Overview of Fuji Electric's Energy Solutions

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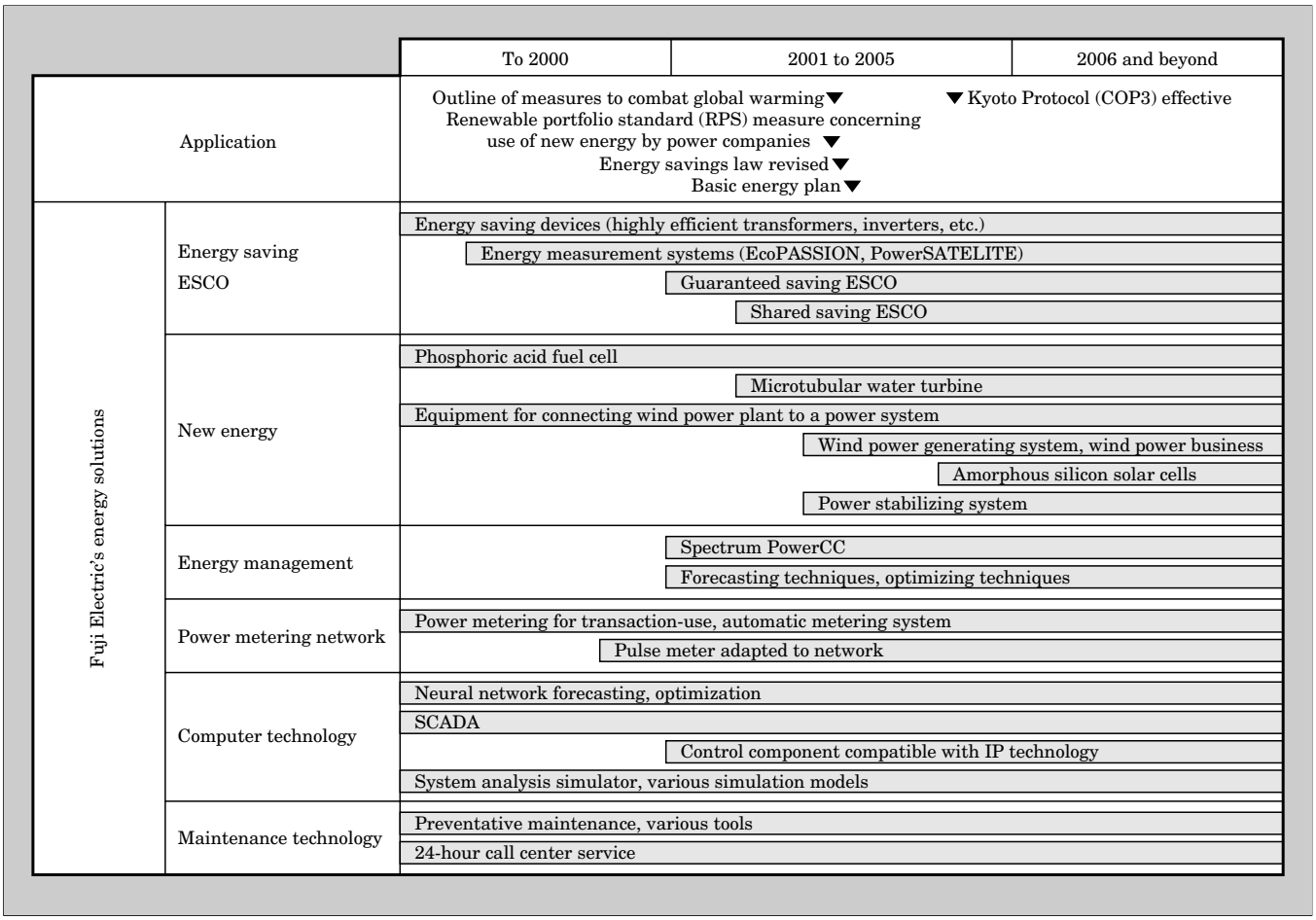
1. Introduction

In response to the increasing severity of global warming, acid rain, ozone layer depletion, destruction of tropical rainforests, desertification and other such environmental problems of a global-scale that are not limited by national borders, the Kyoto Protocol took effect in February 2005. Japan has announced a "Basic Energy Plan," a medium and long-range energy policy that emphasizes energy security, environmental suitability and the application of free market principles, and which calls for the introduction of alternative (oil-free) energy sources and energy saving, and the introduction of free market principals to the energy field as typified by the opening of an exchange for electric power transactions.

