is used again for washing at the metal plating factory.



Recycled water storage tank.



Detoxification and water recycling equipment is monitored on a 24-hour basis.



Equipment Operations Supervisor Nagaike (left) and Technical Director Akashi, responsible for ensuring a reliable water supply at the metal plating facility.

## State-of-the-art Water Recycling



**Akihisa Takahashi**  
Senior Manager  
Engineering, Manufacturing &  
Information Systems  
Department  
Transmission & Distribution  
Systems Center

Mitsubishi Electric considers water as a "3R" resource (reduce, reuse, recycle), and the Transmission and Distribution Systems Center now boasts a model of state-of-the-art water recycling as an integral aspect of its makeup. It took about a year and a half for planning and implementation. So after 35 years of operations, we got a chance to implement a solution for more effective utilization of water through the renewal of equipment for the detoxification of water used in the metal plating process.

We train staff members to have confidence in the safety of the system, as well as sharpen environmental awareness, by maintaining a miniature biotope sustained by recycled water from the facility. Other industrial processes at the Center, which still use too much water, are targeted for application of the system.



The Mitsubishi Electric Transmission and Distribution Systems Center has established a miniature biotope adjacent to its metal plating facility, where traditional Japanese plant and animal species are sustained by detoxified water from the operation.

### ▶ **Dialog on Environmental Management**

Published Jun 2011

Mitsubishi Electric held a dialogue session with Professor Yoshihiko Takemura of Tokyo Denki University to discuss the achievements and future themes of company's efforts to reduce CO<sub>2</sub> from production.

### ▶ **A New Dimension in Eco Air Conditioning**

Published Jul 2010

- ▶ Focusing on Perceived Temperature
- ▶ Secrets of Sensing & Analysis
- ▶ The Idea Behind "Move-Eye Navi"
- ▶ An Industry First: A Navigation Function

### ▶ **Intelligent Ways to Save Energy and Reduce CO<sub>2</sub> from Production**

Published Jul 2010

- ▶ Goals and Merits of the Energy Conservation Expert Inspection
- ▶ On-site during an Energy Conservation Expert Inspection
- ▶ Experts Discuss Ways to Conserve Energy
- ▶ Close-up: The Air Conditioning & Refrigeration Systems Works

### ▶ **Coordinated Regional Waste Recycling (Kyushu Region)**

Published Jul 2010

- ▶ Mobilizing Managers from Seven Factories
- ▶ Mutual Inspections Uncover Areas for Improvement
- ▶ Sharing Information on Waste Processors
- ▶ Streamlining the Waste Material Flow
- ▶ Creating a Win-Win Relationship

### ▶ **Exchanging Ideas with Experts (Respecting Biodiversity)**

Published Jul 2010

We invited Ryo Kohsaka, Associate Professor at Nagoya City University, as an advisor to exchange ideas on the promotion and strengthening of initiatives to respect biodiversity. This section presents an overview of that discussion.

### ▶ **Innovative Products and Production**

Published May 2009

- ▶ Product Innovations
- ▶ Production Process Innovations
- ▶ Engineers' Perspectives
- ▶ Working with the Community for the Environment

### ▶ **Rebuilding and Developing Automotive Equipment**

Published Aug 2009

- ▶ Rebuild Operations: Recycling in Action
- ▶ Providing Cutting-Edge Alternators
- ▶ Initiatives to Reduce Waste

### ▶ **Towards Zero Emissions**

Published Sep 2008

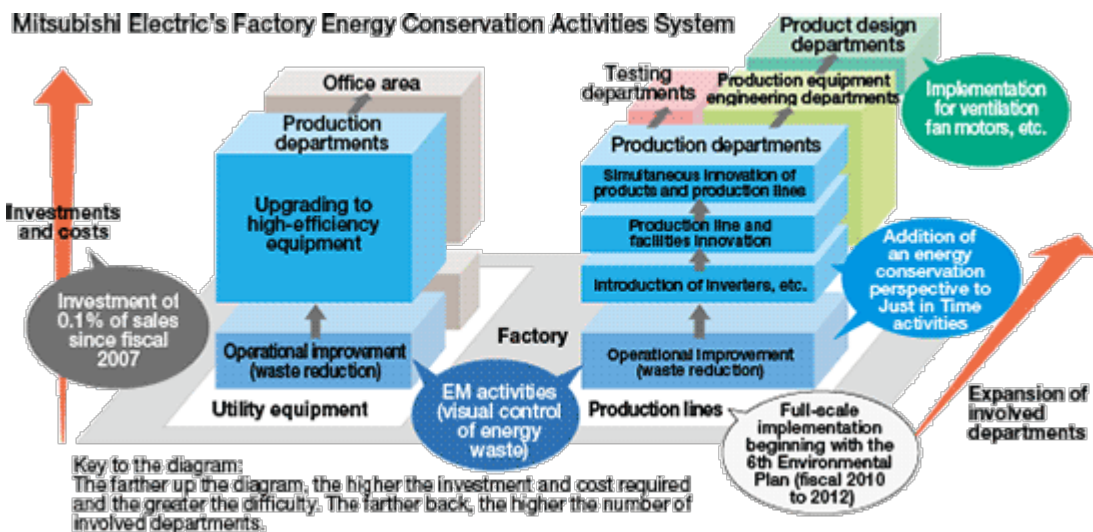
- ▶ Birth of a Recycling System
- ▶ Recycling Examples
- ▶ Future Development

# Environment – Dialog on Environmental Management

## Reducing CO2 Emissions from Production

Under its Environmental Vision 2021, Mitsubishi Electric has established an Environmental Plan and is implementing wide-ranging energy conservation measures. We have already seen a number of results under the 6th Environmental Plan (fiscal 2010 to 2012), including the achievement of our CO<sub>2</sub> reduction targets two years in a row. At the same time, we also consider it important for outside experts to assess whether our conservation efforts are effective or adequate, since this enables us to discover issues that may have previously escaped our attention and may provide hints for future activities.

With this in mind, on April 6, 2011, we invited Professor Yoshihiko Takamura of Tokyo Denki University to participate in a dialog on environmental management. Well-versed in current issues regarding energy conservation in Japanese industry, Mr. Takamura has on many occasions played a leading role in the process of revising the Act on the Rational Use of Energy and is one of Japan's foremost experts in energy conservation research. In this section, we introduce Mr. Takamura's key points for energy conservation inspections, along with his performance evaluation and advice.



## Topics

### Efforts at Factories

1. Cornerstone of Energy Conservation Activities: Measurement of Energy Consumption and Discovery of Waste Based on Measurement Results
2. Cornerstone of Energy Conservation Activities: Horizontal Deployment of Effective Energy Conservation Practices and the Introduction of Different Perspectives
3. Linkage with Management: Management Involvement in Energy Conservation Activities
4. Linkage with Management: Expanding the Scope of Energy Conservation Activities
5. On-Site Per-Unit Target Management

### Efforts at Offices

6. Energy Conservation Measures at Offices

## Topic 1. Cornerstone of Energy Conservation Activities: Measurement of Energy Consumption and Discovery of Waste Based on Measurement Results

**Mr. Takamura:** I am often asked, "Where should we start in our energy conservation?" First and foremost, I say, "You don't have to do anything. First gain a grasp of the status quo." If people approach energy conservation with the preconception that "there must be wasted energy around here somewhere," they tend to overlook things, or end up satisfied with measures that only address what they can see. Understanding the status quo is also known as "visualization," the cornerstone of which is measurement. And the results of those measurements, such as discovering waste in the form of certain facilities or equipment that consume electricity even when not in use, lead to energy conservation. How is Mitsubishi Electric working toward greater visualization?

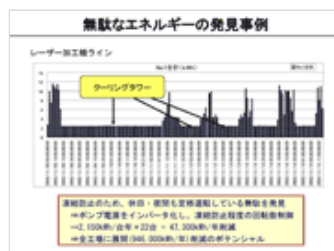
**Mitsubishi Electric:** Energy visualization is a specialty of Mitsubishi Electric. Our product lineup includes "EcoMonitor" electric power measurement systems that provide highly effective support for energy conservation. As one facet of our Energy Loss Minimum (EM) activities, since 2004 we have been installing EcoMonitors at production lines and facilities at our factories in Japan and engaged in activities to discover and eliminate waste utilizing data collected on energy usage.

For instance, at a laser processing machine production line at one of our factories, continuous measurement of electricity use around the clock for one week revealed that electricity consumption didn't fall to zero even on weekends or weeknights, when no energy should have been used. The cause was a continuously operating cooling tower designed to prevent freezing. Because the electrical source for the pump on this cooling tower could be controlled only with an on/off switch, turning the switch on put it in the same operating mode as if the line was in full operation. We eliminated this waste by converting the pump's electrical switch to an inverter, enabling the pump to be operated at the minimum necessary to prevent freezing.

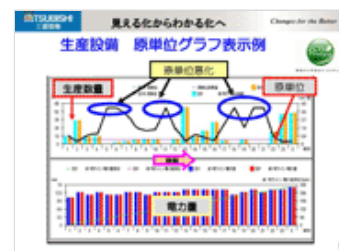
In addition, we have prepared real-time graphs for each production line displaying per-unit numbers that compare electricity used as measured by EcoMonitors against production volume. Analyzing the data from EcoMonitors on specific lines or individual equipment has enabled us to identify areas, production lines and time periods in which electricity is being consumed even though production is not taking place, and link the results of such measurements to production efficiency improvements. We have also established target per-unit values by factory, facility and workplace, and in the event actual figures exceed the targets set, each department works to analyze the data, identify the cause, and through energy conservation committees and other small group activities, systematically implement improvements.



EcoMonitor electric power measurement unit



Energy use data helps visualize wasted consumption



Graphs for visualizing production facility per unit



**Mr. Takamura:** It is very good that Mitsubishi Electric has measurement devices developed in-house and in its product lineup, and is taking advantage of its expertise in this field to conserve energy. While measurement is a cornerstone of energy conservation, some business owners say that installing such devices doesn't save energy, or fail to see the point of installing them in the first place. I think the fact that Mitsubishi Electric has made measurement the starting point of its energy conservation activities is one reason for these effective results.

## **Topic 2. Cornerstone of Energy Conservation Activities: Horizontal Deployment of Effective Energy Conservation Practices and the Introduction of Different Perspectives**

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**Mr. Takamura:** I have many opportunities to visit the factories of various companies, and I have noticed, unfortunately, that in very large companies, approaches to energy conservation sometimes differ between business groups, or there may be gaps in their level of enthusiasm for such efforts. If there were someone who could see across all of a company's business groups, or all of its factories, it would be possible to deploy measures that were effective in one factory horizontally across the organization. The latest revisions to the Act on the Rational Use of Energy will require companies to manage energy company-wide, rather than on the existing factory-by-factory basis, and one of the goals of this revision is to change this kind of piecemeal approach. What kind of horizontal deployment of positive examples is Mitsubishi Electric working on?

**Mitsubishi Electric:** Mitsubishi Electric considers horizontal or company-wide deployment of effective practices to be a critical and fundamental business function, and we promote such practices on a variety of levels and through a variety of methods.

For example, our company-wide Environmental Promotion Managers' Conferences, attended by the environmental managers from each business group, and our Energy Conservation Best Practice Presentations, attended by the persons responsible for energy conservation at all of our factories in Japan, ensure that we share information on best practices across the organizational boundaries between business groups and factories. We also compile case files containing effective measures implemented at each factory and utilize them in energy conservation activities.

Other activities include mutual energy conservation inspections and [Energy Conservation Expert Inspections](#), designed to check on our efforts from differing perspectives. These inspections always include proposals for improvements, which help in the horizontal deployment of the best initiatives.

**Mr. Takamura:** In addition to horizontal deployment between business groups and factories, I think your efforts to introduce differing perspectives in the form of mutual audits can be extremely effective, because there are cases in which one factory may deploy such practices as a matter of course, while another doesn't, or doesn't know how to make improvements. Mutual audits provide an opportunity for each factory to learn where it is lacking, or what its strengths are, and can be a valuable experience for all involved.

**Mitsubishi Electric:** Since fiscal 2004, the mutual energy conservation inspections have been conducted on average bimonthly, by the Energy Conservation Subcommittee of the Environmental Technology Committee. In these audits, a team of qualified energy managers drawn from the various factories spends an entire day visiting another factory's worksite to make inspections and propose improvements. The factories audited then report on the results of their decisions regarding each of the proposals offered. One of the goals of these mutual energy conservation inspections is the development of young energy managers; by allowing them to see veterans at work in the inspection process, it provides an excellent opportunity for young employees to learn.

At the same time, Energy Conservation Expert Inspections involve a team consisting of energy conservation pioneers and old hands. These employees, selected from among workers involved in energy conservation at our factories in Japan for their wealth of experience and outstanding results, make the rounds of factories in Japan and overseas. These activities are useful for expanding the scope and potential of energy conservation measures at our factories, and also contribute to the development of younger employees.



Energy conservation experts perform inspections at Mitsubishi Electric factories worldwide

**Please see the feature article for details about Energy Conservation Experts**

**Environmental Topics: Intelligent Ways to Save Energy and Reduce CO2 from Production**

**Mr. Takamura:** As with energy conservation, the issue of skills succession to younger employees has become a hot management topic in recent years, so I think this is a very positive trend. I sense that Mitsubishi Electric places an emphasis on awareness attained through the introduction of different perspectives and proactively engages in practices to promote this process. I think it would be good to take this a step further by incorporating perspectives from different industries, as well. For some time now, I have been involved with a cross-industry enterprise exchange group in Nagano. Members of the group first learn the basics of energy management, then visit one another's companies and draw up proposals based on things they've noticed during those visits. Initiatives that may be commonplace in one industry may often represent new discoveries for other industries, and these activities have been effective in revealing and then improving on wasteful practices.

**Mitsubishi Electric:** We appreciate the advice. In the past, we have spoken with people in other industries and even made visits to their factories, but going forward, we hope to incorporate these kinds of activities more strategically in our own energy conservation efforts.

### Topic 3. Linkage with Management: Management Involvement in Energy Conservation Activities

**Mr. Takamura:** Under the current revised Rationalization in Energy Use Law, companies will be required to have in place an energy management control officer. Until now under the Law, energy conservation was promoted by qualified energy managers at each place of business, but in many cases management was not receptive to ideas that required capital investment or expenditures. It is common in Japan for companies to do fine eliminating waste in ways that don't cost money, but once capital or expenditures are involved, progress tends to stop. The current revisions resulted from the conclusion that in order to change this status quo, it will be necessary to create a structure under which the rationalization of energy use can be promoted from a business management perspective. In other words, the objective is to place among those with management authority someone who truly understands energy. In this respect, how is Mitsubishi Electric attempting to tie its energy conservation activities to corporate management?

**Mitsubishi Electric:** Mitsubishi Electric believes that environmental conservation initiatives are a corporate issue and, on the occasion of the ISO 14001 revision in 2004, elected to integrate environmental management systems into our main business activities. In response to this, since the launch in fiscal 2007 of our 5th Environmental Plan, a full-scale environmental management plan, we have invested 0.1% of sales in energy conservation.

In addition, in the current 6th Environmental Plan (fiscal 2010 to 2012), we are focusing on reducing CO<sub>2</sub> from production by implementing two key measures: The replacement of utility equipment with high-efficiency equipment, which requires planned investment; and production line improvements involving the elimination of waste during production. Of these, specific measures regarding production line improvements are incorporated in each year's fiscal year plan.

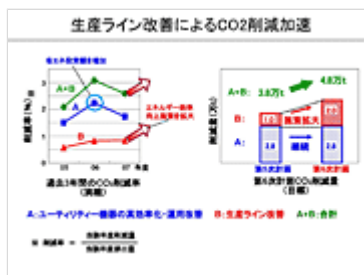
Further, to more vigorously promote production line improvements, on April 1, 2011 we launched the Productivity Promotion Group. Some of the issues which arise as a result of the inspections by energy conservation experts may require production line innovations and may be difficult for individual factories to address on their own. We formed this group out of the belief that an organization was needed capable of responding to those issues and empowered to implement improvements, including development of technology.

4つの施策(実績:効果と費用)

項目	2010年	2011年	2012年	2013年	2014年	2015年	2016年	2017年	2018年	2019年	2020年
省エネ設備投資	1,200	1,500	1,800	2,100	2,400	2,700	3,000	3,300	3,600	3,900	4,200
省エネ効果	1,500	1,800	2,100	2,400	2,700	3,000	3,300	3,600	3,900	4,200	4,500
削減率	12.5%	15.0%	17.5%	20.0%	22.5%	25.0%	27.5%	30.0%	32.5%	35.0%	37.5%
削減率(目標)	10.0%	12.5%	15.0%	17.5%	20.0%	22.5%	25.0%	27.5%	30.0%	32.5%	35.0%

●省エネ設備の1/10を、省エネ設備に投資(固定エネルギー削減が促進効果をつける)  
 減額効果は速やかに新しい高効率設備に置き換える  
 ・1/10を以上削減している設備  
 ・2/10を以上削減している設備  
 ・3/10を以上削減している設備  
 ・2010年以降(2010年度以降)の削減率の向上  
 ●エネルギー管理システム導入による省エネ効果  
 ・エネルギー管理システム導入による省エネ効果  
 ・省エネ効果の向上による省エネ効果の向上

Costs and effects of four key measures: introduction of high-efficiency equipment; EM activities; introduction of co-generation; fuel conversion) effects and costs



CO<sub>2</sub> reductions accelerated through production line improvements

**Mr. Takamura:** I think that investing 0.1% of sales in energy conservation is a significant commitment, and one that I have not seen elsewhere. It clearly shows that Mitsubishi Electric is addressing energy conservation as a management priority. Recent years have seen the introduction of a steady stream of excellent materials, products and technologies, including insulating materials, LED lighting, and nano-processing and measurement control technologies. I think that the proactive inclusion of such new technologies in energy conservation investments will enable Mitsubishi Electric to continue to achieve wide-ranging innovations.

