Global Warming Mitigation Initiatives in Plants and Offices of the Fujitsu Group

● Hideaki Namiki ● Toshiharu Nakano ● Masayuki Nihei ● Hiroyuki Ito
● Kazuaki Sato ● Masayuki Kitajima

In July 2015, the Japanese Government adopted a draft target to achieve a reduction in greenhouse gas (GHG) emissions of 26% from the FY2013 level in FY2030, and submitted this pledge to the UN before the 21st session of the Conference of the Parties (COP21) to the UN Framework Convention on Climate Change (UNFCCC) in Paris. Based on this pledge, the CO_2 emissions reduction target for the Fujitsu Group for FY2018 would be 4.2% from 2013 levels. The Group is in fact striving to surpass this figure, and aiming to reduce emissions by more than 5%, as set forth in the Fujitsu Group Environmental Action Plan (Stage VIII). This paper presents our Group-wide global warming mitigation initiatives, which we pursue in our plants and offices. These include examples of our continued efforts in the facility-based energy-saving programs, and development of energy-efficiency technologies for manufacturing plants.

1. Introduction

The prevention of global warming is a global issue and all countries are taking measures to this end from a long-term perspective. Japan, along with all major greenhouse gas (GHG) emitting countries, shares the international community's goal of halving the world GHG by 2050, and is working on reducing domestic GHG emissions. Major environmental regulation trends in Japan and abroad are described below.

- COP21

The 21st session of the Conference of the Parties (COP21) to the UN Framework Convention on Climate Change (UNFCCC) adopted the Paris Agreement in December 2015 whereby, in addition to the target agreed upon at COP16 in 2010 to limit global average temperature rise to below 2°C relative to the level before the Industrial Revolution as a long-term goal for the entire world, mention was made of efforts to be made to achieve an even higher target of less than 1.5°C.[1)]

- IPCC Fifth Assessment Report

The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) published in October 2014 indicates the need to reduce GHG emissions by 40% to 70% by 2050 relative to 2010 levels.[2)]

- Japan's Intended Nationally Determined Contribution (INDC) towards the Paris Agreement

Prior to COP21, Japan drafted a pledge in July 2015 to reduce by 2030 substantial emissions (emitted amount−removed amount) by 26.0% compared to FY 2013 (by 25.4% compared to FY2005) through reduction of domestic GHG emissions and removal of GHG, and submitted it to the UN.[3)]

- Energy Saving Act in Japan

The "Measures Pertaining to Factories, etc." in the Act on the Rational Use of Energy (Energy Saving Act) obliges business operators to periodically report, and in FY2016, a Business Operators Classification Evaluation System that classifies them into the four classes of S, A, B, and C, was launched.[4)] S class business operators will be announced as good business operators, but a notice will be sent to representatives of business operators ranked as B class or lower, and such business operators will be especially targeted for the collection of reports, field investigation, and on-site inspection.

- Japanese electrical and electronics industries: Action Plan for Commitment to a Low-Carbon Society

The electrical and electronics industries the Fujitsu Group belongs to have been working since 2012 toward the common industry goal of achieving a unit

energy annual average improvement rate of 1% towards 2020.[5)]

The Fujitsu Group has formulated the Fujitsu Group Environmental Action Plan setting concrete targets for the implementation of environmental policies. Currently, we are implementing the Fujitsu Group Environmental Action Plan (Stage VIII) for the FY2016-FY2018 period, and based on the social trends and business forecasts mentioned so far, we set the following targets for our plants and business offices.

- Reduce GHG emissions by 5% or more compared to FY2013
- Improve unit energy consumption by an average of 1% or more each year
- Expand the use of renewable energy

The Fujitsu Group's CO_2 emissions target for FY2018 as calculated based on Japan's INDC towards the Paris Agreement, is a 4.2% reduction from the FY2013 level, but the Fujitsu Group has set for itself and is aiming for a reduction of over 5% (**Figure 1**). While an increase in CO_2 emissions is expected at some of the Fujitsu Group's electronic parts manufacturing plants owing to increased production, the Group is actively promoting energy conservation through capital investments and operational improvements to achieve its reduction target.

