SANYO DENKI TECHNICAL REPORT No.8 November-1999

Features:Environmental Protection Technologies

Efforts for Photovoltaic Power Systems

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1. Introduction

In recent years, global warming, acid rain and other global environmental issues have been strongly attracting the attention of the international community. The Third Conference of Parties to the United Nations Convention on Climate Change (COP3) set the goal of reducing greenhouse emission gases by 6% from the 1990 level between 2008 and 2012. In response to this goal, "Projections of Long-term Supply and Demand of Energy" in the intermediate report by the Supply and Demand Task Force and Advisory Committee for Energy, changed its target to be achieved by fiscal 2010 for Photovoltaic (PV) Power systems (for which hopes run high as one of the new energy sources) from 4.6 million to 5 million kilowatts.

Various subsidy programs have been provided and PV systems have been aggressively introduced, expanded, and promoted in order to reduce the introduction cost - which is now the greatest constraint - and to spread such systems to the public.

In this paper, the effects of the 20kW PV system installed at Sanyo Denki's Technology Center on the global environment are calculated as part of environmental conservation and by means of a field test on products. This paper also presents a typical PV system delivered in fiscal 1998.

2. A typical installation at the Technology Center

2.1 System configuration

Fig.1 shows the configuration of the 20kW PV system provided at Sanyo Denki's Technology Center.

2.2 Equipment specifications

The components of the equipment conform to the following specifications:

Table 1 Equipment specifications

Component		Specifications
Solar cell module	Type	Polycrystal
	Maximum Power	120 W
Array	Number of modules	180 pcs
	Module configuration	9 series x 20 parallel
	Maximum Power	21.6 kW
	Tilt angle	30 degrees
	Azimuth	25 degrees
Current Collector box	Construction	Outdoor, wall-mounted
	Number of circuits	10 circuits
	Quantity	2 units
Utility Connected inverter	Capacity	20 kW
	Construction	Indoor, standalone
	Operating input voltage range	200-500V DC
	Output voltage	3-phase, 3-wire, 200V
	Power conversion efficiency	92% minimum
	Control system	Maximum power point tracking
	Utility protective device	Internal
Radiometer	Designed for	All weathers and slopes
	Performance	ISO second class
Thermometer	Type	Resistance bulb
	Sensor	Pt 100 Ω
Solar cell thermometer	Type	Thermocouple
Data collector/ analyzer	Applicable equipment	Personal computer
	Display screen	Power generation status diagram, various trend graphs
Display unit	Construction	Indoor, standalone
	Details displayed	Generated power Accumulated generated power Message (text)

Fig. 2 is an external view of a typical solar cell array.

2.3 Operation data

This system measures various data with a data collector/analyzer as shown in Figs. 3 and 4 in order to monitor the operation status of the system and to give an overall evaluation.

Fig. 5 shows actual and projected amounts of irradiation and generated power as measured with the data collector/analyzer during one year from January to December 1998. For the yearly generated power, the projected amount was 24,000kWh and the actual amount was 24,500kWh. The generated power can thus be projected accurately.

Following its "PMA-TD" series, Sanyo Denki developed a "PMB-TD" series of high-efficiency unit-type utility connected inverters. The inverter installed at the Technology Center was run on utility grid by means of a "PMA200TD" from the time of completion in July 1997. It was then replaced with a "PMB200TD" in June 1999. One feature of the high efficiency of the "PMB-TD" series is the quantity control for unit operation. When an inverter of 20kW or more has an output power lower than the specifications, superfluous units are stopped to reduce the normal running loss, thus improving the overall efficiency of the system within that operation range. Fig. 6 compares the efficiency characteristics of the "PMA200TD" and "PMB200TD" when actually run on the PV system at the Technology Center. This reveals that the efficiency characteristics have been improved at low power, so that one can expect a rise in generated power.

2.4 Effects on the global environment

The yearly generated power mentioned above is used to calculate the cut achieved in carbon dioxide, which is the main factor of global warming. A comparison of carbon dioxide emissions is made with oil-fired thermal power generation. The emissions are calculated in 200g-C/kWh, and carbon dioxide generated when a PV system is produced is in 20g-C/kWh. Operation data of the PV system in the Technology Center mentioned before reveals that the yearly generated power is 24,500kWh and that the yearly reduction in carbon dioxide emissions was

(200g - C/kWh - 20g - C/kWh) x 24,500kWh = 4,410kg)

Next, let us calculate the oil loss. Let the amount be 9,250kcal/liter in terms of quantity of oil heat and let the energy requirement for power generation be 2,250kcal/kWh. Then, the required oil quantity is 2,250/9,250 = 0.243 liters/kWh.