## Topic 4. Linkage with Management: Expanding the Scope of Energy Conservation Activities

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**Mr. Takamura:** Earlier, we spoke about how energy conservation investments and other money issues tie into management; now I would like to ask about the organizational and personnel side of things. For example, when reviewing a manufacturing process from the perspective of how energy will be utilized, the scope of improvements must often be expanded to include production line design and even the design of the products themselves. Such a broad scope requires decision making from a company-wide standpoint. How does Mitsubishi Electric approach this?

**Mitsubishi Electric:** At Mitsubishi Electric, even the facilities engineering departments participate in production line improvement activities. We are also expanding the scope of activities to include farther upstream product design processes and have in some cases succeeded in eliminating high energy-consuming equipment through changes in parts and materials, and shortening production lines and increasing efficiency through size and weight reduction at the product design stage. Focusing on the upstream is, we feel, an important step.

We have also begun expanding the scope of energy conservation efforts to the quality control test stage. Since this testing involves verifying whether products can function under harsh conditions, the tendency has been to consider the testing process different from production lines, and off limits for energy reduction. However, actual measurement of electricity use revealed that at some factories, the testing departments account for as much as 15% to 30% of total electricity use, and that testing for product quality is in fact on the rise. This is why we are now in the midst of reviewing the entire process, beginning with initial set-up time, to determine whether a particular test is really needed, or whether it can be simplified or the time required for the test shortened.

**Mr. Takamura:** It's impressive that you have put aside formerly "off-limits" processes by including the testing department in your efforts. It is important to initiate improvements at departments not previously covered by such improvement efforts. By all means, I hope that you will continue to carry on with this initiative.

## Topic 5. On-Site Per-Unit Target Management

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**Mr. Takamura:** In setting forth a company-wide policy of reducing CO<sub>2</sub> emissions, what is most important is what results a company's respective divisions and workplaces can deliver toward attaining that goal. And note that, while units for CO<sub>2</sub> reduction targets are absolute quantities, the standard under the Rationalization in Energy Use Law is per unit of energy. Because this per unit actually represents efficiency, goals can be difficult for those in the workplace to manage unless it is clear that their objective should be to improve productivity, and the efficiency of their own work, based on that per unit. How is Mitsubishi Electric approaching this issue?

**Mitsubishi Electric:** In Environmental Vision 2021, Mitsubishi Electric has set a target of a 30% reduction in CO<sub>2</sub> emissions from production, and the factories aim to achieve the target. At the same time, to pursue higher productivity at the factories, we manage energy use by employing per-unit indicators. Beginning in fiscal 2011, we have started incorporating energy conservation perspectives in our productivity improvement (Just in Time) activities and are working toward even further improvements in our base energy units. What is difficult in managing per unit in this way is deciding what to use as a unit.

**Mr. Takamura:** I believe it is necessary to use targets for both total energy consumption and per unit as performance indicators, but as you note, this can present some difficulties. If sales were used as a per unit, for example, figures would change enormously with fluctuations in product prices. This has been pointed out as an issue before in the semiconductor industry, for example, where prices can drop dramatically from one year to the next. As a result, no matter how much energy efficiency is improved at the point of production, when assessed using sales as a per unit, it only seems to worsen.

**Mitsubishi Electric:** Actually, there is something else we would like to ask your opinion about along with the per unit issue. At Mitsubishi Electric, we would like to carefully assess the cost of our CO<sub>2</sub> reduction efforts and give CO<sub>2</sub> reductions a higher management priority. Currently, however, there is no indicator for directly translating CO<sub>2</sub> reduction volumes to costs. We are thinking that it may be possible, for example, to use the unit price per ton of CO<sub>2</sub> in emissions trading as a reference. What do you think? While our policy is not to trade in emissions rights, if CO<sub>2</sub> prices are given a high valuation, we believe that in a sense, that may serve as an effective motivation for further energy reduction activities.

**Mr. Takamura:** The question of whether or not to engage in emissions trading aside, I think CO<sub>2</sub> prices can be used to assess the results of your activities. While most people say that it is overwhelmingly less expensive to purchase emissions rights, you gain nothing in technology by trying to solve the problem through such purchases. After all, energy conservation is a cumulative process.

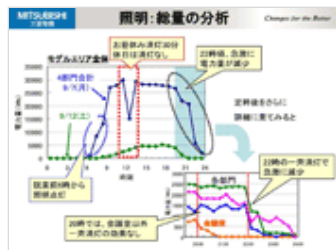
**Mitsubishi Electric:** Since we believe that reducing CO<sub>2</sub> emissions and eliminating waste fundamentally strengthen our corporate constitution, we can certainly identify with your opinion about not gaining anything technologically. If emissions trading means missing out on opportunities to gain energy conservation expertise, that is another reason for us to continue focusing on efforts under our own steam.

## Topic 6. Energy Conservation Measures at Offices

**Mr. Takamura:** We have heard a lot about your energy conservation initiatives at the factory level. What sort of initiatives are you employing in your offices?

**Mitsubishi Electric:** Mitsubishi Electric sets up model areas in offices and conducts demonstration tests. In 2010, we used EcoMonitors to monitor and analyze electricity consumption and engaged in electricity reduction activities focused on lighting, which accounts for approximately 60% of energy consumption outside of air conditioning. We found that the per unit per person following the end of the workday was particularly bad and are working to devise improvements by, for example, turning on lights only in parts of the office that are still occupied. However, in buildings in which we are just a tenant, use of shared air conditioning systems managed by the building owner may not be included in our measurements, so we may need to make adjustments with the building owners in those cases.

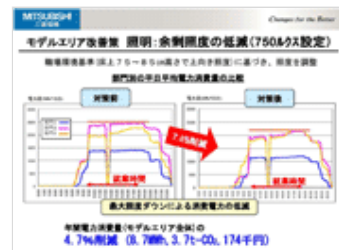
### Example of analysis and improvement based on energy use data measured by EcoMonitors



Lighting: Analysis of total use



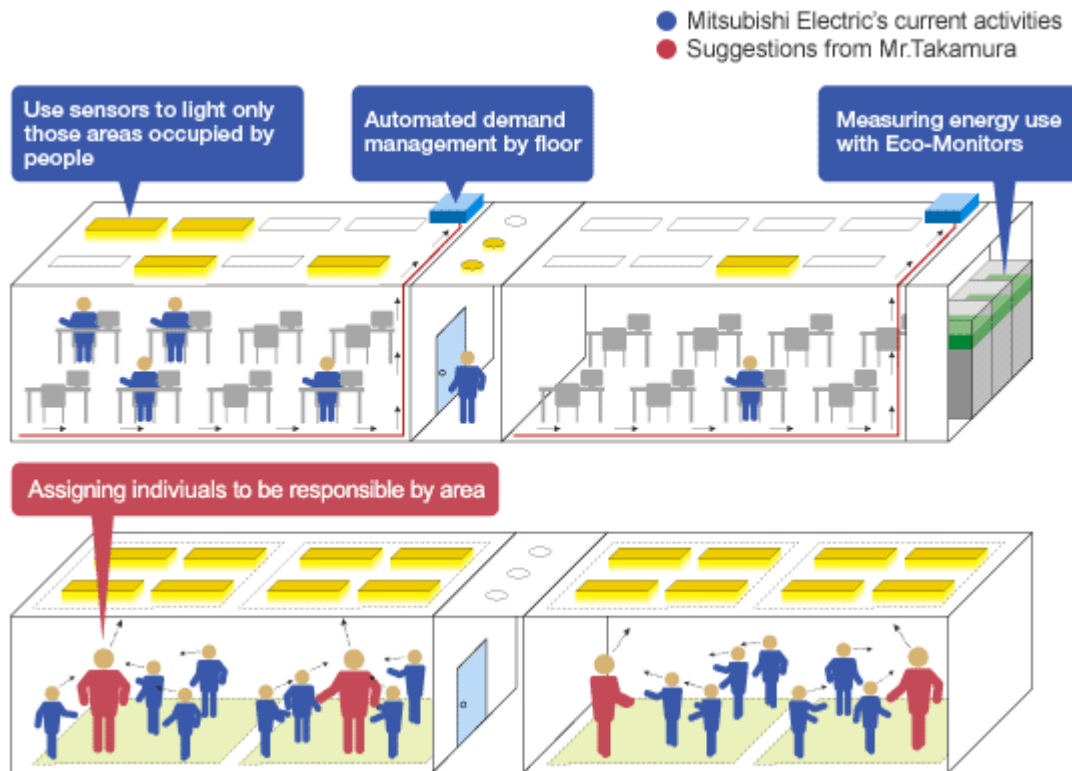
Lighting: Per-unit analysis (per person present)



Improvements to office model areas Lighting: Reducing over-illumination (set at 750 lux)

**Mr. Takamura:** I think that beginning with measurement and analysis and then devising efficient ways of using lighting is an excellent approach. What is key to such initiatives in the office is to be careful in bringing in lighting only those areas actually occupied by people. And, while it is of course important to raise awareness at the individual level, I would also propose that you introduce further support measures utilizing sensor technology. Further, if I might make a proposal, it would be effective to decide upon a person responsible for each model area, and then encourage all employees in that area to follow the lead of the person responsible and devote themselves to energy conservation activities.

## Energy conservation activities needed in the office



## In Closing: Rolling Blackouts

**Mitsubishi Electric:** Given the situation with power shortages arising from the recent Great East Japan Earthquake, what do you think our concerns should be going forward?

**Mr. Takamura:** Once rolling blackouts and restrictions on total energy use have been decided upon, I think you will find that the data you have collected to date can be extremely useful. If rolling blackouts are conducted, that is when you will truly need to be systematic in your use of electrical power. To prioritize which departments to keep running in such cases will require that you have a complete picture of energy use in each department. Energy management is also crisis management.

In addition, proper energy management has a number of ripple effects. For example, using florescent lighting releases heat, but reducing its use will reduce other related energy, such as the load on air conditioning systems. As peoples' awareness changes, products grow smaller and more energy-efficient. In the same way, proper data collection can be useful in a variety of ways.

**Mitsubishi Electric:** Currently, Mitsubishi Electric is discussing how to adjust its production shifts to so-called peak cuts. These methods might include, for example, running automated feeder lines at night, while having assembly lines requiring manual attendance run only during the day. Since we have all of the energy usage data collected by factory, we believe this will be an ideal opportunity to make use of our efforts to date. Your mention of the link between energy conservation and crisis management was also extremely helpful. Thank you for your time today.

## After the Dialog

### **With its workplace improvements and the involvement of management, it is clear that Mitsubishi Electric has established an exemplary set of initiatives**

Through this dialog, it is clear to me that Mitsubishi Electric is engaged in leading-edge initiatives which can serve as a model for other companies. You are identifying waste and promoting improvements by using measuring equipment to closely measure energy use, which is fundamental to energy conservation. It is also great that, company-wide, your factories share information about their respective strengths and weaknesses and deploy that information horizontally. I was also very impressed with the emphasis you place on developing personnel and nurturing successors in the workplace.

First and foremost, I appreciate the fact that you have leaders in place who understand these issues. Second, you are working to change production methods and develop manufacturing methods that use less energy, and to accomplish that are providing feedback to your design departments. I also think it's excellent that you are expanding your vision beyond the factory to your design departments and beginning to work on initiatives farther upstream, while also moving ahead with data-based improvements in your testing facilities, previously considered off-limits. I very much hope that other companies will use these examples as a model for their own energy conservation efforts.



**Yoshihiko Takamura**  
Professor, Tokyo Denki  
University  
Councilor, Energy  
Conservation Center, Japan

## After the Dialog

### **I believe that a scenario for further incorporating energy conservation into management will be necessary**

Through Professor Takamura's review of our energy conservation activities, we were able to confirm that our activities to date have been on target. I believe that the energy conservation results we have achieved stem from having applied our expertise and knowledge to the task and engaged in energy conservation as a management priority, investing 0.1% of sales in energy conservation and implementing measures as part of a group-wide environmental plan. Despite this success, I am concerned that we may be unable to continue achieving such results as things currently stand.

Now that we have taken energy conservation to the limit, we must increase the amount of investment to achieve further advances. I believe that to move beyond this limit, it may be necessary to develop a scenario for further incorporating energy conservation into management. We are putting into practice the initiatives we highlighted in our environmental statement, Eco Changes – for a greener tomorrow, right now, but we need to carry these measures out as part of our main business activities, not simply for energy conservation. I feel that doing so would enable us to make more progress in areas where we cannot actually visualize what the problems are. Accordingly, we need new management indicators allowing us to tighten the relationship between our energy conservation activities and our mainstay business.

We have been simultaneously pursuing strengthening of our corporate constitution involving production with less energy and fewer resources, and contributing to society through business activities and environmental mindset. After the dialog, I strongly felt that we have reached the stage where it has become necessary to integrate efforts to strengthen our corporate constitution and our social contribution.



**Masaharu Moriyasu**  
Executive Officer in Charge of  
Total Productivity Management  
& Environmental Programs  
Vice President,  
Corporate Total Productivity  
Management & Environmental  
Programs Group



# Environment – A New Dimension in Eco Air Conditioning

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## Maximum Comfort = Maximum Ecology 10 Years of Pursuing the Essence of Air Conditioning

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In fiscal 2010, the Kirigamine Move-Eye Navi room air conditioner (models on sale in Japan from winter of fiscal 2010) was the only major appliance to win the Japanese Energy Conservation Grand Prize in the white goods category. In addition to ease of use and the highest energy saving function in the industry, the Move-Eye Navi has received particularly high acclaim for its innovative approach to energy conservation. This product represents more than 10 years of Mitsubishi Electric development history and the pursuit of making maximum comfort = maximum ecology. This section gives an overview of the development concept and technology that makes the Move-Eye Navi second to none.

### Note

The Kirigamine Move-Eye Navi room air conditioner is only sold in Japan.

### Contents

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- ▶ Focusing on Perceived Temperature
- ▶ Secrets of Sensing & Analysis
- ▶ The Idea behind "Move-Eye Navi"
- ▶ An Industry First: A Navigation Function

## Environment – Focusing on Perceived Temperature

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**The pursuit of comfort is no less than the pursuit of energy conservation. So we created a system based on perceived temperature.**

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Of all home appliances, air conditioners consume the most electricity. Today there is a need for households to reduce CO<sub>2</sub> emissions in order to create a low-carbon society, as energy conservation becomes an increasingly critical priority in today's world.

Making air conditioners more energy efficient is a matter of course, but regardless of the equipment's energy-saving performance, if it is used in a wasteful, inefficient way, energy efficiency is reduced. However, such wasteful, inefficient use is actually the result of people's pursuit of comfort.

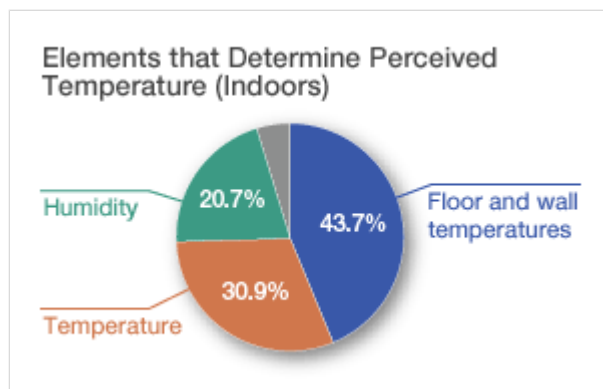
For more than 10 years, Mitsubishi Electric has been focused on this dilemma. Applying the innovative development concept of air conditioning based on user's perceived temperature, we have evolved our air conditioner technology. Air conditioning that self-adjusts based on perceived temperature—that is to say, air conditioning that delivers optimum comfort—dramatically reduces energy loss resulting from the method of use.

### Perceived temperature

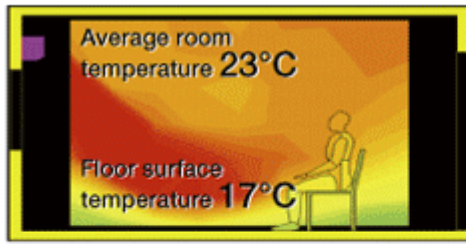
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"Perceived temperature" is not the absolute value of heat and humidity. It is a scale of comfort based on how the air conditioning user senses or feels the room's atmospheric environment.

For example, even at the same room temperature, if the floors and walls are cool, it feels cooler than the absolute room temperature value; conversely, if a person has been exercising and their body is hot, a lower room temperature will not feel all that cold to them.



■ Without Move Eye (Heater)

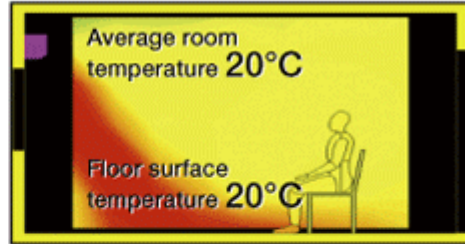


Temperature setting 23°C

Perceived temperature 20°C

3°C of waste

■ With Move Eye (Heater)



Temperature setting 20°C

Perceived temperature 20°C

No waste

Adjusting the air based on perceived temperature keeps the feet comfortably warm even when the temperature setting is low.