This paper introduces trends in Japanese regulations concerning global warming mitigation measures and energy use, along with the initiatives of the Fujitsu Group at its plants and offices to reduce CO_2 emissions.

2. Initiatives to reduce CO_2 emissions in manufacturing

The Fujitsu Group is striving to reduce CO_2 emissions in the manufacturing field to ensure the achievement of the Environmental Action Plan (Stage VIII). Until now, efforts to reduce CO_2 emissions at Fujitsu Group plants have mainly focused on facilities, which account for approximately 60% of total CO_2 emissions of plants. Such efforts include the replacement of air conditioning equipment such as chillers and boilers, the adoption of intermittent operation, and disconnection of unnecessary lights. To achieve CO_2 reductions in the manufacturing field, which accounts for the remaining 40%, it was necessary to develop technologies capable of realizing at the same time energy saving, product quality, and productivity, and promote reduction activities across plants.

To this end, a Green Manufacturing Working Group (hereafter, the WG) was established at each manufacturing plant. Each such Working Group works to extract energy saving items by reviewing production lines and processes, taking into consideration the six viewpoints on energy saving shown in **Table 1**, and constructing a mechanism for result sharing and horizontal deployment. Representative examples of items extracted by the WG are given below.

1) Change: Development of a constant temperature tester compatible with one-by-one production

The need to perform batch processing in large test tanks was eliminated, thereby reducing the amount of

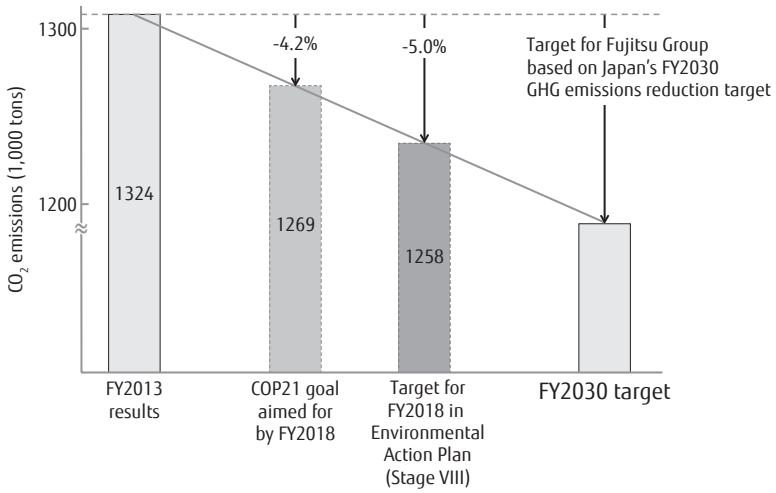


Figure 1
Fujitsu Group's CO_2 emissions results and reduction targets.

Table 1
Main standards for achieving top-level energy-efficient products.

No.	Viewpoint	Concept	Application examples
1	Change	Change equipment, energy, and method	• Introduction of high efficiency equipment • Line configuration • Individual cold air blowers • Nighttime operation
2	Eliminate	Eliminate excesses, losses	• Review of excesses and exigencies • Excess supply pressure • Electricity use during non-operation • Heat insulation enhancement
3	Stop	Stop waste	• Frequent stops • Improvement in capacity utilization rate and stopping of redundant equipment • Disconnection of unnecessary lights
4	Reduce	Reduce loads	• Reduction in equipment pressure • Shortening of lines • Reduction of indoor heat release • Filter cleaning
5	Fix	Fix problems	• Suppression of deterioration loss • Improvement of energy productivity through review of manufacturing process flows
6	Pick up	Pick up energy	• Melting of snow/heating indoors using heater exhaust heat • Power generation • Self-heating etc.

electricity expended per product.