Fuji Electric established a "Basic environmental protection policy" in 1992, and has acquired ISO14001 certification, promoted energy saving in manufacturing processes, deployed a zero emissions plan based on strict implementation of the "3 Rs" (reduce, reuse and recycle), and has advanced the protection and preservation of the global environment by providing solutions in the fields of energy, electric power distribution,

Fig.1 Changes in the environment and Fuji Electric's energy solutions



water treatment, industry and transportation, information, lifestyle, and the like.

In the energy field, Fuji Electric has responded to global environmental problems, and contributed to ensuring energy security and reducing energy cost with energy solutions that combine technologies for energy saving, ESCO (energy service company), new energy, energy management systems, power quality improvement, maintenance, environmental preservation and the like. Figure 1 lists environmental changes and Fuji Electric's involvement with energy solutions. An overview of Fuji Electric's energy solutions is presented below.

2. Current Status and Future Outlook for Energy Solutions

In October 2003 the Basic Energy Plan was approved at a Japanese government cabinet meeting and reported during a session of the Japanese parliament. The basic policy of this plan relating to power demand can be summarized as follows.

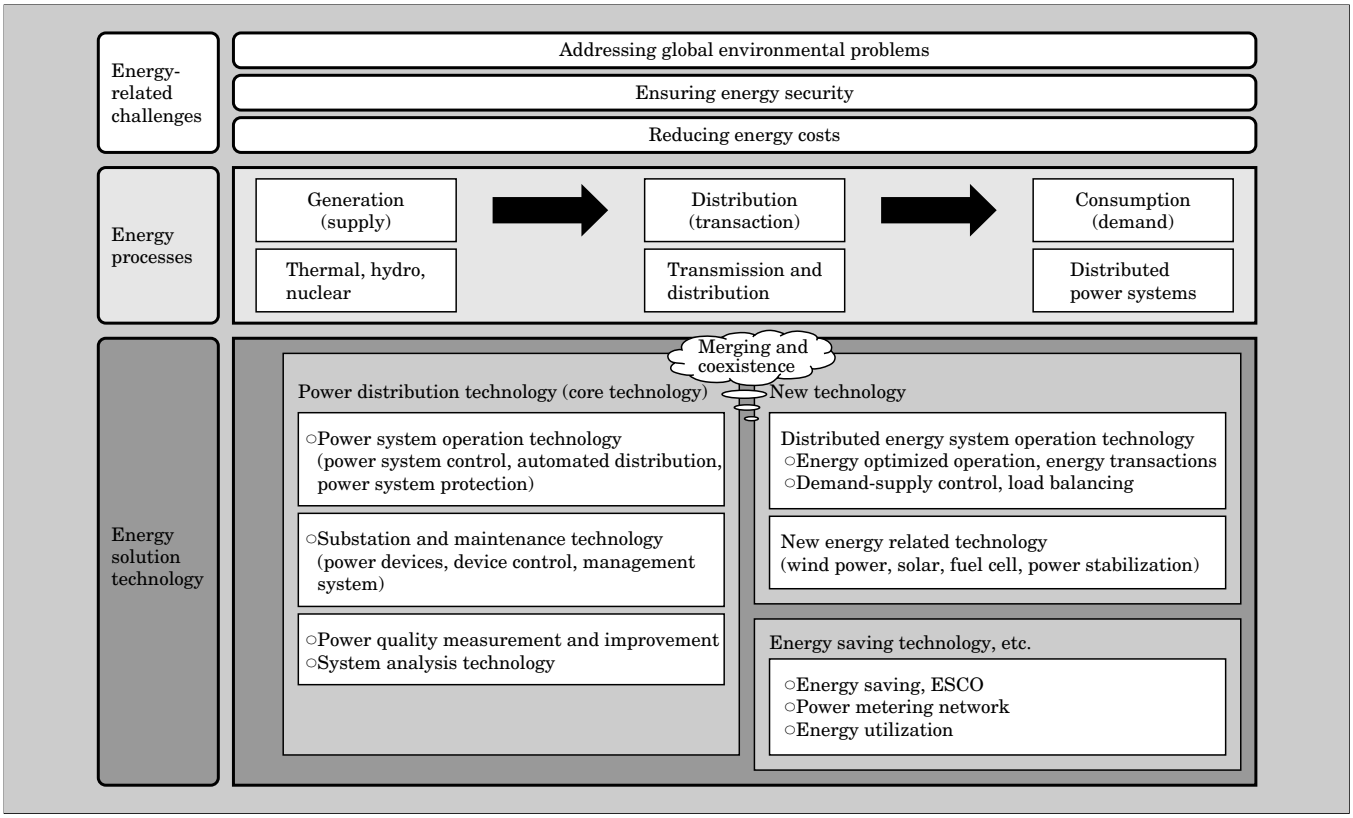
(1) Measures relating to energy supply and demand
  (a) Support for research and development that would not be undertaken sufficiently if left solely to market forces
  (b) Official regulations for ensuring profit and safety for the entire population
(2) Measures to counteract energy demand
  (a) Creation of a resource-saving economic and social structure
  (b) Load leveling
(3) Development and introduction of various types of energy
  (a) Development, introduction and use of nuclear power: Promotion of nuclear power as a key power source, with a guarantee of safety as the major precondition
  (b) Development, introduction and use of new energy: Contribute to improved energy self-sufficiency and efforts to combat global warming; expected to be implemented as distributed energy systems