# Environment – Secrets of Sensing & Analysis

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## Developer's Perspective

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**Technology that makes use of data analysis is an indispensable prerequisite to achieve maximum comfort and maximum ecology.**



**Takashi Matsumoto**  
Specialist Advanced  
Development  
Group Room Air Conditioning  
Manufacturing Department  
Shizuoka Works

The eight infrared sensors located at the center of the Move Eye Navi unit are constantly acquiring thermographic data, making a pass over the room every 30 seconds and dividing the scanned area into 752 quadrants. The thermographic data is then analyzed to find the position and surface temperature of the walls and floor, the position and state (open or closed) of the doors and windows, sunlight coming in from the windows, and the condition of the people in the room. More than simply ascertaining whether or not there are people in the room, their location and perceived temperature (hot or cold) measurements are also possible.

Mitsubishi Electric has spent the past 10 years developing this high-level thermographic data analysis technology. Recently, sensor-equipped air conditioners have become more common, but only Mitsubishi Electric's air conditioner is able to operate by simultaneously sensing the temperature both of people and their location. Technology that makes use of data analysis is an indispensable prerequisite to achieve maximum comfort and maximum ecology.

# Environment – The Idea Behind "Move-Eye Navi"

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## Planner's Perspective

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**Aiming for the realization of advanced energy conservation that would bring people and machines together as never before.**



**Shin Harada**  
Specialist Room Air  
Conditioning  
Sales Planning Group  
Sales Department  
Shizuoka Works

Recently, improvements to the energy-saving functions of air conditioning units have been dramatic, making it difficult to hope for significant additional improvements. For this reason, Mitsubishi Electric has moved into the realm of energy-saving action, something which until now has been left up to the user.

Running the air conditioner with the doors or windows open, or with the curtains or blinds unclosed, or when the outside temperature is falling is clearly a waste of energy. Nevertheless, people all too frequently engage in this type of wasteful usage. Continually performing detailed checks of the room and persons within it, the Move Eye Navi sensor function identifies inefficient usage and informs the user. In this way, the air conditioner becomes one with the human user, realizing advanced energy efficiency that brings people and machines together as never before.

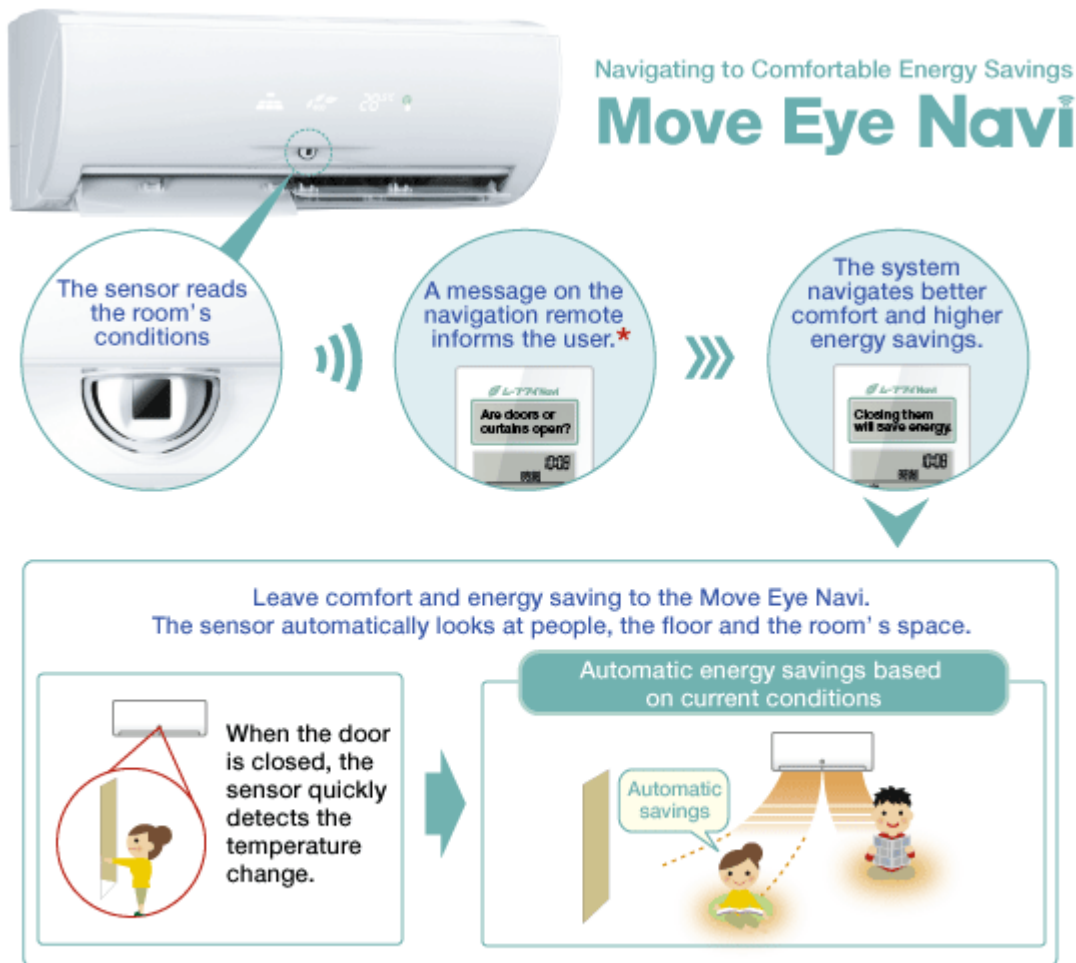
# Environment – An Industry First: A Navigation Function

## An Industry First\* —A Navigation Function that Informs People of Unnoticed Wastefulness

In addition to functionality that provides comfortable air conditioning based on perceived temperature, the Move Eye Navi is equipped with a smart function that informs the user of inefficient usage and navigates the user to information on how to get better air conditioner efficiency.

For example, if the door is left open while the air conditioner is running, the message "Is a door or window open? You can save energy by closing it" appears in the remote control window display. If the outside temperature is falling but the air conditioner is still cooling, the smart function will advise "The outside temperature is dropping. The air conditioner should be turned off."

This advanced energy efficiency that informs the user of unnoticed wastefulness is a special feature of the Move Eye Navi, a technology that is rewriting the pages of air conditioning history.



\* Move Eye detects floor, wall, window and door temperature differences. When temperature differences are small and there is little impact on energy savings, there are no alerts even if doors or windows are open.



### Forgetting to close the door is common

Are doors or curtains open?

Closing them will save energy.

The air conditioner seems to be working much better.



### If we open the window, it's probably cooler outside.

The outside temperature is dropping.

The air conditioner should be turned off.

Natural breezes are also comfortable.



## TOPICS

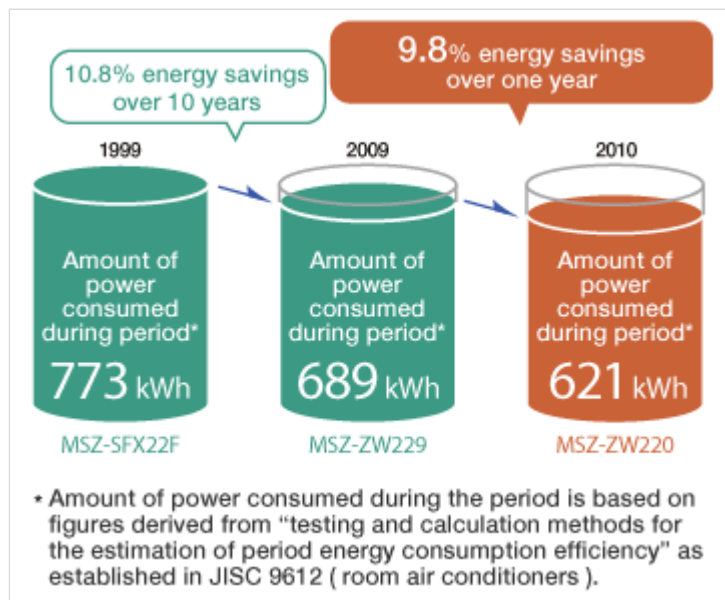
### Ten years of energy efficiency improvements achieved in just one year Winner of the Energy Conservation Grand Prize

The Move Eye Navi has the highest energy-saving performance in the industry, boasting an annual performance factor (APF) of 7.1, the highest in the industry among 2.2kW class air conditioners. According to internal comparisons, this is approximately 9.8% higher than the APF of the 2009 model (2.2kW-class). This value achieved in one year, compares to the ten years of improvements leading up to 2009.

Such significant improvement in energy efficiency is the result of innovative technological developments applied to the compressor and fan motor, which are the main elements of air conditioners. A range of innovations in production and other aspects have contributed to the realization of an air conditioner with top-class energy-saving performance.

#### Note

Annual Performance Factor (APF) is the energy consumption efficiency during a given year. The operating efficiency of an air conditioner run for one year established as one of the Japanese Industrial Standards (JIS). The larger the number, the greater the energy savings.





# Environment – Intelligent Ways to Save Energy and Reduce CO<sub>2</sub> from Production

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## Inspections by Intelligent Energy Conservation Experts Accelerate the Reduction of CO<sub>2</sub> from Production

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From fiscal 2010, Mitsubishi Electric Group is focusing on reducing CO<sub>2</sub> from production under the 6th Environmental Plan (FY2010-2012). Up to now, we have made improvements at each factory by enhancing and promoting just-in-time activities in pursuit of improved productivity, and reducing energy waste through greater production efficiency. However, from the perspective of CO<sub>2</sub> reduction and energy conservation, there are certain areas that remain unaffected by such activities. To resolve these issues, we have introduced energy conservation expert inspections to support production site improvement activities. Selected domestic and overseas employees who have participated in energy conservation improvement at various factories tour manufacturing sites to support the desire for vigorous improvements. By discovering and presenting many areas for improvement, further reduction of CO<sub>2</sub> is possible. This special feature introduces intelligent ways the experts have found to reduce CO<sub>2</sub> from production.



Is the boiler pressure too high?



What is happening during standby?

### Contents

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- ▶ Goals and Merits of the Energy Conservation Expert Inspections
- ▶ On-site during an Energy Conservation Expert Inspection
- ▶ Experts Discuss Ways to Conserve Energy
- ▶ Close-up: The Air Conditioning & Refrigeration Systems Works

# Environment – Goals and Merits of the Energy Conservation Expert Inspection

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## Experts Selected from Factories Across Japan to Support Energy Conservation through Production Line Improvements

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Energy conservation experts are employees who have been involved in energy conservation initiatives at factories across Japan, particularly those who possess considerable experience, have a track record of excellence in energy conservation activities and are highly skilled pioneers. Several experts are selected nationwide to be strong supporters of energy conservation through production line improvements promoted by the head office's Corporate Environmental Sustainability Group.

These experts constitute a team that tours factories in Japan and overseas, conducting inspections from multiple perspectives. At present, these inspections are focused on factories that emit a comparatively large volume of CO<sub>2</sub>, as well as factories that are models of energy conservation. In fiscal 2010, inspections were conducted at three domestic and one overseas factory. In addition to pointing out areas for improvement overlooked by factory staff, experts encourage staff to join them in taking a fresh look at the factory. Looking at their workplace from a different point of view, employees discover new perspectives and ways of thinking.

## Eyes Trained to Spot Areas for Improvement

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Experts visiting factories to conduct inspections observe every detail of the production site. From infrastructure such as electrical equipment, boilers, air compressors and ductwork, to the management of production equipment, experts make detailed observations of operations as well as people, checking for the smallest losses and inefficiencies.

Although each factory has traditionally engaged in energy conservation improvement initiatives under their respective environmental promotion managers, the experts possess experience cultivated at many production sites and are able to discover the need for improvement in a wide range of areas. With backgrounds that include personal involvement in the development of production equipment for the manufacturing technology department, the promotion of line energy visualization as the head of energy management and various other work histories, these experts have formulated their own theories on improvement based on visits to numerous factories and wealth of experience. They use this experience to discover areas for improvement from a fresh perspective.



Energy conservation experts conducting inspections.

## Supporting On-Site Improvements with a Detailed Inspection List

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After inspections have been conducted, each recommended improvement is explained to the factory manager and provided as a list of action items to the factory. In 2010, inspections conducted at the Shizuoka Works in January uncovered 120 action items, activities at the Nagoya Works in February found 70 items, and inspections at the Air Conditioning & Refrigeration Systems Works (Wakayama) in March discovered 170 items.

The action items are categorized into improvements that can be implemented immediately and those that require a certain amount of time and cost, so that each factory can determine the most efficient way to make improvements based on the inspection list and given their present situation. The energy conservation experts provide an excellent opportunity for promoting production line improvements at factories.



Setting up a venue to share inspection results. At this meeting, employees learn the expert's perspective to discover areas for improvement.

## Advice for Progress, Not an Audit

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Energy conservation expert inspections differ from audits and examinations in that they provide forward-looking suggestions and advice rather than evaluating past activity.

The inspections provide strong support for vigorous improvement activities at each factory. In this way, they are similar to the diagnosis a doctor would give their patient. Factory staff appreciate these diagnoses, which in turn inspires the experts to redouble their discovery efforts.

Experts encourage staff to take a fresh look at the factory with them. Looking at their workplace from a different point of view helps employees discover new perspectives and ways of thinking. The direct and indirect effects of these inspections combine to raise the overall level of improvements at each factory.

## Inheriting the Experience of Experts to Target Further Developments

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In the past, we multiplied our production output by a 0.1% investment in energy-efficiency, but volatile business conditions have lowered our overall production output, making investment and capital expenditures difficult. As a result, production line improvements are conducted through "intelligent" energy conservation. Despite our inability to make large investments, each factory is finding intelligent ways to eliminate waste and inefficiency, and promote energy conservation and CO<sub>2</sub> reduction.

The production site is like a living entity, constantly changing in response to a variety of factors, including the movement of markets, the development of new products and the advancement of new technologies. In this sense, the need for improvements is endless. Likewise, for each factory, an energy conservation expert inspection is not the final goal, but a new starting point. By inheriting and further developing the experience of experts, factories in Japan and overseas are able to take their own steps toward the achievement of larger goals.

## A Promotional Leader Discusses Further CO<sub>2</sub> Reductions

### Human Resource Cultivation Part of Ongoing Efforts to Improve Energy Conservation

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We are seeing results beyond the inspections conducted by the energy conservation experts. Their accurate inspections and our own efforts are linked to significant improvements.

We plan on cultivating energy conservation promotion leaders to advance energy conservation improvements at each production site. We will cultivate these promotional leaders through training on energy conservation methods and improvement expertise, selecting employees from each production site to promote energy management and improvement activities. Promotional leaders will conduct inspections along with energy conservation experts to develop knowledge and skills firsthand, with the long-term goal of becoming energy conservation experts in their own right.



**Yoshio Kasuga**  
Promotion Group Manager,  
Corporate Environmental  
Sustainability Group

# Environment – On-site during an Energy Conservation Expert Inspection

## More Than 100 Areas for Improvement at a Single Factory

This section takes a closer look at an inspection conducted at Mitsubishi Electric's Air Conditioning & Refrigeration Systems Works (Wakayama) in March 2010.



I wonder...why was this temperature sensor installed? If the goal is to regulate drain temperature, just use a high-temperature pump.



This is a great power supply method, and it has very little start-up power loss. We should definitely make it a standard.



There is heat loss coming from this open steam pipe. You should put a flange and thermal insulation cover over it.



This steam heater is increasing the temperature, but it is inefficient due to significant steam loss. Since the temperature is low, you should be able to use a more efficient heat pump.



The outdoor unit on this laboratory air conditioning is above the ceiling, but its exhaust should be directed outside the factory to reduce the heat load.



The valve on this through-flow boiler is exposed. To eliminate heat loss, you should use a thermal insulation cover.



You are very thorough about switching off the power on machines that are not in operation. This is a great way to eliminate wasteful standby power.



What is the management range of this pressure gauge? What is the basis for that pressure reading? Can it be lowered?



One of the boilers has stopped. Isn't the pressure too high? Ah, yes, it is. Let's suggest lowering it after we check what the operating pressure is supposed to be.

## On Energy Conservation Expert Inspection

Although this factory has been engaged in thorough energy conservation initiatives for several years, we are very appreciative that the inspection identified 177 areas for improvement. I was present during the inspection, and realized that I had become lax in my view of what was considered normal at our factory. The experts were very good at pointing out how insufficiently prepared we were to respond to fluctuations in production, and how disparate and unorganized our efforts really were.

This inspection was different from environmental audits in that it also told what we are doing right. They acknowledged our efforts and ideas and responded with advice on how to further improve both. This provided much more incentive than simply being told what to do.

Going forward, we will complete a detailed investigation of every action item on the inspection list, creating keywords and prioritizing actions to realize improvements. We will determine new standards for the entire factory and promote further reductions in CO<sub>2</sub> and energy usage.



**Tsunenori Mori**  
Deputy Manager, Air-Conditioning &  
Refrigeration Systems Works  
(Wakayama)

# Environment – Experts Discuss Ways to Conserve Energy

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## A Careful Look at Current Processes Reveals All Kinds of Waste

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As I am in charge of developing equipment for the production line, I clearly understand the feelings and perspective of production site staff. This also enables me to easily recognize waste. When searching for waste, I begin by looking at the energy required for production and the energy required for the production environment, and then check to see if the energy being used is meeting those objectives. For example, if a machine used in processing is operational but idle, or if an air conditioner is running in an empty room, then energy is being wasted.