Similarly, the yearly-generated power was 24,500kWh, so that the yearly reduction in oil loss was

24,500kWh x 0.243 liters/kWh = 5.954 liters.

The time required for the energy loaded over the life cycle to be collected by produced energy (energy payback time) is reported to be 2.4 years, when a crystal silicon solar cell is used. The service life is thus much shorter than that of PV systems. Energy profitability can thus be sufficient.

3. Typical deliveries made during fiscal 1998

Various subsidy programs have been provided to promote the introduction of PV systems. Among these are the Project for Field Tests on Industrial Photovoltaic Power Generation launched by the New Energy Development Organization (NEDO) and the buildup of the Eco-campus based on the Fiscal 1998 Third Supplementary Budget by the Ministry of Education. Sanyo Denki's PV inverter has already seen 3,600kW worth of shipments made since its arrival on the market. Of these, the PV systems delivered in recent years are presented below.

Fig.7 Yono Institute, The Dowa Fire & Marine Insurance (20kW)

Fig.8 Kirigaoka School for Physically Handicapped and MentallyRetarded Children, Tsukuba University (20kW)

Fig.9 Hinode Nursery School and Children's Hall, Shiojiri City (10kW)

4. Conclusion

This paper has so far presented how Sanyo Denki has been working on PV systems.

PV systems can contribute greatly to the prevention of global warming and other projects for environmental conservation. Demand for such systems is expected to rise even further when power generation efficiency is improved and the system lasts longer.

The authors are determined to aim at higher conversion efficiency and lower pricing and work on development and design of eco-friendly products in order to promote the introduction of eco-friendly PV systems.

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Worked on development and design of
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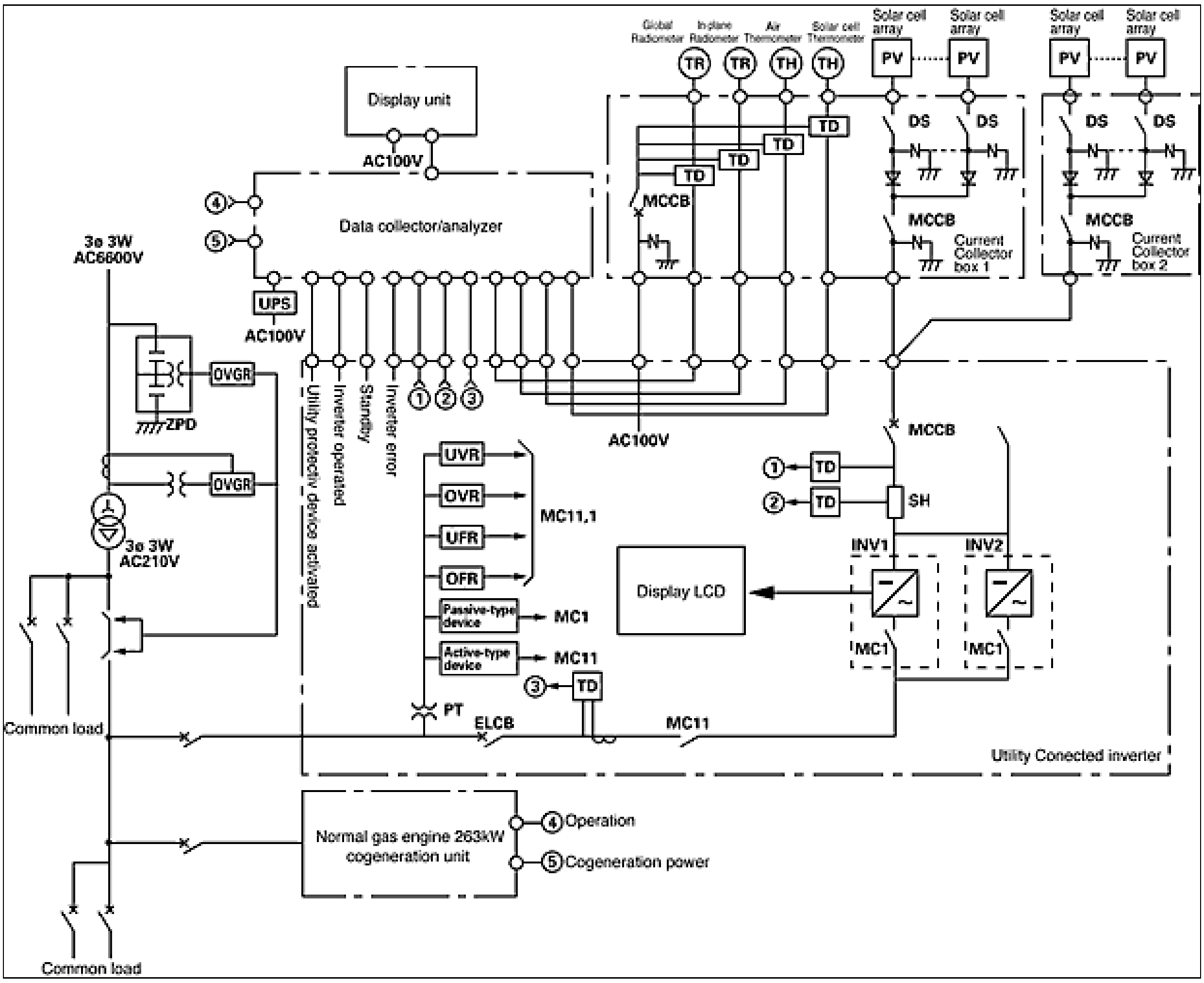