2) Eliminate: Promotion of energy just-in-time (JIT) for soldering equipment

Electricity use during non-operation was reduced through automatic detection of product presence in equipment, and in case of no product, switching to standby power mode.

3) Stop: Monitor display control of test processes

A tool allowing process management monitors installed in large numbers on test lines to be switched on and off all at once from a central terminal was developed to effectively reduce electricity use by monitors when not in use.

4) Eliminate: Installation of insulation around heat generating part of soldering machines

Heat insulation material was affixed to the heat generating part of soldering machines to suppress radiant heat and thereby reduce the load on air conditioning equipment.

5) Eliminate: Shortening of test time

System allowing processing of multiple test items in parallel was developed to reduce power usage for testing.

6) Reduce: Compressor load reduction

The process of dust removal through air blowing was reviewed and the required pressure was reduced by modifying the equipment to operate at lower pressure, thereby reducing electricity use by compressors.

Among the above items, items 4) Installation of insulation around heat generating part of soldering machines (15% CO_2 emissions reduction), 5) Shortening of test time (30% CO_2 emissions reduction), and 6) Compressor load reduction (50% CO_2 emissions reduction) are highly cost effective, and since investment recovery can be expected within one year, they were shared and deployed horizontally at many plants. Further, as part of the activities at each plant, the scope of activities is expanded by, for example, setting reduction targets for each floor and each manufacturing department and holding meetings to consider measures for the achievement of targets.

In this way, the visualization of plans and achievements, and the sharing of policies and their horizontal deployment are advanced through the promotion of energy conservation activities by the WG. As a result of autonomous and continuous activities at each plant, total CO_2 reductions of about 1% per year, equivalent to approximately 1,000 tons per year, are realized annually by manufacturing plants.

In order to extract CO_2 reduction items from the six viewpoints on energy saving, it is necessary to visualize the state of electricity use of each equipment unit. However, this has been difficult to achieve for the following reasons.

- Power distribution panel construction is required for accurate effective power measurement.
- It is necessary to stop the production equipment for construction, thus affecting production.
- Due to wiring and power meter size constraints, it is difficult to set up and it takes time and effort.

To solve such issues, the Non-contact Power data Logger (NPL) (**Figure 2**) was developed. The NPL has the following features to satisfy the requirements of plants.

- The development of non-contact effective power measurement technology has made possible effective power measurement using just a clamp-on probe on the target cable, which can be used on equipment while it is operating and can easily be transferred to other locations. Moreover, since installation by a specialist is not required, installation and relocation costs can be greatly reduced.
- The time and effort required for installing wiring to a data collection terminal is reduced by doing away with wired connections and incorporating ZigBee-compliant wireless communication capability (with a connectivity range of up to about 20 m).
- The NPL has a built-in rechargeable battery, making it unnecessary to provide a power outlet on the power distribution panel. It comes also with a contactless power supply function built in, allowing recharging of the NPL's battery with the electric power supplied to the equipment under measurement.
- The NPL is compact and thin (W 120 mm × D 70 mm × H 20 mm, 100 g), allowing easy installation in a power distribution panel.

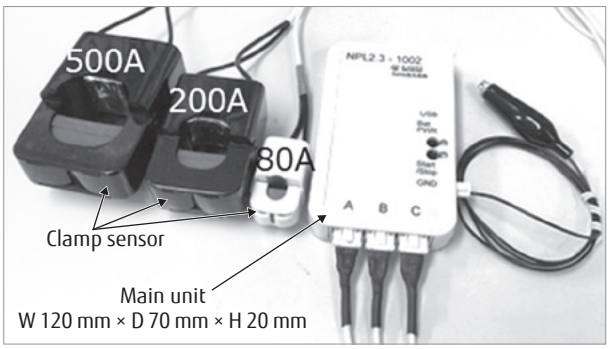


Figure 2
Non-contact Power data Logger (NPL).

- The NPL supports the power outlets to be measured, up to 200 V, 500 A for single-phase and three-phase AC. It can measure up to 15 points for single-phase AC, and up to 5 points for 3-phase AC.