Taking a careful look at things taken for granted at the production site and questioning the usefulness and necessity of things will reveal all kinds of waste. This is the perspective I hope to impart through the inspection activities at each factory.

**Teruyuki Shibata**  
Sanda Works

Mr. Shibata has been touring factories since 2003. In 2005, he received The METI Minister's Award for Excellent Energy Conservation Factory for his efforts as a front runner in factory energy conservation.

## Indicating Immediate Improvements through Discussions with Factory Staff

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I am a bit different from other members in that although my background is in architecture and building services, I conduct inspections that confirm the usage of air and boilers. I look at the use of energy based on the perspective of just-in-time production activities. If necessary items are not in their necessary place at the necessary times, loss occurs. I have visited many factories in the past where oil pressure pumps and exhaust fans were running even though nothing was being produced. This type of waste must be eliminated.

Employees who work at the production site play a leading role in the promotion of energy conservation. This is why I always try to talk with as many on-site staff as possible when conducting inspections. Offering my suggestions and then asking their opinions gets them started asking questions, so we can have a constructive dialogue. By indicating immediate improvements, I can convey my thoughts and ideas easily and directly.

**Kazumi Kobayashi**  
Fukuyama Works

Mr. Kobayashi has made significant achievements in the promotion of basic unit management. At present, he recommends energy-saving equipment and systems to customers across Japan as a consulting business based on his expertise. He also has considerable experience with improvements in non-Mitsubishi Electric factories.

## Energy Conservation Improvements at Production Sites an Ongoing Effort

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My specialty is electronics, but my particular focus in the context of inspections is heat. Heat-related energy loss is common, and oftentimes more energy than necessary is used. One familiar example is heating a kettle to boil water. This process wastes considerable energy. I think that thorough heat-related improvements will have a major effect on energy conservation.

With energy conservation improvements at production sites, continuity is key. When on-site activities first began, many ideas were suggested, and people gradually began believing that nothing further could be accomplished. I think energy conservation inspections are crucial to ongoing improvements. This is why I make the utmost effort to discover areas for improvement at each factory I visit.

**Michitoshi Takagi**  
Power Distribution Systems Center

Mr. Takagi was a pioneer in the visualization of energy in on-site production, and has made notable achievements in this area. In 2008, he was awarded the METI Minister's Award for Excellent Energy Conservation Management.

## Inheriting the Knowledge of Veteran Employees to Carry on to the Next Generation

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As the member with the least amount of experience, I always try to add some of my own originality during inspection activities. My particular focus is the various components used in production equipment and the energy they use. In many cases, waste occurs because energy conservation was not taken into consideration when equipment was introduced. Such cases offer the potential for energy savings through changing the equipment controls. I check for waste by applying the experience I have cultivated in production equipment.

Being younger than the other experts, I benefit a lot from the knowledge of veteran employees. Their presence during inspections is helpful, and the feedback and communication they provide during and after inspections is particularly useful. I want to continue this process of inheriting knowledge and passing it on to the next generation.

**Shinichi Ichikawa**  
Nakatsugawa Works

Formerly a production technology manager developing production equipment, Mr. Ichikawa moved to the Environmental Department 11 years ago, where he began participating in factory inspection tours originally conducted for educational purposes. After gleaning knowledge from veteran employees, he began promoting improvements at his factory, and he is now the youngest energy conservation expert on the team.





The reliable energy conservation experts

# Environment – Close-up: The Air Conditioning & Refrigeration Systems Works

## Initiatives as a Factory That Excels in Environmental Improvements

Among Mitsubishi Electric's many production sites, the Air Conditioning & Refrigeration Systems Works is particularly focused on environmental conservation. From early on, they have incorporated energy conservation initiatives into just-in-time activities and promoted various improvements to ensure the necessary item is in the necessary place at the necessary time by conducting energy usage inspections from six perspectives (change, quit, stop, lower, fix and reuse). These activities produced remarkable results, which were recognized with two first prize awards for factory excellence at our internal improvement activities announcement, which is attended by representatives from each site.

### Six Perspectives for Energy Conservation Activities



### Air Conditioning & Refrigeration System Works

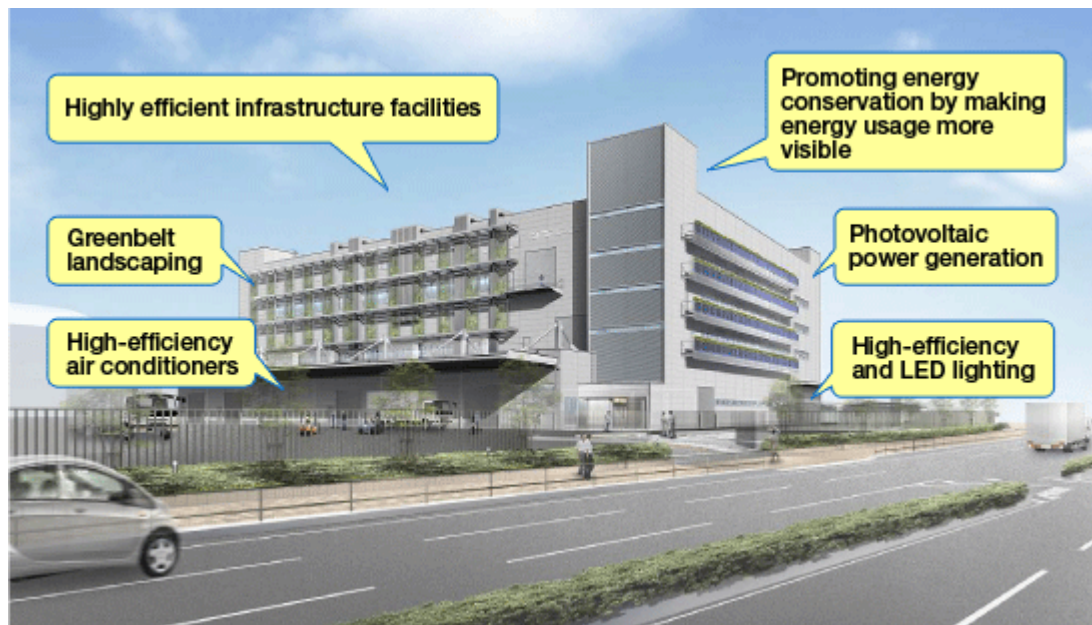
Manufacturing large-scale air conditioning and refrigeration systems, including commercial cooling systems

Also, the works independently created a booklet titled Factory Energy Conservation Initiatives that provides case studies and a summary of achievements at the Air Conditioning & Refrigeration Systems Works. This booklet is particularly popular with customers who are concerned with how to make their entire factory more energy efficient.

Furthermore, at present a new, environmentally compatible wing of the factory is under construction on the Works' premises. In addition to highly insulated facilities and energy-saving equipment, the facility will include a photovoltaic system and greenbelt landscaping on the roof and walls. And the factory's product display area is designed around the concept of factory-wide energy visualization, showcasing the energy visualization initiatives of the Air Conditioning & Refrigeration Systems Works.

## Factory Energy Conservation Initiatives

Presented in a series format, this publication is in its 12th edition, providing readers with energy conservation success stories and practical pointers.



The environment-themed wing is scheduled for completion in August 2010.

## Expanding the Scope of CO<sub>2</sub> Reduction Measures to Testing Facilities

The Air Conditioning & Refrigeration Systems Works has been engaged in initiatives to reduce the amount of CO<sub>2</sub> emissions from production in accordance with company-wide policy, but from fiscal 2010 the focus of these activities was expanded to incorporate testing facilities in energy conservation initiatives.

This factory, which mainly produces air conditioning equipment, must conduct tests under a variety of environmental conditions, and energy used during product testing makes up a large percentage of overall energy usage, which, at 20%, is second only to the 28% of overall energy usage during production. Of this 20%, a large amount is used in the testing facilities, where we promote various improvements.

We are promoting various measures, including the visualization of changes in electric power usage for each testing procedure and the change to inverter-based control to operate testing facilities. Furthermore, in noise measurement testing for indoor units with low heat loads, knowing that even setting wider tolerance for temperature conditions we can still meet our objective, we put into practice key measures that rigorously calculate the energy required to acquire valid data.

# Environment – Coordinated Regional Waste Recycling (Kyushu Region)

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## Seven Different Factories Working Together to Promote Environmental Contribution and Cost Reductions

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Since 2008, in the Mitsubishi Electric Group's Kyushu area (comprised of Nagasaki, Fukuoka and Kumamoto Prefectures), several factories have been working together across prefectural and regional boundaries to promote coordinated waste recycling activities. Such regional partnerships among Mitsubishi Electric Group companies originally began in the Kansai area. However, the Kyushu area efforts are noteworthy for their meticulous approach to collaboration and partnerships that discover and create win-win scenarios for Group affiliate companies and waste disposal partners. This section provides an overview of these unique initiatives.

### Contents

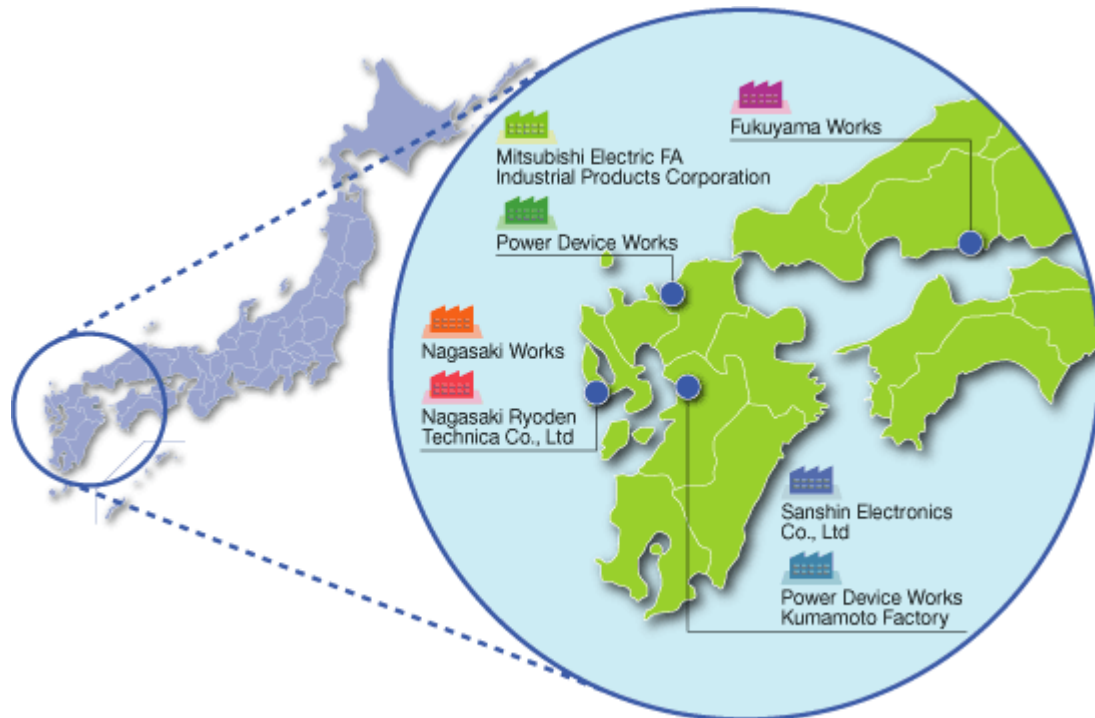
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- ▶ Mobilizing Managers from Seven Factories
- ▶ Mutual Inspections Uncover Areas for Improvement
- ▶ Sharing Information on Waste Processors
- ▶ Streamlining the Waste Material Flow
- ▶ Creating a Win-Win Relationship

## Environment – Mobilizing Managers from Seven Factories

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The island of Kyushu, located in southern Japan, has an area of 13,761 square miles (35,640 km<sup>2</sup>) and is divided into seven different prefectures. Until recently, the seven Mitsubishi Electric factories, which are spread across a region including Hiroshima Prefecture and the entire Kyushu area, have promoted waste recycling initiatives individually. The processing of general industrial waste was carried out by each factory, usually without the involvement of factories outside the area. However, the major success of coordinated regional recycling activities in the Kansai area in 2007 led to the formation of a working group consisting of seven managers from four Mitsubishi Electric Factories and three affiliated companies in November 2008. The Nagasaki Works, which is passionate about reducing waste, spearheaded the establishment of this working group.



## Environment – Mutual Inspections Uncover Areas for Improvement

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When the working group was created, the seven members began inspecting each of the seven factories, learning that "normal" practices at one site were not always viewed the same way at other sites. They ended up making several important discoveries.

One example was the discovery that the waste one factory paid to dispose of was viewed by another factory as a goldmine. By meticulously separating waste according to type and purity, some factories were able to convert as much as 40% of their waste into saleable materials.



### **Working Group Members (From left)**

**Yuki Ono**, Nagasaki Works (Project Leader)

**Mitsuhiro Yano**, Power Device Works

**Masafumi Mino**, Sanshin Electronics

**Hideto Yoshizumi**, Power Device Works Kumamoto Factory

**Takahiro Hamachi**, Mitsubishi Electric FA Industrial Products

**Tomoyasu Sato**, Fukuyama Works

**Hajime Murata**, Nagasaki Ryoden Technica

## Environment – Sharing Information on Waste Processors

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In the past, factories selected waste disposal partners based on in-house knowledge, but now they understand differences in processing technology, processing expenses, the purchase price of saleable materials and storage facilities. Based on this knowledge, factories are now able to switch to processing methods with lower environmental impact and select excellent partners, leading to a higher level of environmental conservation activities. In addition, in cases where multiple factories employ the same outsourced waste operators, the factories conduct inspections of these operators and their facilities on a rotating basis, sharing information about the inspections with other factories. This approach conserves energy and strengthens management.

### Seven People Exchange Information on Waste Processors

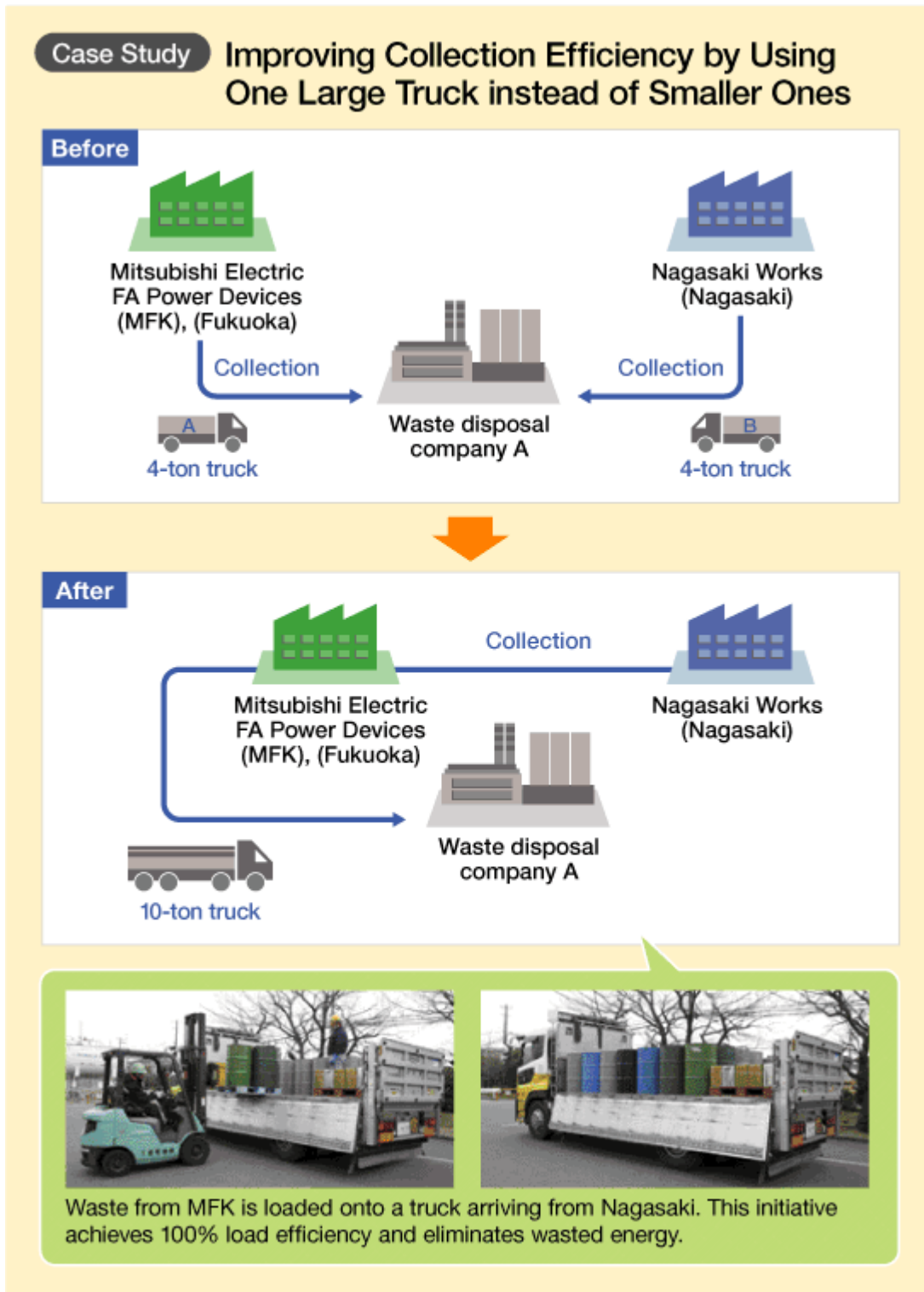
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- Company A has set up a compliance department, so from now on they should be even more legally observant.
- Did you know that Company B put in place an initiative to cut landfill waste to zero?
- Company C has expanded its facilities and has extra capacity, so they might be flexible on pricing.
- D waste disposal company respond quickly, and they're very reasonable.
- "Thanks for the tip! We'll give them a try!"