fig.1 System configuration

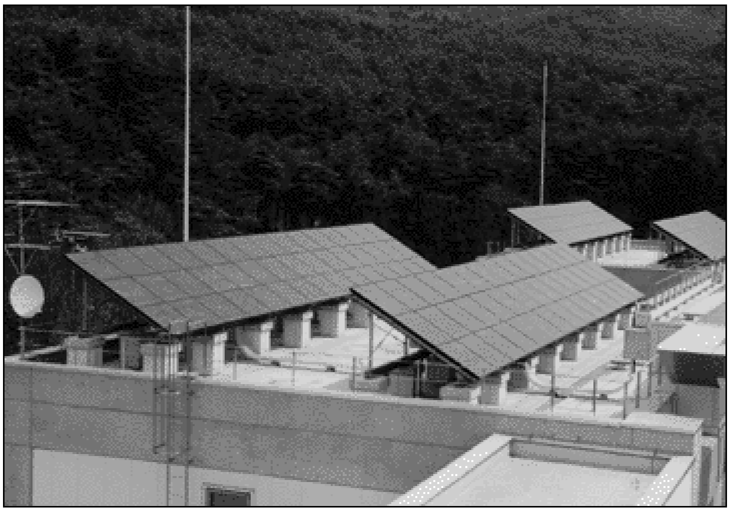


fig.2 External view of a solar cell array

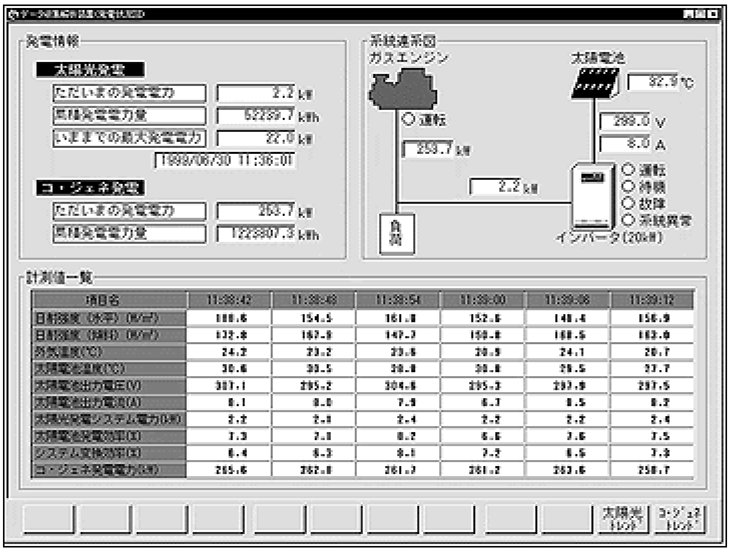


fig.3 Power generation status diagram

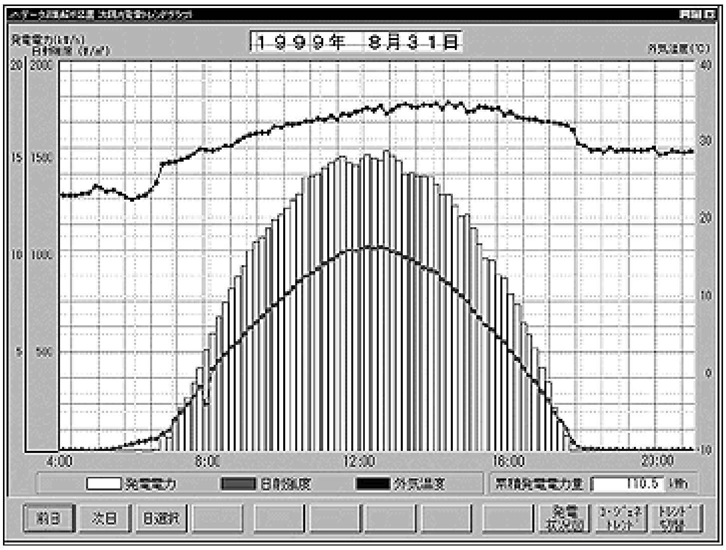
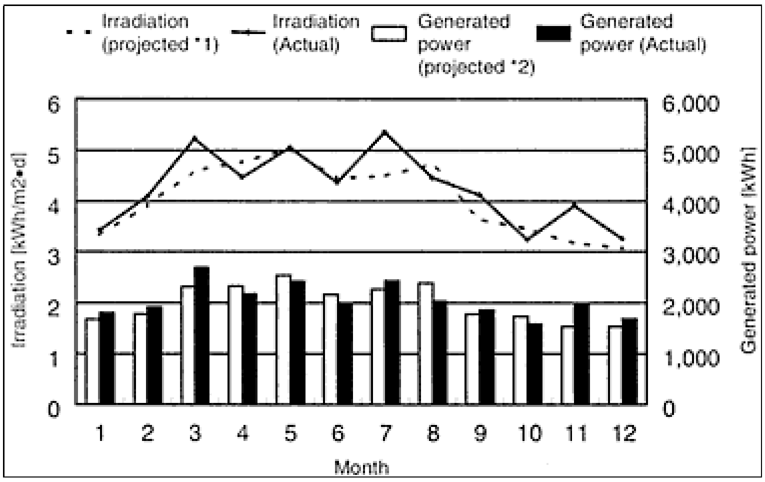


fig.4 Trend graph of photovoltaic power generation



*1: As per "Basic Survey of Power Generation" by the Japan Weather Association.