Thus far, the NPL has been installed on more than 80 equipment units including air conditioners, soldering machines, testing machines, processing machines, and personal computers, helping visualize the state of power use. This visualization, combined with correlation analysis of such factors as production volume, equipment operation information, and temperature and humidity data, contributes to on-site improvement activities by exposing power wastage (**Figure 3**).

We are also beginning to offer NPL utilization know-how as a service to customers outside the company. Already more than 20 NPLs are connected with customers' Environmental Management Dashboard (described later) to visualize the state of power use, and their data are analyzed together with information such as temperature and humidity acquired at the same time, and the findings are utilized for CO_2 reduction activities. Further, in addition to promoting high voltage (400 V) compliance to allow overseas use, we are applying for the required wireless device certification.

The facts that the NPL is easy to install and that it can measure effective power are highly rated, and it is the subject of high expectations for use both domestically and overseas, as attested for example by its selection as a "Smart manufacturing creation support tool"[6] at the IoT Tool Event for Small- and Medium-Sized Enterprise Manufacturers organized by the Robot Revolution Initiative (RRI). Going forward, besides adapting the NPL for overseas use, we will continue to improve its functions and capabilities in response to customer needs in preparation for its commercialization.

3. Promotion of energy saving through Environmental Management Dashboard

As a base system to support environmental management, the Fujitsu Group has created the "Environmental Management Dashboard," which collects and analyzes various kinds of environmental information in real time, displays it on a portal screen in a centralized manner, and has introduced it at all

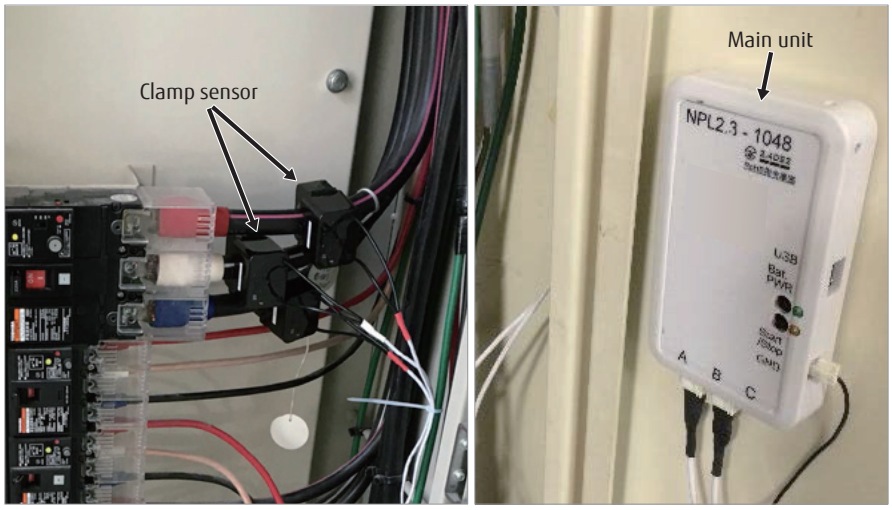


Figure 3
Example of installation of NPL on power distribution panel.

domestic Fujitsu bases. We also offer similar systems to customers outside the company.

Starting in FY2016, we have been newly adding a function for further power saving, which optimizes power contracts with power companies through visualization to assess the feasibility of standard measures for reducing peak power consumption and automatic recommendation for the type of power contract for the next term. Specifically, this function helps each site reduce its CO_2 emissions by analyzing past power usage data and predicting the occurrence of peak power use, and automatically selecting the most appropriate power contract based on analysis of the difference between actual performance and contract power supply.

Using the Environmental Management Dashboard, we analyze the relation between actual power usage and temperature, and examine energy saving measures. Specifically, we perform analysis to determine, in kW, how much power use changes for each temperature change of 1°C, based on actual power usage and temperature at 30 minute intervals (**Figure 4**). If the correlation between the temperature and the amount of power used is high, measures such as enhancing the heat insulation of the building are examined. Further, list display on the dashboard screen allows comparison of plants/offices for the identification of sites where energy conservation measures need to be strengthened.