## Environment – Streamlining the Waste Material Flow

Before this initiative, multiple factories contracted the same waste disposal operator individually to collect factory waste. Now, waste is collected from those factories using one large truck, thereby eliminating wasted energy and achieving 100% load efficiency. The efficient use of large trucks, which have a comparatively low degree of capacity utilization, also benefit the waste disposal operators, who can now use smaller trucks—which have a higher turnover rate—for other uses. Furthermore, by abolishing weekly waste collection that took place regardless of the amount of accumulated waste, and establishing a system in which collection occurs only when a truckload of waste has accumulated at each factory, the number of required truck trips as well as CO<sub>2</sub> emissions have been reduced.





## Environment – Creating a Win-Win Relationship

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All these achievements could not have been accomplished by the factories working on their own. Cooperation among factories and with waste disposal partners was indispensable to the program's success. Through the development of a meticulous methodology and cooperation that contributed to factories and waste disposal operators alike, these efforts resulted in the creation of a win-win relationship. Although the working group is less than one year old, its members have already discovered that waste disposal can be interesting, and they are eager to achieve further success. In fiscal 2011, we plan on adding an affiliated company located in Kumamoto Prefecture to the Kyushu area working group. In coordination with activities in other areas, including those of the Kansai area, Mitsubishi Electric will continue to share information and find opportunities for collaboration, aiming to further enhance our level of activity.



## Environment – Exchanging Ideas with Experts (Respecting Biodiversity)

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### Exchanging Ideas with Experts (Respecting Biodiversity)

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To strengthen and promote the Company's initiatives to respect biodiversity, we established the [Mitsubishi Electric Group Biodiversity Action Guidelines](#) and created a [chart](#) to help people understand the impact and consequences of our business activities on biodiversity. We are also considering whether or not it would be appropriate to establish special indices that numerically evaluate product environmental performance, the impact of the supply chain and other activities. We invited Ryo Kohsaka, Associate Professor at Nagoya City University and advisor to the executive committee of the 10th Conference of the Parties to the Convention on Biological Diversity (COP10), to exchange ideas with respect to these initiatives. The following is an overview of our discussion with Mr. Kohsaka.



### Activities Are Based on Feelings, and upon those Are Actions Based on Logic

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**Mr. Kohsaka:** I would like say something before discussion begins. I believe there are two levels from which we can approach the preservation of biodiversity.

The first level is feelings, the feeling of being connected to other living things. Many people feel that living things are cute or that they should be taken care of or protected. These feelings link us to these living things. The feeling that living things should be taken care of is itself a first step toward respecting biodiversity. Starting out with an awareness of these feelings will result in a much deeper understanding of the need to reduce CO<sub>2</sub> and waste.

The second level is logic. We objectively recognize that businesses and everyday people receive various benefits from the ecosystem, and at the same time business and people impact the ecosystem in various ways. Based on this awareness, changing our actions on a person-by-person basis is linked to highly effective activities. It is from these two perspectives that I want to discuss the many initiatives you are engaged in here at Mitsubishi Electric.

## Advice on the Mitsubishi Electric Group Biodiversity Action Guidelines

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**Mitsubishi Electric:** We are currently formulating biodiversity action guidelines. What advice can you give us?

**Mr. Kohsaka:** The basic principles of management, actions and business contributions proposed in your plan represent the basic elements necessary for corporate biodiversity initiatives, and I think you are headed in the right direction. In particular, I commend you highly for your actions in terms of fostering environmental awareness and communicating the importance of protecting the ecosystem. These actions reflect feeling, which is the basis of respecting biodiversity.

Taking this idea a step further, I think it would be even better to promote these activities with the cooperation of regional communities. The cooperation of knowledgeable specialists and local citizens is indispensable to understanding the impact of your efforts on biodiversity. Based on your guidelines, for example, collaboration with an NPO engaged in environmental protection in each region would be a good way to develop a solid base for regional activities.

- ▶ In May 2010, the Mitsubishi Electric Group Biodiversity Action Guidelines were announced.

## Advice Regarding the "Impact on Biodiversity" Chart

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**Mitsubishi Electric:** We are in the process of creating a chart entitled "Relationship between Business Activities and Biodiversity". What advice can you give us?

**Mr. Kohsaka:** I think looking at the overall relationship between business activities and biodiversity is an excellent idea. However, looking at the basic chart, it appears that you have given equal weight to the procurement, design & production, shipping & sales, use & storage and recycle & product waste stages of the lifecycle. You should probably give more weight to raw materials procurement in the manufacturing supply chain. The reason is because many people are concerned about the kinds of materials products are made from, and how they might impact biodiversity. This has to do with the feelings I mentioned previously.

For example, if you asked the average person how they would want Mitsubishi Electric to contribute to environmental conservation, they would probably say that they want you to make products that don't use a lot of electricity. However, if you asked the same question in respect to biodiversity, I think they would say that they want you to carefully consider materials procurement. This is because their image of Mitsubishi Electric is a large corporation that manufactures products from materials and resources procured from around the world. Manufacturers place a lot of emphasis on design and production when considering biodiversity, but the average person approaches this issue from a logical level. It is important that actual activities begin at the feeling level in order to create understanding.

- ▶ In May 2010, the Impact on Biodiversity Chart was published.

## Supply Chain Considerations

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**Mitsubishi Electric: With respect to the supply chain, specifically, the acquisition of resources and materials, how far back do we need to go in considering impact on the ecosystem?**

**Mr. Kohsaka:** All products have parts that are interconnected with the ecosystem. The questions of how far back you should go and what actions you should take are critical, but I think a visual awareness that our lifestyles have an impact in this area on the environment in other countries is an important first step.

Using the paper industry as an example, many European companies have their own forests and they use wood from their own trees, making the connection easy to see. With Japanese companies, that connection is difficult to see. However, with the destruction of ecosystems in various places around the world, there are definitely connections with the activities of Japanese companies. It is important that we understand the limits and impact of those connections.

One other perspective, the contribution to other people, is important. This is missing from discussions about biodiversity across the globe. Although we have protections for orangutans and gorillas, little thought is given to the people who live in those same areas. However, education, hygiene and poverty levels are all an extremely important element of respecting biodiversity. When these conditions worsen, slash and burn and other detrimental types of farming have a higher probability of occurring. It is important to view contributions to biodiversity as critical to providing a stable and sustainable lifestyle to people in these regions.

## Regarding the Establishment of Numerical Indices

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**Mitsubishi Electric: Do you think indices quantifying life cycle assessment\* and voluntary standards are effective for respecting biodiversity?**

**Mr. Kohsaka:** It is easy for companies to promote initiatives when they are represented numerically in indices, and I think it is an effective method in terms of creating objectives and measuring improvements. However, there are more than a few cases where the creation of indices is actually done simply as a means of disclosure. At present, there are various indices created by various countries, and I think these should be viewed with caution. Also, with respect to individual indices, there is a possibility that only certain numbers are presented. I don't think this type of activity is an appropriate methodology. For example, by focusing only on the reduction of CO<sub>2</sub>, the degree to which resources are being used effectively might get ignored. I think it is necessary to position the various activities from the perspective of sustainable corporate management.

For this reason, I don't believe it is necessary to create more indices in support of biodiversity initiatives. Indices established for improvement efforts toward the creation of a low-carbon society are frequently a plus for biodiversity. Rather than creating a new index, I think it is more important, for example, to conduct manufacturing with consideration for the impact of resource extraction.

\* Life cycle assessment is a method of quantitatively and comprehensively evaluating a product's environmental impact as it passes through the product lifecycle, from resource extraction, design, production, shipping to use and disposal.

## Expectation for Mitsubishi Electric

### Mitsubishi Electric: What are your expectations for us in terms of realizing a sustainable society?

**Mr. Kohsaka:** The top page on your [Japanese] corporate website uses photographs from The Beauty of Nature taken by Mitsuaki Iwago, and conveying the beauty of nature to the visitors to your website is a highly effective means of inculcating positive feelings about biodiversity. I think the next step will be critical in terms of how you will connect that feeling to the next level, which is logic. I think making that connection successfully is both an action item and an opportunity for Mitsubishi Electric.

For example, if you do create an index, making the objectives clear both within and outside the company, employees and consumers alike will see the link between your corporate activities and biodiversity. I would like to see you promote initiatives that make people aware of your efforts in this area. On this point, your strength lies in making products with a wide range of everyday uses. I hope that you will maximize on this strength and lead Japan in biodiversity-related efforts.

### Idea Exchange Participants

#### Advisor



**Ryo Kohsaka**

Associate Professor, Nagoya City University

Executive Committee Advisor, The 10th Conference of the Parties to the Convention on Biological Diversity (COP10) Guest Researcher, United Nations University Institute of Advanced Studies

#### Mitsubishi Electric Corporation



**Michio Hiruta**

General Manager,  
Corporate Environmental  
Sustainability Group



**Kanji Ota (Energy-Saving Specialist)**

Chief Engineer,  
Corporate Environmental  
Sustainability Group



**Motohiro Tanaka (Eco-Design Products Specialist)**

Strategic Planning,  
Corporate Environmental  
Sustainability Group



**Hiroko Higuma (Chemical Substance Regulations Specialist)**

Strategic Planning,  
Corporate Environmental  
Sustainability Group



**Yasuro Toba (Procurement Specialist)**

Planning Group,  
Corporate Purchasing Division



**Junko Tawada (Social Contribution Specialist)**

Philanthropy Promotion Section,  
Corporate Administration Division

## After the Idea Exchange Meeting

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From a corporate perspective, biodiversity is a difficult topic to grasp. We of course understand its importance, but how to go about addressing it was a bit elusive until our meeting with Dr. Kohsaka. Thanks to his insight and ideas, we have a deeper understanding of biodiversity. It is very helpful to understand the two levels of initiatives in respecting biodiversity, and how to apply them to our own activities.

The Mitsubishi Electric Group aims to foster environmental awareness among all employees through initiatives such as the Mitsubishi Electric Outdoor Classroom and woodland preservation activities, and recognizes the importance of feeling with respect to all living things. Also, through making the link between business activities and the ecosystem more visible, we felt that it is possible to help each employee better understand our activities focused on creating a low-carbon and recycling-based society as promoted by Environmental Vision 2021; this is an important step in helping each employee change their actions.

We will take Dr. Kohsaka's ideas to heart and continue to promote Mitsubishi Electric Group initiatives to respect biodiversity.



**Michio Hiruta**  
General Manager,  
Corporate Environmental  
Sustainability Group

## Environment – Innovative Products and Production

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The minimo motor for compact ventilators meets Mitsubishi Electric's goals of energy efficiency and resource conservation. The motor is the result of concurrent engineering, which refers to various engineers cooperating on design, manufacturing technology and facilities development to make the best product. This section introduces the eco-compatible minimo.

### Contents

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#### ▀ Product Innovations

minimo—the world's smallest\* fan motor—greatly reduces the environmental impact of housing.

- minimo is energy efficient and conserves resources
- minimo provides outstanding environmental performance

\* Among AC capacitor start motors for compact ventilators. As of Feb. 2008, Mitsubishi Electric survey.

#### ▀ Production Process Innovations

Superior process pooling Mitsubishi Electric's strengths in motor design, manufacturing technology and facility development

- Concurrent engineering is the DNA of the Nakatsugawa Works
- The development stage combines the Company's technologies, knowledge and experience
- Concurrent engineering evolves in the Iida Creation Lab

#### ▀ Engineers' Perspectives

#### ▀ Working with the Community for the Environment

# Environment – Product Innovations

World's smallest fan motor greatly reduces the environmental impact of housing

## "minimo" is energy efficient and eco-compatible

Motors in pipe fans used to ventilate living rooms, bathrooms and other rooms are installed in the airflow channel. So a smaller motor provides less wind resistance and greater airflow. However, as the size of the motor is reduced, the power efficiency declines, as does the ventilator's performance.

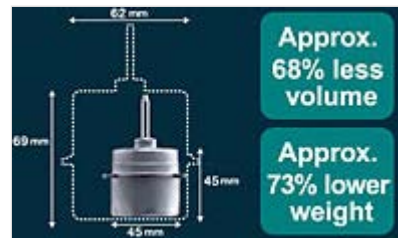
Mitsubishi Electric solved this problem with minimo, a substantially smaller yet high-performance motor. minimo's outer diameter is 43 millimeters, making it the world's smallest motor of its kind. Compared with similar conventional motors, the compact minimo has 68% less volume and is 73% lighter. Pipe fans that employ a minimo use around 22% less power yet still provide 25% more airflow than typical models. Being compact, minimo saves valuable limited resources by substantially reducing the plastic, iron, copper and other raw materials needed to produce it.



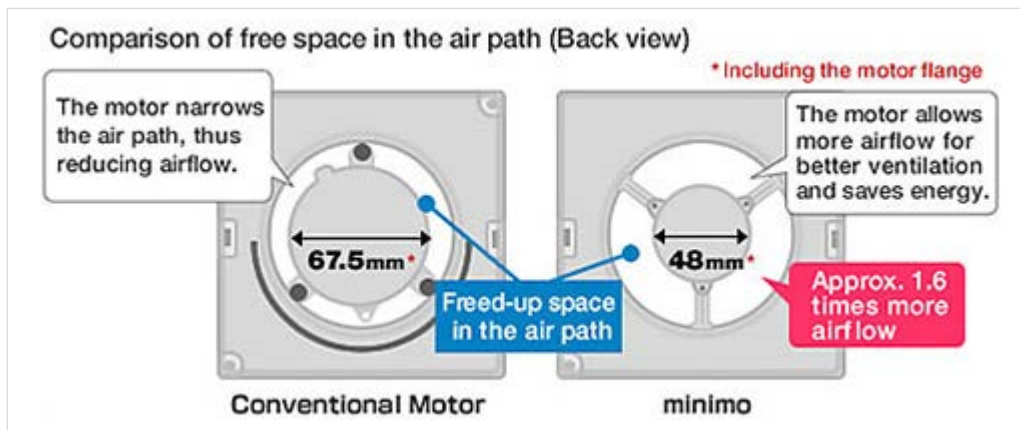
The world's smallest capacitor start motor for compact ventilators: minimo

### Higher airflow and less energy consumption

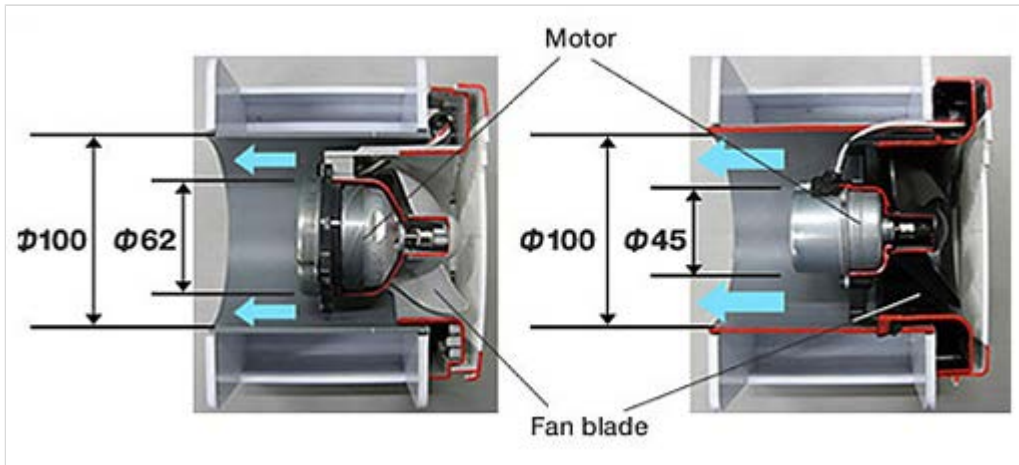
In conventional motors with a diameter of 67.5 millimeters, including the flange, part of the motor blocks the airflow. This part takes up 56% of the cross-sectional area, compared to only 28% for fans equipped with the minimo. Moreover, minimo fans reduce air resistance (boosting airflow by 25%), yet at the same time lower power consumption by 22%.



Compactness saves resources

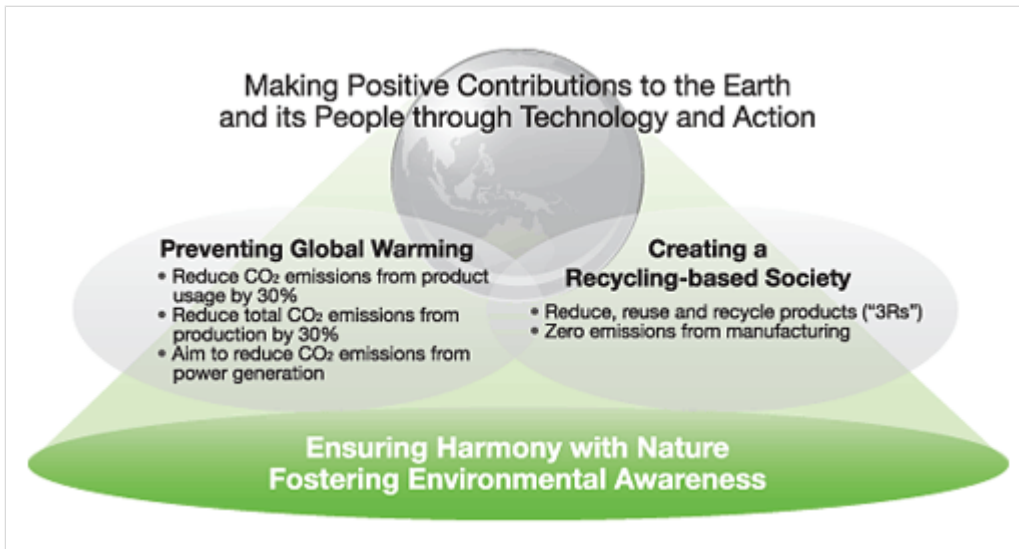






### Environmental Vision 2021 and minimo

Environmental Vision 2021 sets targets to be achieved by the year Mitsubishi Electric celebrates its 100th anniversary. Major objectives include reducing CO<sub>2</sub> emissions from production and product usage to prevent global warming, and actively promoting 3R (reduce, reuse, recycle) initiatives to bring about a recycling-based society. The innovative minimo, which is energy efficient and eco-compatible, contributes to these objectives. minimo is a model for Mitsubishi Electric's product development efforts.