This plan, based on new energy and nuclear power generation in the medium and long-term, and using distributed-type new energy power sources, ensures energy security and environmental suitability. The future challenge for energy systems is to create a network in which a distributed energy system that uses new energy, for example, can coexist with a large-scale existing energy system based on nuclear power generation.

Issues involving environmental considerations, regulations and technology will be clarified and these measures advanced, but solutions to the following technology-related issues are essential.

- ○ Technology that supports energy conservation and energy management for the consumer; ESCO-based support
- ○ Device technology for new energy such as fuel

Fig.2 Fuji Electric's energy solution technologies



cells, solar power generation, wind power generation, and micro hydropower generation; System interconnection technology

- ○ Power quality measurement, status monitoring, control technology, power system analysis technology, and stabilization control technology to prevent a degradation of power quality caused by distributed power sources
- ○ Operation and control technology, including a storage system for distributed energy, so that an existing large-scale energy system and a distributed energy system can coexist
- ○ Technology for constructing a virtual micro-grid system based on IT (information technology)
- ○ Energy management technology having functions for controlling the supply-demand balance of generated and consumed energy including heat, and for supporting exchange transactions

To resolve the above technology-related issues, as can be seen in Fig. 2, Fuji Electric aims to establish a system placing "power distribution" technology as its core technology for the energy cycle sequence of generation, distribution and consumption. Fuji Electric is working to develop customer-oriented total energy solutions that combine energy saving, ESCO, power metering network, and system maintenance technology, by promoting the restructuring of energy solution technologies so that existing large-scale energy systems can coexist with distributed energy systems that use new energy or the like.

3. Fuji Electric's Efforts

Table 1 shows an overview of Fuji Electric's energy solution technology and main products and services. The main examples of Fuji Electric's involvement include supply-demand control systems that include local energy systems (micro-grids) and ESCO service, wind power generation equipment that includes power output stabilizing equipment, a wind power business, and lightweight and flexible film-substrate amorphous silicon solar cells. In addition, by participating in national projects and cooperating with external institutions, including joint research between industry, academia and national research institutes and joint development overseas (in China), Fuji Electric is also committed to the development of new technologies and products. Fuji Electric's various solution technologies are described below.

3.1 Energy saving, ESCO solutions

Energy saving measures help to combat global warming by reducing the final consumption of energy and thus suppressing the generation of carbon dioxide (CO_2) caused by energy consumption, and together with the introduction of new energy, are important environmental measures. As disclosed in the concept of the "Law Concerning the Rationalization of Energy Usage" (also known as the Energy Saving Law), energy savings measures are used to rationalize the usage of energy by eliminating waste and increasing the efficiency of energy usage. Because energy saving based only on economizing and self-restraint is not sustainable and has limited effectiveness, basic measures that include a reassessment of the entire system are needed in order to realize effective energy saving without sacrificing productivity and comfort. For this purpose, ingenuity, ideas and specialized knowledge are needed.