Moreover, based on the analysis results for each

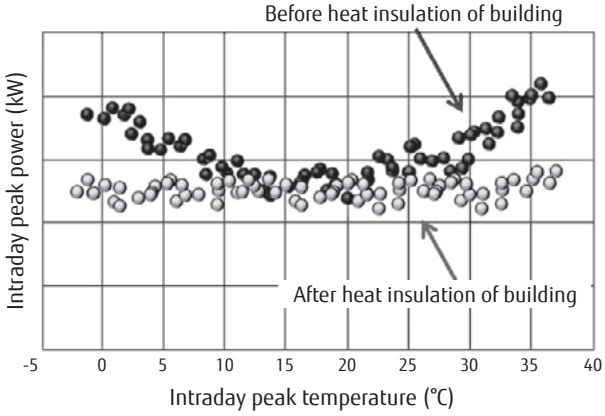


Figure 4
Correlation analysis of temperature and power used.

site, it is possible to predict peak power over the next fiscal year, and to select the best power contract accordingly, yielding a beneficial power cost reduction effect for each site. Energy conservation is promoted through automatic distribution of the analysis results by email to the persons in charge of each site one month prior to the renewal of the contract with the power company and urging consideration of review of the contract power supply.

Further, in order to cope with day-to-day operations, a function to predict power usage is also provided. **Figure 5** shows predicted power usage at peak time and predicted peak occurrence time. This figure shows also actual power use data for comparison

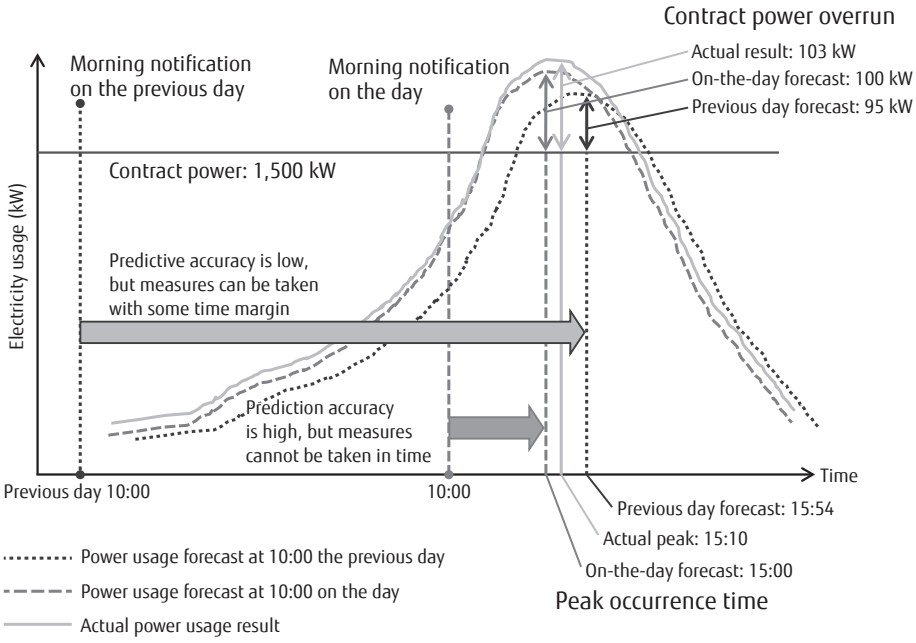


Figure 5
Contract power overrun forecast.

of prediction accuracy. Comparing the prediction at 10 o'clock the morning of the previous day and the prediction at 10 o'clock of the morning on the day, the prediction for on the day is obviously closer to the actual value and the prediction accuracy can be said to be high. This is due to the accuracy of the weather forecast data used for peak prediction. However, even if the time of occurrence of peak power use is notified on the same day, it would be difficult to implement power use reduction countermeasures for peak time including power saving in time. This time, we have made it possible to take power use reduction countermeasures for peak time well in time through notification of the peak power time one day in advance. Looking forward, we will continue to promote energy conservation and power cost reduction at each Fujitsu Group site through this system.