## Excellent environmental performance possible because ventilators generally not seen

Customers are not usually aware of the performance of the pipe fans preinstalled in the homes they purchase. However, the energy they consume is significant.

Pipe fans account for about 30% of the ventilators used in Japan, according to a 2007 survey by the Japan Electrical Manufacturers' Association. Following revisions to the Japanese building code in 2003, full-time ventilation has become a requirement for most new dwellings, and pipe fan installations are expected to increase.

Pipe fans are used in most houses, but they are seldom chosen directly by consumers. For this reason, Mitsubishi Electric has accepted responsibility for providing products with exceptional environmental performance. Our minimo-equipped pipe fan received the 2007 Energy Conservation Grand Prize from the Director-General of the Agency of Natural Resources and Energy.

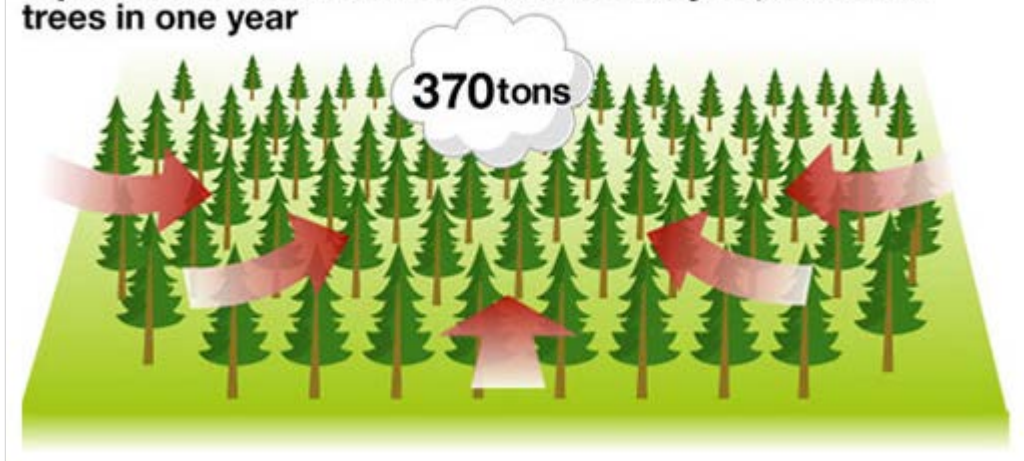


### How much does minimo benefit the environment?

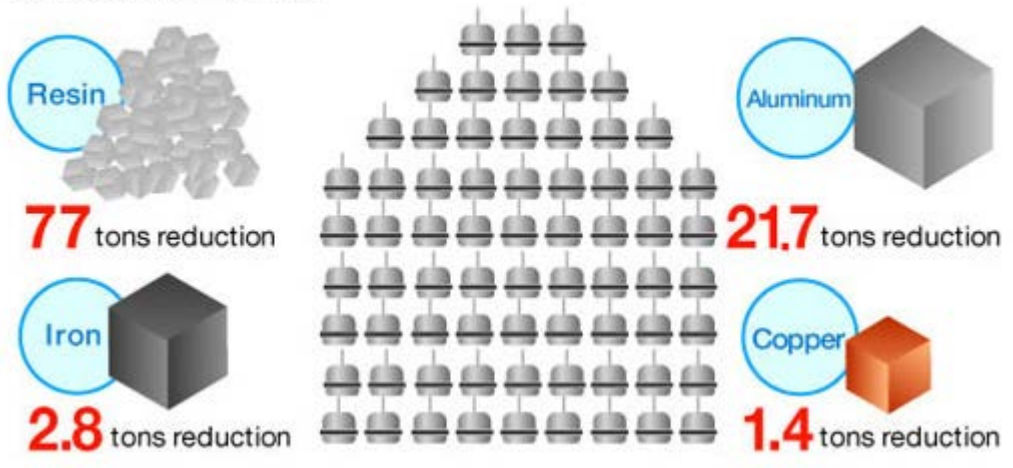
If all the pipe fans sold by Mitsubishi Electric were equipped with minimo, the energy saving would equal some 370 tons of CO<sub>2</sub> a year. Using minimos would also reduce resource usage: plastics by 77 tons, aluminum by 21.7 tons, iron by 2.8 tons and copper by 1.4 tons. These savings by minimo would make a significant contribution to preserving the environment.

\* Assuming half of the pipe fans sold by Mitsubishi Electric are run 24 hours a day and the other half five hours a day.

### Equivalent to amount of CO<sub>2</sub> absorbed by 26,000 cedar trees in one year



**Materials equivalent to around 200,000 conventional models are saved**



## Environment – Production Process Innovations

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**Superior production process combining the strengths of motor design, manufacturing technology and facility development**

### Concurrent engineering: the DNA of Nakatsugawa Works

minimo was developed by a project team from the Iida Factory at the Nakatsugawa Works. For the project, engineers specializing in motor design, manufacturing technology and facility development gathered at the factory. This concurrent engineering resulted in the development of this product.

The Iida Factory is one of Japan's leading facilities for ventilator production. It manufactures duct ventilators, pipe fans and other models. As competitors shift production overseas, the Nakatsugawa Works has remained focused on production in Japan while pursuing a high market share and customer satisfaction through high-quality products matched to the needs of the Japanese market.

The Iida Factory makes highly competitive products because of its ongoing factory automation. The Nakatsugawa Works can handle production from line design to the design and development of automation equipment and molds. The factory combines these technologies to build automated, high-efficiency, high-precision production lines that cannot be imitated. Product development does not follow a typical pattern of design production. Instead, an automated production line is a prerequisite, and so divisions collaborate to create the optimal motor design, production line configuration and equipment molds. The Company has used this development process for many years. Long before concurrent engineering became widespread, the Nakatsugawa Works applied this approach to product development, a process it terms its DNA.



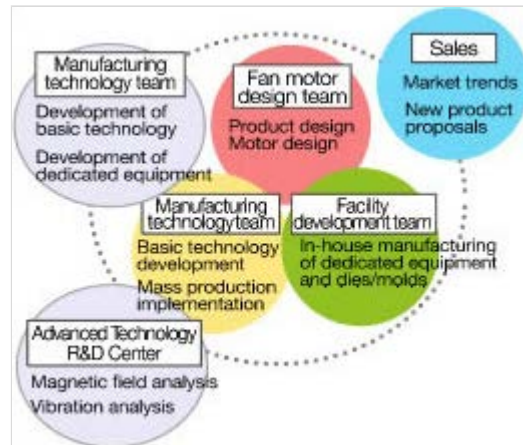
Motors produced at the Nakatsugawa Works. At front, a motor produced at the Iida Factory. The Nakatsugawa Works has produced ventilators since 1943 and made its 100 millionth product in 2006, produced. The Iida Factory had manufactured more than 40 million as of 2005. The high-quality, highly reliable products that come off these facilities' automated production lines have made Mitsubishi Electric the No. 1 manufacturer for four straight years, as chosen by material and equipment manufacturers, according to a survey by Nikkei Architecture.

## Combined technologies, knowledge and experience at the development stage

The Nakatsugawa Works' DNA was evident in the development of minimo. To create the ultimate fan motor, top staff members from sales, motor design, manufacturing technologies, facility development and other divisions participated. Also enlisted was the Manufacturing Engineering Center, which provides technical support for all of Mitsubishi Electric's production sites around the country. Highly experienced employees were invited to the Iida Factory. This new team pursued the best product development process by combining and fusing technologies, knowledge, and experience cultivated on the production floor, the front line of product manufacturing.

As the team developed concurrent technology, a key was technical innovations related to integrating design with manufacturing. For example, the motor coil was separated from the insulating framework and insulated after winding the copper wire as densely as possible and inserting other parts. This new technology shattered conventional views about fan motors and is why minimo is compact and efficient. The minimo is the direct result of combining a new manufacturing perspective with motor design. The Nakatsugawa Works is well known for this type of innovation.

Technical innovations went beyond designs. Concurrent engineering resulted in many manufacturing innovations as well. An experienced employee in fan motor design was put in charge of production technology, a move that infused a new perspective. Similarly, staff from the Manufacturing Engineering Center worked closely with team members in charge of facility development and combined their respective expertise. Efforts were made to reduce loss in every process, including the development of a work conveyance system. The team constantly innovated to ensure the best product was manufactured with high-precision efficiency.



Technology Development System for minimo



minimo: a product of concurrent engineering



Project Members for minimo From left: Deguchi (design leader), Yamaguchi (production technology leader), Kinoshita (project leader), Miyake (production technology development assistance)

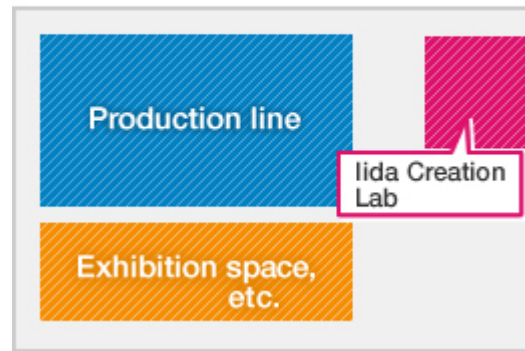
## Iida Creation Lab: Source of concurrent engineering

The Iida Creation Lab at the Iida Factory was a key element in the concurrent engineering used to develop Minimo. This lab houses parts and components for experiments and product development. It also hosts meetings at which project members exchange ideas.

The Iida Factory is a production site without a formal development division. At the start of the project, space was created next to the factory entrance of the where all development team members could meet. The development site was located within a few steps of the production line to aid in fusing design and production.

Many manufacturing facilities aspire to concurrent engineering, but their actual development process typically involves technology developed separately because of the high degree of specialization required, with regular meetings to coordinate these disparate efforts. In contrast, all team members gather at the Iida Creation Lab to inspect the manufacturing line that will be used and debate how to improve mechanisms and processes. Rather than trying to coordinate their efforts in a meeting room at a later date, the team members meet at the actual production site, making the lab an essential tool for effective concurrent engineering.

### Iida Factory: manufacturing factory for motors and ventilators



Creation Lab located next to the production line



Engineers gather in the Creation Lab.



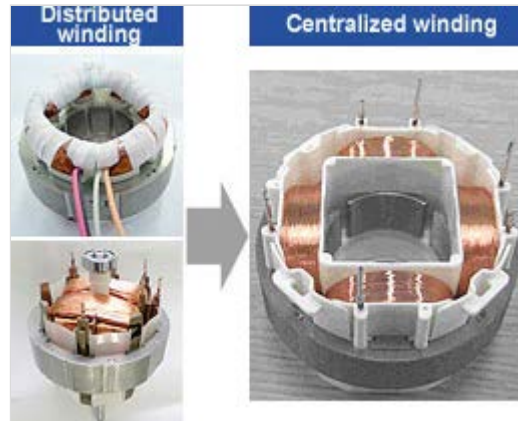
All team discuss ways to create the best product.

**New technology born from concurrent engineering – the minimo innovation**  
**Reducing primary loss, which accounts for 40% of power loss**

**Centralized winding used to reduce coil resistance by half**

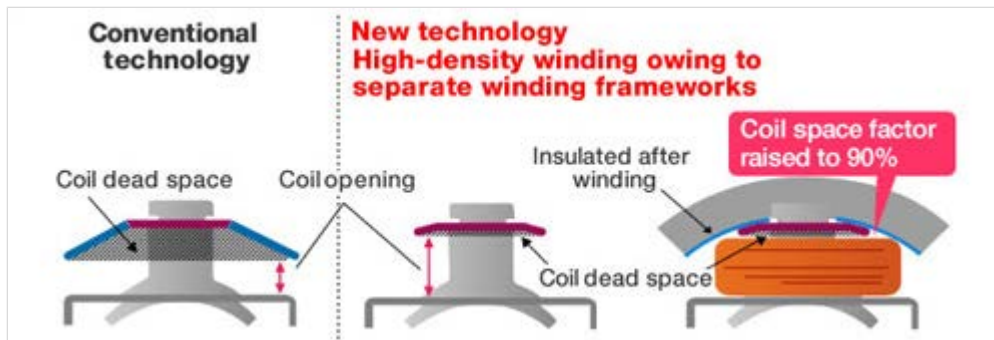
Reducing the size of a motor typically reduces its output and power efficiency. Coil innovations provide a way to make a motor compact while maintaining its efficiency.

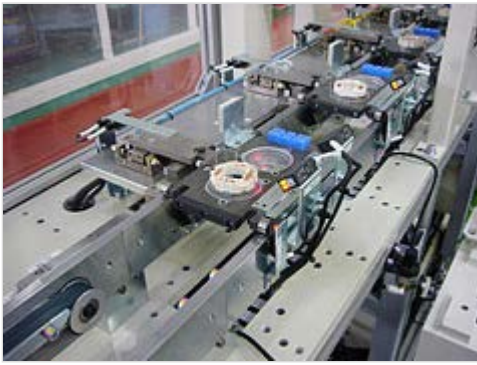
Primary loss, the major power loss by a motor, refers to power lost due to heat from electrical resistance when current flows through the coil connected to the power source. This loss accounts for around 40% of losses in compact capacitor start motors. To reduce this primary loss, minimo uses concentrated winding in which the copper wire is directly coiled on the stator (the part of the fan motor that does not revolve), which differs from regular distributed winding. As a result, primary power loss from coil resistance is reduced by about half.



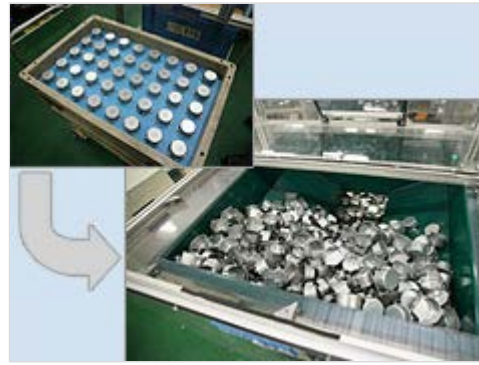
**Coil space factor increased to reduce coil resistance 20%**

A problem with centralized winding, which involves few slots, is that the amount of dead space increases. Dead space is where the copper wire cannot be wound because it is blocked by the framework that insulates the coil. To solve this problem, the framework was separated and the wire was wound around a portion that could not be used previously. Other insulating parts were inserted on the portion that juts out after the coil was wound. The coil space factor (ratio of the space occupied by the copper wire to the area of the slots) was increased 12% over conventional models, which enabled primary loss to be successfully reduced another 20%.

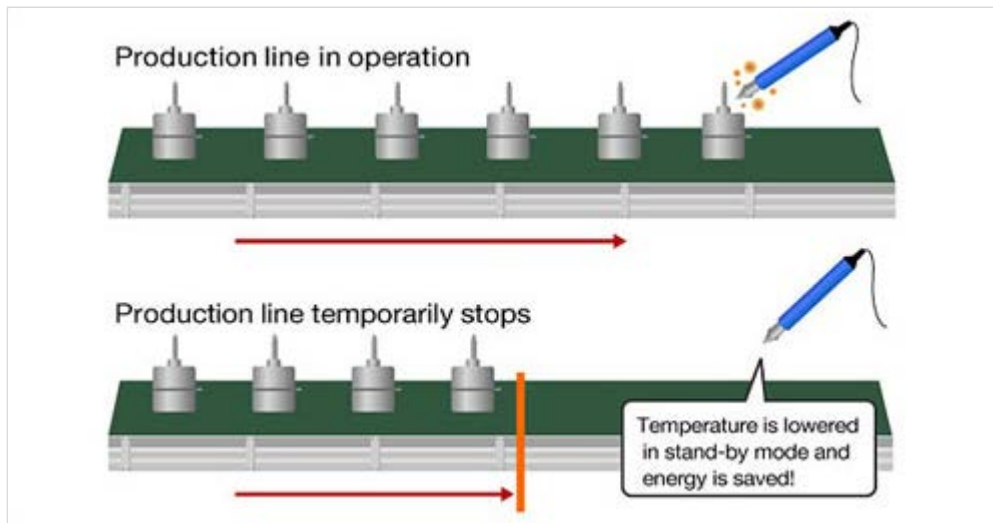




A high-speed, low-shock conveyor. To ensure the high precision required by minimo, the Manufacturing Engineering Center and Facility Development Division worked to develop a conveyor that is smooth, fast and does not jolt parts. Development of this equipment was not outsourced; instead, the production line was built concurrently with the design of minimo.