*2: Calculated on the basis of a loss factor of 0.75.

fig.5 Irradiation and generated power

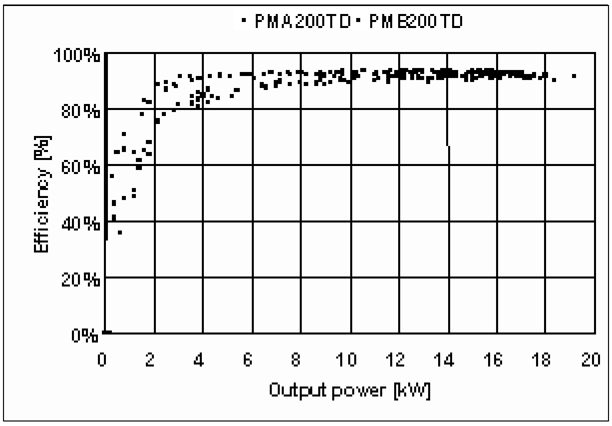


fig.6 Efficiency characteristics

fig.7 Yono Institute, The Dowa Fire & Marine Insurance (20kW)

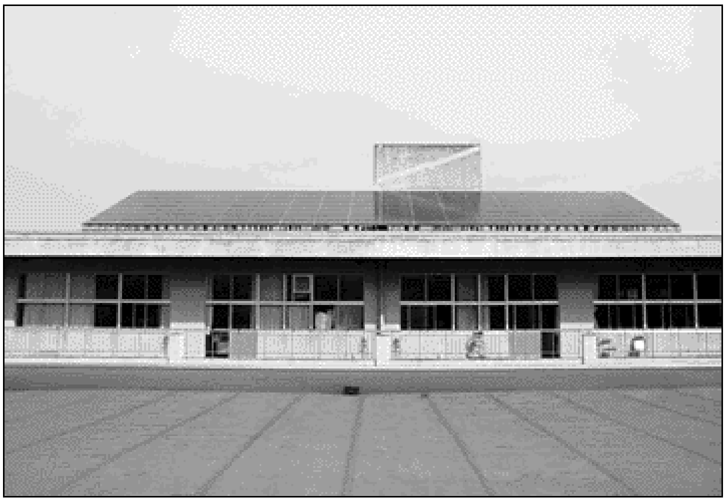


fig.8 Kirigaoka School for Physically Handicapped and MentallyRetarded Children, Tsukuba University (20kW)

fig.9 Hinode Nursery School and Children's Hall, Shiojiri City (10kW)