4. Energy saving measures for facilities and infrastructure

At the Fujitsu Group's plants and offices, air-conditioning and heating equipment are among the applications that use consume the most energy (electricity, fuel, and gas), and a large energy saving effect can be obtained by implementing countermeasures designed for such equipment. Currently, we are promoting energy conservation mainly through the following items as major priority measures, to good effect.

- Optimization of air conditioning and heating capacity according to current business scale and loads
- Systematic update to higher-efficiency equipment
- Switch to electric power and fuels causing low CO_2 emissions

Below, we introduce the case of the Fujitsu Oyama Plant as an example of energy conservation through the elimination of air conditioning waste.

The Oyama Plant promoted energy conservation by reducing the amount of outside air introduced by the air conditioners that adjust the indoor environment including the manufacturing area and common areas such as restrooms and the staff kitchen.

The indoor environment of the entire building was good to start with, but measurement of the indoor environment (temperature, humidity, CO_2 concentration, number of occupants) and a balance survey (amount of outside air introduced and indoor air exhausted by air conditioning equipment) led to the conclusion that the amount of outside air introduced by air conditioning was excessive. Based on this result, a floor allowing easy effect verification was selected for improvement. To reduce the outside air introduction amount, a

supply-and-exhaust balance check was conducted, taking into consideration the displacement volume of the manufacturing area and common areas.

As a result of reducing the amount of air introduced from the outside while making adjustments to prevent the indoor air pressure from becoming negative, it was confirmed as follows that there was no problem with the introduction of a reduced amount of outside air equivalent to 70% of the past level.

- Room temperature and humidity: No change
- Indoor CO_2 concentration: Normal (maintained at 1,000 ppm or less)
- Supply and exhaust balance: Normal (indoor positive pressure state)

Reduction of the amount of introduced outside air on that specific floor resulted in reduction of the use of steam and chilled water heating value by an average of 30% or more (**Figure 6**). In terms of energy saving effect, it is estimated that this will reduce power usage for cooling by 2,750 kWh annually, and fuel consumption for heating and humidification by 22,000 L per year (equivalent to annual energy cost of about 1 million yen, CO_2 emissions of about 60 t).

Going forward, this measure will be deployed across the entire plant.

5. Energy saving initiatives at overseas plants

The Fujitsu Group has been actively working on energy conservation at overseas plants too with good results.

In Vietnam, Fujitsu Computer Products of Vietnam has been carrying out various energy saving activities for several years now. Already implemented activities include the following.

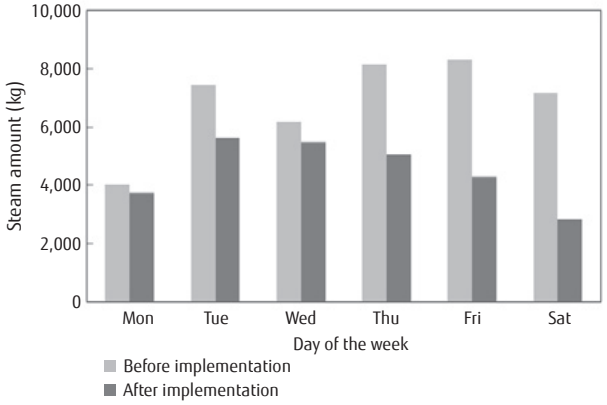
- Replacing the fluorescent lamps in the production and office areas with compact, low-energy fluorescent lamps (from fluorescent lamp specification T8 lamp type 56 W to T5 lamp type 30 W)
- Installation of power saving switches for fluorescent lamps in office areas
- Replacement of exhaust equipment (change from compressor type to cooling water type)

As a result, total annual energy consumption was reduced by about 1.4 GWh and energy cost by about 92,000 U.S. dollars.