With conventional models, parts are supplied to the line by a robot that lays them out on a pallet. Switching to a direct-parts supply system made possible by a parts feeder manufactured in-house eliminated the manual laying out process upstream on the line.



The soldering trowel features a new mechanism that lowers the temperature in stand-by mode when the line stops temporarily. Thorough efforts were made to totally rationalize energy efficiency.



## Environment – Engineers' Perspectives

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Concurrent engineering that integrates development and manufacturing is one ideal pursued by Mitsubishi Electric. This section presents the comments of the engineers who put concurrent engineering into practice to develop minimo, the ultimate fan motor.

### Building the best-ever production line for fan motors

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Over the past 20 years, the Nakatsugawa Works has developed many exceptional fan motors, thanks to across-the-board automation. We have always engaged in concurrent engineering, which involves all divisions—sales, fan motor design, production technology and facility development—working to tackle challenges.

When I was assigned to lead this project, I wanted to pass on the Nakatsugawa DNA to a younger generation. Moreover, I wanted to keep Japanese manufacturing alive. The goals of this project were to develop the "ultimate fan motor" while at the same time creating the best-ever production line for fan motors. I was confident that if we maximized the power of our concurrent engineering we would build the best production line, not only in terms of quality but also delivery times, cost and environmental factors.



**Haruo Kinoshita**  
Project Leader  
Nakatsugawa Works, Iida  
Factory

### Passing on concurrent engineering to the next generation

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We established the Creation Lab with a great view of the production floor as a place where team members could exchange ideas. This lab was created to put concurrent engineering into practice. The team members met for discussions almost daily, which resulted in innovations in motor design and manufacturing. Using this lab, we created minimo, but the biggest achievement for me was passing down the Nakatsugawa DNA to the younger generation.

The Creation Lab concept is now not only at the production site, but at the Manufacturing Engineering Center. The lab will continue to be used for projects such as the development of elemental technologies.

I expect our younger employees to practice concurrent engineering and advance product development and manufacturing in a way that contributes to society and the environment.

### Objectives achieved without compromises

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On this project, I was most pleased that we made exactly what we intended to make—minimo. Normally in the development process, compromises are dictated by circumstances faced by each division, but on this project, all team members—fan motor design, manufacturing technology and facility development—did not compromise.

By not compromising, we achieved the project's objectives. Also, as team members with different specialties discussed issues in the Creation Lab they shared a common awareness of the goal. They developed minimo by working together at the Iida Factory. Design leaders tend to focus solely on product performance, but through this experience I learned that developing products that benefit society is done best with our approach.

In future projects, I plan to engage in development from a wide range of viewpoints, including those from the production floor and market identified by the sales team, and develop products with less environmental impact.



**Manabu Deguchi**  
Design Leader  
Nakatsugawa Works

## Think of products from design and manufacturing perspectives

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**Hideya Yamaguchi**  
Manufacturing Technology  
Leader  
Nakatsugawa Works Iida  
Factory

I had been in the Motor Design Division for many years, but when this project started I was transferred to the Production Technology Department and put in charge of developing manufacturing-related technologies. I learned many things when I considered the product from the vantage point of manufacturing technology and asked the question: What does a motor need? I also deepened my awareness of the connection between products and the environment, something I did not give extensive thought to before.

I also came away with an appreciation for the effectiveness of people with different specialties forming a team and working to solve problems while exchanging ideas and opinions. As a result of constant discussions with other team members and pursuing the best product and manufacturing process, I now realize that Nakatsugawa's automated lines are the realization of concurrent engineering. This experience is not easily gained, even when desired. I am grateful for this valuable experience and hope to spread what I have learned throughout the Company and help raise the global competitiveness of Nakatsugawa Works.

## I would like to spread the DNA of motor development throughout the Company

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**Nobuaki Miyake**  
Production Technology  
Development Assistance  
Manufacturing Engineering  
Center

When Project Leader Haruo Kinoshita came to the Manufacturing Engineering Center in Amagasaki, he expressed his conviction that we must build an exceptional production line on par with overseas production to keep Japanese manufacturing alive. I empathized with his conviction and remember feeling that we must succeed.

The Nakatsugawa Works and the Manufacturing Engineering Center have made motors for 20 years. Our predecessors focused on ease of winding and proposed a structure with a split core, which made it possible to raise motor performance and automate its production. This led to the birth of Mitsubishi Electric's Poki-Poki motor. This DNA was passed on to the younger team members on this project, and after discussions that included engineers from other production sites, a one-of-a-kind motor and production line were created.

This basic integration of design and manufacturing is essential not only to producing exceptional products but also to protecting the environment. The Manufacturing Engineering Center intends to stay true to this DNA and work with all motor team members to make Mitsubishi Electric the world's No.1 motor manufacturer.

# Environment – Working with the Community for the Environment

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## Environmental JIT activities by all employees

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The Nakatsugawa Works' Iida Factory, which began operations in 1974 as a ventilator factory, established a production floor for home photovoltaic systems in 1998. Together with the Nakatsugawa Works, the plant has made many products that benefit the environment.

The Iida Factory reduces its environmental impact through such initiatives as Environmental JIT (just in time), which involves saving energy resources (electric power, gas and fuel oil), protecting river ecosystems by purifying wastewater and recycling coolant water, and promoting zero emissions by reducing waste volume and recycling.

The Iida Factory converts all the resources it uses, not just electricity and gas, but also iron, copper, aluminum and plastics, to carbon dioxide emissions so that each and every employee maintains a strong awareness of the environment during the course of their day-to-day work. For example, saving one ton of iron is equivalent to reducing carbon dioxide by 1.5 tons. Efforts are made to raise awareness of the fact that all improvement activities not only reduce costs but also are directly linked to environmental benefits. This serves to encourage all employees to participate in improvement activities (efforts to eliminate waste of all kinds).

### Example of Environmental JIT

#### Delivery truck trips from parts supplier reduced by improving packing and raising loading efficiency



## Working with government and citizens as a community environmental leader

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Iida, located in Japan's Central Alps, is involved in initiatives based on its own Environmental Plan in an effort to bring sustainability to the region. A leading initiative is using more photovoltaic power systems. Since fiscal 1997, Iida has carried out measures to encourage greater use of these systems, offering financial intermediation and interest payment subsidies to citizens who install them. Iida has been selected as an "Environmental Cultural City" for its efforts to become a low-carbon city that produces energy from the sun and forest. The city's efforts are expected to significantly expand Mitsubishi Electric's photovoltaic power system business. Mitsubishi Electric participates in the Research Group for Regional Environmental ISO launched in Iida in 2000. This group has developed into an organization that is critical to the region's environmental and cultural progress. Its members are 29 local businesses, including the Iida Factory. As the deputy representative of the research group, factory employees give lectures at environmental forums held by local administrative bodies and participate in local environmental activities conducted by the private and public sectors and private citizens.

## Apple trees symbolic of a factory open to the community

The Iida Factory has 78 apple trees near its entrance that symbolize its environmental activities with the community. The trees were planted 35 years ago when the factory was established and express its basic stance of being open to the community, as the trees contribute to the environment by providing green space and replacing other types of fences.

Many employees have painstakingly cared for the trees. In the fall, they produce 35,000 apples, a local specialty of Iida. Every red apple is stenciled with the Mitsubishi logo, and these apples are one of the factory's celebrated products. They are given as souvenirs to people who tour the factory and are donated to local senior citizen centers and care facilities. In December, children from local care facilities are invited for an apple-picking event. The children express their appreciation in letters, often commenting on the great-tasting apples.



The Iida Factory has a row of apple trees instead of a traditional fence. The apples have the Mitsubishi Electric logo. There was a special version in 2008 to commemorate 40 years of producing duct ventilators.



A poster received from children who participated in the apple-picking event. The factory receives letters from children expressing their thoughts about the day.



## Perspective

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**Yoshiyasu Shirokane**  
Plant Manager  
Nakatsukawa Works,  
Iida Factory

### **Valuing all resources and letting nothing go to waste**

These days, business must be discussed along with the environment. However, if environmental contributions are separated as a special activity, then progress becomes difficult. What is important is not letting anything go to waste. When every person is dedicated to avoiding waste—whether of energy resources like electricity and gas, materials like iron and copper, or things used at the office like paper—this will lead to everyday environmental activities. Based on this idea, the Nakatsugawa Works promotes its environmental activities as a "war against waste" with full employee participation. Reducing costs and expenses are essential, but it is also important that we use natural resources wisely.

Companies must also conduct activities with their communities. Environmental activities do not make much of an impact when conducted by a single company. I give lectures on the regional activities being promoted by Iida, and in my talks with people with a variety of local perspectives I have learned many things. I hope to deepen ties to the community and promote environmental contributions at the regional level based on a spirit of letting nothing go to waste.

# Environment – Rebuilding and Developing Automotive Equipment

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## Automotive Equipment Initiatives in the United States

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As a leading global automotive equipment manufacturer, Mitsubishi Electric has an obligation to reduce the environmental impact of automobiles.

This special feature focuses on two new Mitsubishi Electric initiatives in the United States, which is one of the most automobile-oriented countries in the world.

### Rebuild Operations: Recycling in Action

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Our Rebuild Operations in California.

▶ [Click for details](#)



### Providing Cutting-Edge Alternators

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The forefront of alternator development and production is in the United States.

▶ [Click for details](#)



### Initiatives to Reduce Waste

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Nearing the achievement of zero emissions, our U.S. facility turns waste into a saleable materials.

▶ [Click for details](#)

# Environment – Rebuild Operations: Recycling in Action

## Contributing to the Creation of a Recycling-based Society

Mitsubishi Electric Automotive America - Orange County (MEAA-OC) in California rebuilds starters and alternators.

The starter, the first part of the engine to turn over, is the small motor that starts the engine.

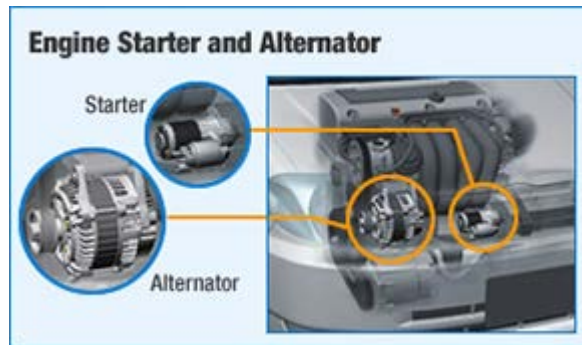
The alternator is the power generator. The battery cannot supply a sufficient amount of power to all of the electrical components in an automobile, so the alternator is indispensable.

The alternator and the starter may fail if they are exposed to excessive severe environmental conditions or if they are subjected to excessive severe operating conditions. However, when it does, often only one part within the alternator has a problem, such as corroded electrodes or sliding parts worn from exposure to water. The alternator can be made to work like new simply by replacing just the parts that are broken or worn—this is the idea behind rebuilt components.

Mitsubishi Electric manufactures and sells automotive equipment at four U.S. locations. The first location was established in 1979 in California, where rebuild operations have been conducted for 30 years. The number of rebuilt products has increased and are now available for a wide range of vehicles, from standard and compact to large and heavy-duty. To improve our products, information from recovered core\* products is regularly provided to the development center in Japan.



MEAA -OC in California



The rebuild business reduces resource input and helps create a recycling-based society.

Mitsubishi Electric's alternators and starters recovered from automakers are used to create genuine rebuilt parts. Trusted by automakers, we will continue to expand our rebuild operations.

\* Core: Used alternators and starters that have broken down and need to be replaced.

Average Salvaged Commodities at MEAA-OC FY2009 Production							
	Wt. Per Unit (kg)			Monthly Core Build Qty.	Annual Resource Saved (tons)		
	Aluminum	Steel	Copper		Aluminum	Steel	Copper
Starter	0.50	2.25	0.57	1,822	10.93	49.17	12.39
Alternator	0.94	2.96	0.90	1,484	16.68	52.77	16.11
<b>Annual Grand Totals (tons) =</b>					<b>27.6</b>	<b>101.9</b>	<b>28.5</b>

## Rebuilding Alternators

Alternators recovered from automakers are rebuilt as follows:





## Enthusiastic MEAA Orange County Employees



**Tadashi Katashima**  
General Manager  
MEAA-OC

Five years ago, I was assigned to the MEAA-OC (OC) factory. At present, the factory's rebuild operations are growing steadily. Productivity has greatly improved, with stable supply capacity and quality. Our highly motivated local employees, who show great pride in their work, are supporting these activities.

For example, at our regular morning meetings, factory managers offer ground-breaking ideas to improve productivity and quality. This proactive attitude is evident in recycling, energy-saving and other activities designed to reduce our environmental impact.

At one time, California suffered from much air pollution, and beginning with the landmark Clean Air Act of 1970 (also known as the Muskie Act), various exhaust countermeasures have been implemented. Now, following the environmental countermeasures of the Obama Administration, California leads the nation in environment-related regulatory and aid policies, enabling OC and its employees to more fully develop their environmental awareness and engage in related activities.

I consider it my mission to make the most of my employees' motivation and awareness. By listening to everyone's opinions and ideas, and with the employees' help in expanding our rebuild operations, I will raise the level of satisfaction among our workers. I would like to continue our win-win relationship.



The upbeat California staff at MEAA show their power

# Environment – Providing Cutting-Edge Alternators

## Automotive Equipment R&D: Preventing Global Warming through Improved Environmental Performance

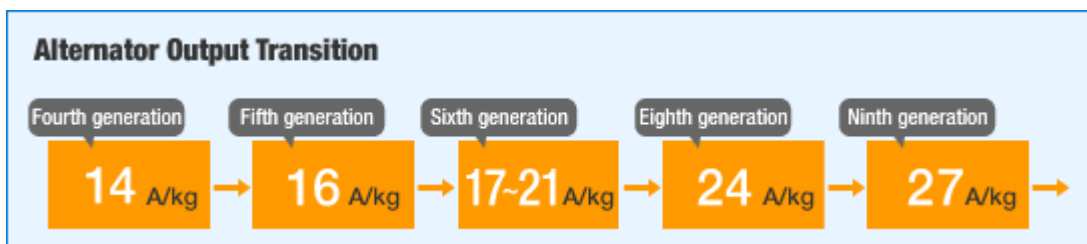
With advances in motors, the emphasis on high-efficiency alternators is growing. The Himeji Works is at the center of development activities to ensure optimal designs with the power supply necessary for each vehicle.

The Himeji Works began developing alternators in the 1960s in pursuit of high efficiency and high power output.

In addition to the sixth-generation and eighth-generation alternators currently in use, ninth-generation models were developed in 2006 (see below).

Ninth-generation models employ improved coil density through use of the pokipoki\* motor with optimized generator size, output and efficiency. This high output, combined with quiet operation, is an example of a product that accurately meets the needs of the times.

\* Pokipoki motor: motor densification achieved by wrapping coils around the extended core



## Expanding Eco Products through Japan-U.S. Cooperation

Alternators and starters for the U.S. market are developed at the Himeji Works and manufactured at Mitsubishi Electric Automotive America—Mason (MEAA -MSN) in Ohio.

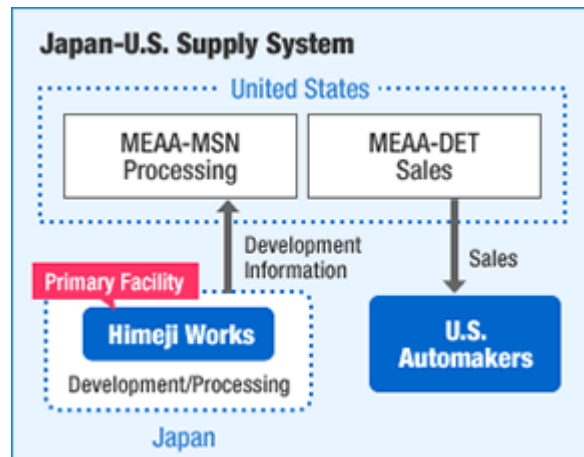


MEAA-MSN(Ohio)

Despite being slow to respond to environmental needs, U.S. automakers are now shifting to the development of smaller, fuel-efficient, hybrid and electric vehicles under the Obama Administration's "Green New Deal." Mitsubishi Electric's automotive equipment business has expanded distribution of its high-efficiency, high-output alternators, which reduce fuel consumption. The Company has also increased the distribution of its small, lightweight starters. We are working with automakers to develop a full range of services, from development, production and supply, to spare parts and rebuilds.

MEAA (-DET\*1, -MSN, -MVL\*2) is expanding America-wide sales of automotive equipment that contributes to lower environmental burden, while MEAA-OC carries out rebuild operations that reduce resource use.

Mitsubishi Electric will continue to supply both OEM products and recycled parts to help reduce the environmental impact of the operation of automobiles in the USA.