Table 1 Energy solution technology and products

Segment	Description	Product or service
Energy saving ESCO	Consulting and implementation of measures concerning the reduction of customer's energy costs	○ Energy saving measurement ○ Energy saving consulting ○ ESCO with inverter ○ ESCO with CHP (combined heat and power)
New energy	Supply of equipment for using new energy and renewable energy Provision of engineering services	○ Wind power generation, Wind power generation business ○ Solar power generation ○ Micro hydropower ○ Fuel cell (biomass power generation)
Energy management Distributed energy system	Assessment of customer's energy utilization status, Rationalization of use and procurement Solutions for optimization, Provision of services	○ Power quality measurement ○ Equipment for power quality improvement ○ Energy management, optimal operation ○ Generator control ○ Energy exchange transaction support ○ System analysis technology
Power metering network	Supply of equipment relating to power metering, Provision of solutions	○ Power metering ○ Automated metering system ○ Automated metering terminal
Computer technology	Supply of equipment for highly reliable energy distribution Provision of solutions and services	○ Power monitoring system ○ Automated distribution system ○ Information sharing system ○ Tele-control, tele-meter ○ Protective relay
Maintenance technology	Energy equipment maintenance, Operation outsourcing, Provision of preventative maintenance services	○ Maintenance network ○ Call center ○ Operation, procurement, maintenance outsourcing

Having developed highly efficient equipment and energy-saving equipment, and having been actively involved in energy saving engineering that applies various plant control technologies, Fuji Electric has provided a wide range of energy solutions. In particular, Fuji Electric has focused on further improving energy saving technology such as by increasing the effectiveness of ESCO businesses for local governmental office buildings, and by creating a BEMS (building energy management system) that utilizes measurement and control technology. In the future, Fuji Electric intends to continue to contribute to all sorts of energy saving measures.

3.2 New energy solutions

From early on, Fuji Electric worked to develop the technology for fuel cells and amorphous silicon solar cells, and has accumulated much experience through its involvement with new energy and renewable energy such as wind power, micro hydropower, wave power, and geothermal power.

At present, Fuji Electric has increased the cell life from 40,000 to 60,000 hours of the phosphoric acid fuel cell only commercially available in Japan, and has introduced a 100 kW model to the market. Furthermore, in order to expand the range of applications, Fuji is strongly promoting the development of a model equipped with a hydrogen supply function and the development of home-use proton-exchange membrane fuel cells.

Introduced to the market is October 2004, the film-substrate amorphous silicon solar cell has the advantages of flexibility and light weight, and has been attracting attention as product that expands the possibilities for solar cells. Additionally, this solar cell has a shorter energy payback time (the interval during which the energy expended for manufacture is generated and recovered by the product itself) and lower impact on the environment during manufacture than a conventional crystalline-type solar cell. Figure 3 shows the appearance of a flexible, film-substrate amorphous silicon solar cell module.

Fig.3 Film substrate-type amorphous silicon solar cell module

Aiming to decrease the initial cost and running cost associated with wind power generation, the output per turbine is being increased and large-scale wind farms are being promoted. However, planned output control is difficult to implement for wind power generation, and the connection of a wind power plant to an electric power system may be subject to many restrictions. Fuji Electric also provides power stabilizing equipment that leverages the power station and substation using monitoring and control technology and system analysis technology for which Fuji has an abundance of experience, and is working to merge wind power generating systems with existing electric power systems.

3.3 Distributed energy system

Natural energy power generation such as wind power generation and solar power generation is unstable because its output is affected by natural conditions, and has limited connectability to an electric power system due to concern about frequency and voltage stability. Of the various distributed energy systems that have been proposed to minimize the impact on an electric power system when connecting distributed power sources that include natural energy generation, the micro-grid is attracting the most attention.