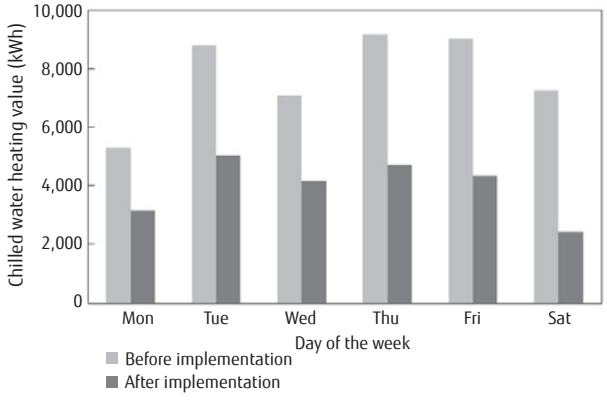
Further power usage reduction by about 0.6 GWh per year and energy cost reduction by about 43,000 U.S. dollars are expected through the following efforts.

- Replace existing compressors with inverter type compressors
- Replace lights in corridors and passageways with LED lights
- Sequentially replace exhaust equipment with newer equipment

Cases of energy saving at overseas plants are also increasing. Crisis awareness among overseas employees with regard to global warming is also high, and there are various overseas practices, such as employees autonomously devising energy saving proposal activities and energy saving measures for personal devices, that domestic plants would do well to use as reference.



(a) Change in steam amount



(b) Change in chilled water heating value

Figure 6
Energy saving effect obtained by adjusting the introduction amount of outside air.

Meanwhile, many people overseas wish for information about energy conservation in Japan to be made available. Up to now, energy saving activities at plants have been conducted mainly as isolated efforts by individual plants, with few opportunities for bidirectional information exchange.

With a view to enabling the sharing of energy-saving information on a common internal website in Fujitsu Group, we are now promoting the consolidation of examples of energy conservation initiatives at domestic and overseas plants and their translation into various languages, and we have started to publish some of them.

6. Conclusion

In this paper, we introduced trends in domestic regulations in Japan and other measures concerning global warming prevention and various initiatives to prevent global warming at plants and offices based on the Fujitsu Group Environmental Action Plan (Stage VIII).

The world as a whole agrees that it is necessary to halve GHG emissions by 2050, and international efforts and Japan's policies are showing corresponding medium- and long-term outlooks in this regard, and reductions in GHG emissions stand to be further strengthened in the future.

For its part, the Fujitsu Group will continue to comply with applicable laws, regulations, and industry targets, and will continue to work on reducing GHG emissions and promoting energy conservation activities in our business activities. At the same time, we aim to strengthen energy creation, first of all, through the use of renewable energy and other means, as well as energy storage as a way to level power usage, not only from the perspective of the prevention of global warming but also based on the view that energy/electricity supply and demand issues are risks to business management and continuity.

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Hideaki Namiki
Fujitsu Ltd.
Mr. Namiki is currently engaged in the development of production equipment and green production technology, and the promotion of CO_2 emissions reduction in manufacturing.

Toshiharu Nakano
Fujitsu Ltd.
Mr. Nakano is currently engaged in the development of production equipment and green manufacturing technology, and the promotion of CO_2 emissions reduction in manufacturing.

Masayuki Nihei
Fujitsu Ltd.
Mr. Nihei is currently engaged in the planning and proposal of measures against global warming, and the emissions reduction activities.

Hiroyuki Ito
Fujitsu Ltd.
Mr. Ito is currently engaged in the planning and proposal of measures against global warming, and the emissions reduction activities.

Kazuaki Sato
Fujitsu Ltd.
Mr. Sato is currently engaged in the planning and proposal of measures against global warming, and the emissions reduction activities.

Masayuki Kitajima
Fujitsu Ltd.
Mr. Kitajima is currently engaged in the planning and proposal of measures against global warming, and the emissions reduction activities.