\*1 MEAA-DET: Mitsubishi Electric Automotive America—Detroit, in Detroit, Michigan

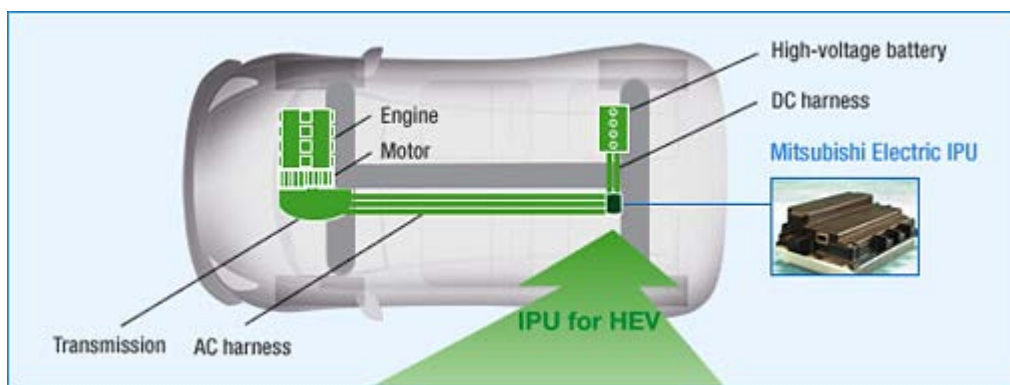
\*2 MEAA-MVL: Mitsubishi Electric Automotive America—Maysville, in Maysville, Kentucky

## Mitsubishi Electric's Contribution to the Use of Hybrid Vehicles

Hybrid electric vehicles (HEV) are becoming a realistic environmental option. These vehicles use Mitsubishi Electric's inverters, which convert battery power from DC to AC. These inverters also regulate optimal engine RPMs to contribute to energy savings. The HEV, which has an electric motor to reduce gasoline usage, also has a large-capacity gasoline-powered motor and battery. The necessity for an adjustable range and the demand for smaller, more efficient components are increasing rapidly.

Automakers use Mitsubishi Electric's Intelligent Power Unit\* (IPU), a DC/AC inverter unit between the battery and the motor that switches battery power from DC to AC. Recently, this unit has been employed in the Insight, made by Honda Motor Co., Ltd. Mitsubishi Electric plans on developing this product for automakers around the world, continuing to use its vehicle components and semiconductor technologies to meet the needs of automakers and contribute to vehicle-related environmental considerations.

\* Mitsubishi Electric's IPUs are referred to by Honda Motor Co., Ltd., as Intelligent Inverter Units (IIUs).



## EGR Valve: Contributing to cleaner exhaust and reduced CO2 emissions

Most vehicles run on either diesel or gasoline engines. In diesel vehicles, the emission of nitrous oxides (NOx), a cause of acid rain, is particularly problematic. NOx is rapidly produced when the engine combustion temperature exceeds roughly 1,700 degrees Celsius (approximately 3,100 degrees Fahrenheit), so lower temperatures must be maintained. The EGR valve reduces an engine's combustion temperature and helps reduce the formation of NOx by governing the amount of exhaust that is returned to the combustion chamber.

In gasoline-powered vehicles, the EGR valve helps prevent the energy loss (pumping loss) that occurs as the pistons move up and down, improving fuel efficiency.

Mitsubishi Electric provides a DC motor-based EGR valve with superior output and responsiveness for diesel vehicles, and a compact and inexpensive stepper motor-based EGR valve for gasoline-powered vehicles, helping address the major issues of air pollution and global warming.



DC motor-based model



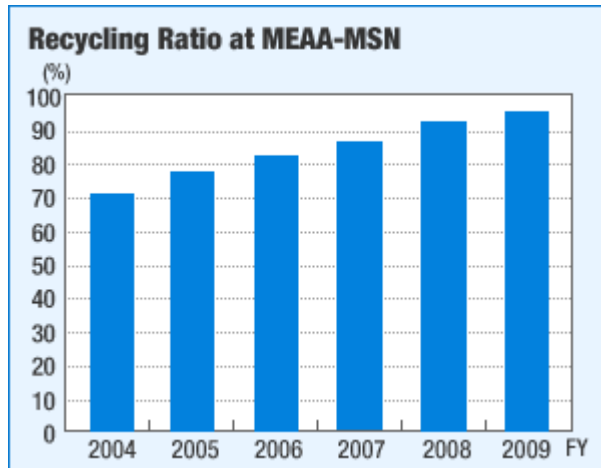
Stepper motor-based model

# Environment – Initiatives to Reduce Waste

## Just One Step Away from Zero Emissions

MEAA-MSN\* manufactures alternators and starters. Many of the parts it receives from Japan, as well as those procured locally, are all cushioned and packaged in cardboard boxes. The company also uses coils and other metal parts in its manufacturing processes. For the past 10 years, MEAA-MSN has been working to reduce the amount of cardboard, expanded polystyrene, metal shavings and other materials that ended up as landfill waste.

In the past, such waste was simply considered trash that companies paid to dispose of, but in addition to costing money, this method did not facilitate the reduction of landfill waste. MEAA-MSN began focusing on converting waste into something that could be sold—resources and products rather than trash. The company created a system whereby recyclers picked up these materials, and they introduced a number of ingenious processes along the way. Through these methods, the company promoted the complete recycling of everything from used work gloves to documents and memoranda. As a result of these efforts, in 2010 MEAA-MSN expects to achieve "zero emissions, zero waste" status.



\* MEAA-MSN: Mitsubishi Electric Automotive America—Mason, in Mason, Ohio

### Case study of Initiatives at MEAA-MSN



Recycling box



EPS densification



Metal scrap separation



Cardboard baler

## Fostering Environmental Awareness: "Ecology = Economy"



**Scott Stephenson**  
Corporate Manager of  
Environmental,  
Safety and Quality Systems,  
MEAA-MSN

Including environmental ISO activities, for more than 10 years I have been working to reduce MEAA-MSN's environmental impact. During this period, the biggest issue that MEAA-MSN faced was reducing final landfill waste. We introduced a number of creative recycling initiatives, but found that the most important factor in putting them into practice was raising the environmental awareness of local staff. Our Environment, Health & Safety and Hygiene Department holds staff environmental training sessions once a year, themed on generating revenue by reducing the environmental impact of our everyday operations. In other words, in our training we adopted the bottom-line approach that "ecology equals economy" as we worked to instill the importance of recycling. Staff awareness changed as a result. Now the question "Can't this be recycled, too?" has become much more frequent.

I believe that this question describes in simple words the concept behind the priority themes of Environmental Vision 2021. At present, MEAA-MSN and MEAA-MVL\* hold quarterly management reviews and other activities that are designed to reduce our environmental impact companywide. Going forward, we will work to encourage associates to share the concepts of the environmental vision as we take the next step along the path to our goal of zero emissions.

\* MEAA-MVL: Mitsubishi Electric Automotive America — Maysville, in Maysville, Kentucky



**Environmental Calendar**  
This calendar features environmentally themed pictures drawn by the children of MEAA-MSN employees.



**Plastic Tubes into a Calculator**  
An employee came up with this idea of turning scrap into a calculator, which is used at local elementary schools. This is considered reuse activity



**Scrap Wood into Bird Houses**  
Birdhouses made of scrap wood from incoming packaging. The first houses are being built for purple martins. The next step will be bat houses. This is also considered reuse activity.

## Environment – Towards Zero Emissions

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The Environmental Vision 2021 program is a demonstration of the Mitsubishi Electric Group's commitment to achieving zero emissions status and promoting the 3Rs (reduce, reuse, recycle) in order to help bring about a recycling-based society. Completely eliminating waste that goes directly to landfills requires that waste be efficiently reused and recycled. Based on proposals made by local area environmental managers, Mitsubishi Electric has initiated a recycling system involving the coordinated efforts of multiple local production areas in June 2007. This type of system is actually quite rare in this industry, so it has garnered the wider attention of the industry as a leading example of progressive cross-regional waste recycling.

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### ▶ Birth of a Recycling System

A group of environmental managers that met while attending a training course have successfully developed a completely unprecedented recycling system. Learn about the system and how it was developed.

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### ▶ Recycling Examples

Learn about the coordinated efforts of local production areas involved in recycling cushioning materials, polystyrene foam and waste cooking oil and provides details on our recycling logistics.

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### ▶ Future Development

Key environmental personnel discuss their thoughts on recycling and their future ambitions.

# Environment – Birth of a Recycling System

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## Collaboration Begins with Environmental Training

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In 2004 Mitsubishi Electric was faced with the retirement of a considerable number of experts who had long been involved in environmental management. So we initiated a training program for key environmental personnel with the aim of training a group of employees to play a leading role in our environmental management activities. This training program proved to be the genesis of recycling activities that cut across our local production areas.

Until the training program, key environmental personnel at our various manufacturing works had little opportunity to get to know one another. Through their conversations while attending the training course they learned that they shared many of the same challenges. This led a group of key personnel who worked close to one another in the Kansai region of Japan to form the Environmental Managers Committee with the aim of facilitating communication on environmental matters. The first committee meeting was held in April 2005. The participants discussed their various activities and shared their own expertise with one another. Talk centered on the problem of waste disposal. What began with how to make the management of waste disposal contractors more efficient ended up shifting to the fundamental problem of how to reduce waste.

## The Kansai Waste Recycling Working Group

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At the time, the company's manufacturing works already had established processing methods for dealing with various types of waste and it was thought that there was little room for improvement. The committee, however, soon discovered that waste categories and amounts differed at each site and that things classified as waste at one site were being bought as supplies at another. As these discoveries were made they came to appreciate the importance of working together. So in April 2005 the Kansai Waste Recycling Working Group was established under the committee. The working group was Mitsubishi Electric's first project team dedicated to recycling that encompassed multiple production sites.

## From Reuse of Cushioning Materials to Recycling of Waste Products

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The working group felt that reusing cushioning materials would be feasible right away. A considerable volume of cushioning materials used to package parts is generated as waste every month at the company's Kobe area sites, where large products like plant equipment for social and public institutions are manufactured. Itami Works, which makes electric components for automobiles, requires a large volume of cushioning materials to ship its products. In June 2006 we began supplying cushioning materials from Kobe to Itami, and the company took its first step toward coordinated recycling.



The project to reuse cushioning materials was eventually expanded into a recycling program for waste plastic sheeting and polystyrene foam that involves coordination among the Kita-Itami, Himeji and Ako Works. This has been further developed into a system by which waste from the various production sites is consolidated at one site, compacted and provided to an outside contractor that turns it into recycled plastic products. In addition, using waste cooking oil from employee cafeterias to manufacture bio-diesel and then using it to fuel forklifts was another idea that we successfully made a reality.

## A Recycling Logistics System that Eliminates Waste

A key question we sought to answer was, where should we bring waste and where should it be processed in order to improve efficiency? After an overall picture of waste reduction and recycling emerged, we next considered how to reduce carbon dioxide emissions in transportation. After considering various proposals, the Kobe, Itami and Kita-Itami Works inked a chartered delivery contract with one of the Kobe Works waste haulers and designed a transport route that would keep trucks fully loaded when moving between Kobe, Itami and Kita-Itami. For trips to the Ako and Himeji Works, which don't require anything from Kobe to be delivered to them, we made a request to the transport company that makes deliveries to customers in Himeji and Ako to stop by Ako and Himeji Works and load the truck with waste plastic sheeting and waste polystyrene foam for the return trip to Kobe.

Through this process, in June 2007, we completed a recycling system that promotes effective resource utilization via an environmentally conscious logistics system involving the coordinated efforts of our five manufacturing works in the Kansai region. The system was very well received outside the company as well, so much so that it was honored with the Chairman's Prize by the 2008 3R Promotion Persons of Merit Awards. We are also proactively providing information on the initiative in order to widely publicize it. These efforts have included exhibiting at the 2008 Environmental Fair in Ako and presenting recycling examples in the Kansai region to visitors as a part of the "City Factory Quiz Bus Tour" put on by the city of Kobe.

Our recycling logistics system has garnered attention for pioneering new possibilities in recycling. In November 2008, we launched a working group for the Kyushu region to move towards further expanding the scope of the system.





# Environment – Recycling Examples

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## Recycling Cushioning Material

Cushioning materials that are no longer needed at Kobe and Kita-Itami are collected at Itami Works and reused as packaging material for product shipments. A specially chartered delivery truck is used to deliver the materials from Kobe to Itami. On its return trip, the truck is loaded with waste plastic sheets and waste polystyrene foam produced by Itami. When the route passes through Kita-Itami, the truck is loaded with cushioning materials, waste plastic sheets and waste polystyrene foam at Kita-Itami, the cushioning materials are dropped off at Itami, and the truck returns to Kobe Works after being loaded with Itami's waste plastic sheets and waste polystyrene foam. The system has reduced cushioning material purchases by Itami Works by around half, saving both costs and resources.



### Genichiro Sasaki

Environmental Promotion Section, Production System Department, Semiconductor and Device Management Division Semiconductor and Device Group

At Kita-Itami Works, in the past we had only thought of waste in terms of semiconductor waste, but thanks to this experience I have realized the importance of everyone aligning their thinking, and not just thinking in terms of the narrow world of semiconductors. This recycling system has captured the wider attention of the semiconductor industry. We reported on the system in February 2008 at an international conference of the Japan Electronics and Information Technology Industries Association, and it was quite well received as a novel approach to resource recycling.

## Recycling Polystyrene Foam and Polyethylene Sheets

Waste polystyrene foam and waste polyethylene sheets are processed at a recycling center that has been established on the premises of Kobe Works. The waste plastic sheets and waste polystyrene foam produced by five of our manufacturing works, including Kobe Works, is collected together and processed all at once via compaction. The waste plastic sheets and waste polystyrene foam are collected from the Itami and Kita-Itami area on return trips from delivering cushioning materials. They are collected from the Himeji and Ako Works on return trips from making deliveries to customers. After the waste polystyrene foam and sheets have been compacted, the material is sent to a recycling contractor and turned into recycled plastic products.



### Yasuo Kugimoto

Environmental Management Group  
Production Management Department  
Himeji Works

In actuality it is more economical to thermally process polystyrene foam than it is to recycle it. In the past at Himeji we had it thermally processed by a vendor, but since this recycling method impacts the environment, we thought that it would be better to utilize material recycling even though it costs more. By consolidating recycling at Kobe, we've created an even more efficient, economical system. We plan to continue to expand by drawing on initiatives taking place at our various sites.



### **Kenichi Yoshioka**

Ako Production Management Section  
Production Systems Department  
Transmission & Distribution Systems Center

At the Ako Works, we formerly had an outside company thermally process polystyrene foam as a part of our ISO 14001 initiatives. However, I felt that integrated recycling at Kobe Works would be more effective in terms of reducing environmental impact.

At the Satoumi Symposium held recently in Ako, there was a presentation on participating in a project to have elementary school students grow eel grass and help make the local marine habitat suitable as a home for porpoises. I think this activity speaks to the fact that we as a company are engaging in these recycling initiatives out of respect for the earth's limited resources.

## **Recycling Waste Cooking Oil**

Equipment for producing bio-diesel was installed at Kobe Works' recycling center in June 2007. Waste cooking oil, which is produced in large volumes everyday by employee cafeterias, is collected and turned into bio-diesel using the equipment. The bio-diesel is then used to fuel forklifts and other vehicles at Kobe Works. Currently, all of the applicable work vehicles at Kobe Works run on bio-diesel, which helps to reduce the plant's environmental impact. We are also considering collecting waste cooking oil from local residents and cafeterias at other sites in order to further the environmental benefit of this program.



### **Yuji Ouchi**

Environmental Promotion Group  
Production Systems Department  
Energy & Systems Center

Himeji and Kita-Itami Works handle smaller sized products, so they use electric forklifts to haul things around onsite. At Kobe Works, however, the products are larger, so they require vehicles with diesel-powered engines. We have cafeterias almost everywhere and they all produce waste cooking oil, so by adjusting output of waste cooking oil based on whether or not diesel is needed, we have improved the situation both in terms of waste and fuel.

## Environment – Future Development

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### Building a Recycling System Helps Foster Environmental Awareness Looking Forward to the Challenge of New Initiatives

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**Yuji Ouchi**  
Environmental Promotion Group  
Production Systems Department  
Energy & Systems Center

With everyone thinking as a team about waste we were able to view the company as a whole from various perspectives. We realized that logistics is extremely important in building a recycling system, and we learned that judgments have to be made on whether it is better to haul something far away to recycle it or dispose of it at a nearby location instead.

I secretly hoped that this new initiative would raise the environmental awareness of equipment designers and manufacturing managers by providing feedback for their primary jobs. I felt that knowing how much waste we produce and directly experiencing the importance of recycling would inspire more designs and manufacturing processes that do not produce waste. As soon as the project got underway, environmental awareness increased dramatically at Kobe area sites. Mitsubishi Electric acquired its first Type III Eco Mark (part of Eco Leaf labeling, a program for evaluating a product's environmental performance). Other manufacturing divisions are currently developing similar systems. Moreover, in the Kyushu region, work has begun on building a recycling governance system that encompasses our affiliates. I'm always happy to hear this kind of news. I look forward to taking on the challenge of new initiatives and continuing to help foster an environmental mindset within the company.

### Scaling Up Activities and Developing the Entire Company's Potential

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I think it is important that we think about the cost of waste when manufacturing products. We need to calculate the cost of waste that is generated and think about what can be improved to eliminate things that aren't necessary. If we do this, waste volume will go down while productivity goes up. Whether waste is sold or recycled, ultimately, it consists of things that aren't needed. Thinking about how to stop generating things that aren't needed is itself environmental management.

The working group's next goal is to scale up. We want to increase the types of waste handled by the system and increase the range of people involved. We also want to expand geographically to other regions. The system we built centers on the Kobe Works, but one can also imagine a system centering on the Ako Works that coordinates with Himeji Works and Fukuyama Works or one centering on the Kita-Itami Works that coordinates with Itami Works and Kyoto Works. Our goal is to have all domestic manufacturing works coordinate with one another so that each site is participating in various systems. We hope to develop the potential of the entire company, including the head office.



**Tetsuji Nishino**  
Manager,  
Environment & Infrastructure  
Maintenance Section  
Production Systems Department  
Itami Works