A micro-grid is an onsite self-sufficient power supply system that receives power from distributed power sources such as CHP, solar cell power generation and wind power generation installed within a certain area where several end-users are located and maintains a balance between energy supply and demand within the grid. A micro-grid requires supply-demand balancing control in order to stabilize the power flow at points of connection to a larger electric power system. Fuji Electric is advancing the construction of a distributed energy system by integrating a wide range of technologies such as generator and inverter device technology, measurement and information processing technology, system monitoring, control and protection technology, and power system stabilizing technology.

3.4 Energy management (Spectrum PowerCC *1)

Fuji Electric is promoting the application of "Spectrum PowerCC," an energy management system ideally suited for comprehensive supply and demand control for the energy and heat that is generated and consumed.

Spectrum PowerCC is a standard software package that incorporates SCADA (supervisory control and data acquisition) and other standard functions such as load forecasting, power generation planning and generator control, engineering tools, various standards that facilitate the linking of data, and the latest IT

*1: Spectrum PowerCC is a trademark of German Siemens AG.

(information technology) such as Windows*2 and Web software. Further, a system running on the Spectrum PowerCC platform and that leverages the technology and know-how cultivated with conventional power monitoring and control systems, for example, by combining that technology and know-how with one of Fuji Electric's proprietary applications such as market transaction support on the end-user side for power exchange transactions, is being promoted as an energy management system suitable for the Japanese market.

3.5 Power metering network system

Efforts to introduce power metering (legal meters for transactions involving electric fees) and an automated meter system for processing that metered data are already underway, and nearly all bulk customers of 500 kW or greater have installed such systems. With the advancement of retail electricity liberalization, high voltage customers rapidly have increased need for such systems and their rate of installation is accelerating. Moreover, typical low-voltage customers are planning to install such systems in some regions where meter reading is inconvenient, and there is increasing need for ON/OFF switching on the load side of the power supply.

Fuji Electric is working to achieve widespread use of network systems through developing electronic power meters provided with a current loop-type communications functionality, and communications terminals and the like that connect power meters to an upper-level network.

3.6 Computer technology

Previously, monitoring and control systems for the large-scale energy systems that form the power system infrastructure were configured so as to collectively monitor and control a local area. In the power distribution field, however, greater importance is being placed on increasing business efficiency and equipment downsizing, monitoring and control systems are becoming more streamlined, and there is increasing demand for information sharing, mutual backup, and more sophisticated business functions among systems distributed over a wide area.

Fuji Electric is developing technology for the construction of a wide-area monitoring and control system that incorporates these types of horizontal integration. Additionally, equipment that utilizes IP (Internet protocol) network technology is being developed for the protection and control equipment and telecontrol equipment directly linked to onsite devices. Systems that do not need to be concerned with the location of computer installations can now be constructed. These technologies can also be applied to a distributed energy system.

On the other hand, under these circumstances, it has also become important to reassess maintenance and preservation tasks in order to use energy more efficiently and to prolong the service life of equipment, and Fuji Electric is moving ahead with the development of applications that employ predictive technology based on neural networks and the deployment of maintenance technology that supports the more efficient operation of equipment. Moreover, Fuji Electric is also developing functions for enhanced information security whereby, instead of relying simply on a user ID and password, authority for an operation area and scope of work is granted based on authentication and an operator security level obtained from an IC card.

3.7 Maintenance technology

Following the revision of Japan's "Electric Utility Law" in 1995, safety regulations for electric equipment were reassessed with greater emphasis on corporate responsibility, and optimal maintenance planning is desired for improved reliability and economic reasons.

Fuji Electric provides support tools for predictive maintenance based on residual service life diagnostic techniques, remote diagnosis, long-term maintenance planning optimization and the like, and is promoting a life cycle service featuring a call center that operates 24 hours per day, 365 days per year.

4. Conclusion

The formation of a sustainable recycling-oriented society is an important challenge.

Fuji Electric intends to continue to concentrate its collective technical expertise and strive to achieve a harmonious coexistence between energy and the environment.

With the publication of this special issue, we wish to express our gratitude to all concerned parties throughout the world and to respectfully request continued guidance and support.

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*2: Windows is a registered trademark of US-based Microsoft Corp.