Creating Energy-Producing "Oil Field"
With Thin-film Solar Cell Technology

Interviewer: Hiroshi OKABE

Sharp Corp. plans to put into operation by March 2010 a giant plant for the production of thin-film solar cells. It will be capable of producing annually enough solar cells to cover electricity consumption by 250,000 households. With its world-class capability in liquid crystal display (LCD) panels, Sharp plans to build the world's most advanced solar cell plant by applying liquid crystal technology to thin-film solar cells. Mikio Katayama, president and COO of the company, says, "What we are trying to do is to build an oil field of the 21st century model." According to him, a plant producing solar cells, which obtain energy from the inexhaustible sunlight on a stable basis without emitting greenhouse gas, is a "next-generation oil field," as it were. Katayama speaks with *Japan SPOTLIGHT* about his hopes for the solar cell business.

What is your stance for tackling the problem of global warming?

Katayama: Sharp's corporate vision is to aim at reducing its load on global warming to zero by 2010. The solar cells we are producing realize "energy creation" and emit no carbon dioxide. We plan to compensate for the energy that is consumed during the process of our production of various goods by creating energy with solar cells. We have been working under the vision to reduce the company's load on global warming to below zero beyond 2010. Needless to say, minimizing energy consumption by conservation is important, but solar cells play a major role in terms of creating energy.

If the Gobi Is Paved with Solar Cells...

Growing awareness of the need for measures against global warming has heightened interest in solar cells.

Katayama: I feel that since around September-October of last year, there has been a dramatic increase in interest in solar cells. As former US Vice President Al Gore received the Nobel Peace Prize and as the COP13 was held, debate on the issue of global warming has become increasingly intense. This has changed how solar cells are being viewed. According to a simulation undertaken by a professor of a prominent university, if we covered the Gobi Desert in China with solar cells, we would be able to generate more than enough power for world consumption (though, in reality, we can only cover about half of the Gobi with solar cells in terms of space because of the need to install various equipment). Their power output will equal that of 15,000 thermal power stations and in terms of carbon dioxide emissions, it will be able to curb them by 33.6 billion tons. Data from the Ministry of Environment show that the world's actual carbon dioxide emissions today are approximately 27 billion tons. Then, our calculation shows that if we can cover the Gobi with solar cells, there will be no need to burn fossil fuel anywhere in the world.

Photo: Kyodo News

Mikio Katayama, President and COO of Sharp

With those numbers, I can understand the importance and future potential of solar cells very well.

Katayama: I would like to emphasize another point. From a global perspective, there are regions without electricity, and 1.6 billion people reportedly live in these areas. If those people wish to improve their living standards like those in advanced countries, they require a huge amount of electricity estimated to reach 1,600 terawatt-hours. Electric power can be generated abundantly with the use of fossil fuel. But if they are to obtain electricity by burning fossil fuel in the conventional manner, it will emit 500 million tons of carbon dioxide. On the other hand, by covering only about 1/100th of the Gobi with solar cells, the people now living in the regions of the world without benefiting from electrification will be able to obtain electricity and enjoy quality lives. We can also calculate that it will be very useful in solving the problem of poverty. Sharp has already been working for five to six years in countries and territories such as Mongolia and China's Tibet region with governmental

Photos: Sharp

Examples of the use of solar cells: *(Upper left) Large-scale thin-film solar cells on the roof of a Flieg plant in Germany. Solar cells are utilized at the plant for the production of large motor vehicles like trailers. (Lower left) A government-funded solar power project in the village of Noyon, Mongolia (Lower right) Thin-film, see-through photovoltaic modules are installed on the ceiling of the Suzuka City Hall. (Upper right) An industrial complex of the 21st century model in Sakai City – comprising an LCD panel plant and a thin-film solar cell plant with eventual annual output of 1 gigawatt, and accommodating infrastructure and parts plants within the same compounds. It will start operation by March 2010.*

aid programs to cooperate in building solar cell power generation facilities. Today, the globe simultaneously faces the environmental and population problems and the problem of flattening of the world. Dispersed power generation, which is a characteristic of solar cells, is the technology best suited for the solution of these problems. It does not require transmission lines. Power can be generated where it is needed. There is no need to build massive facilities for hydro or thermal power generation and networks of power lines. In the future, such needs for solar power will arise at an accelerating pace.

An Industrial Complex of 21st Century Model

We understand that the plant now under construction in Sakai City, Osaka Prefecture, will be not only a production center for LCD panels but also a giant factory for thin-film solar cells. Would you tell us the strategic significance of this plant, which will start operation by March 2010?

Katayama: In the industrial complex of the 21st century model in Sakai, we will build a plant for the production of thin-film solar cells that will be able to generate 1 gigawatt of power, along with a plant for the 10th generation of LCD panels. Compared with the

conventional crystalline solar cells, thin-film solar cells require only about a half of the energy for production and only 1/100th of silicon as their material. Assuming that power consumption by an ordinary Japanese household is 4 kilowatts, the annual production of 1 gigawatt of solar cells means creating every year a power station that can supply power sufficient for 250,000 households. If this plant is in operation for 10 years, it will be able to supply power to 2.5 million households. In 20 years of operation, it will be able to do so for five million households. Moreover, if we build 10 plants like this, we will be able to supply power for 26.5 million single-family households in Japan. If the plant in Sakai goes into operation, we will have acquired technology to build a giant plant for solar cells in the future. It will be, as it were, an energy plant. That is to say, it is equivalent to an "oil field." It means that Sharp has the technology that can create man-made energy fields.

It is going to be a plant that will completely change the world's energy situation, isn't it?

Katayama: I want to discuss the significance of a 1-gigawatt plant for the future. If we assume that the useful life of a plant is 20 years, and if it produces solar cells every year, it follows that there will be a solar power station capable of generating 20 gigawatts of power in total. The difference between solar cells and petroleum or uranium is that once they are produced, solar cells continue to generate energy. In 20 years, it will generate 500 terawatt-hours of energy, which is equivalent to 720 million barrels of petroleum. This is equivalent to 1/100th of the reserves in Saudi Arabia's largest oil field. If we build 100 such solar cell plants, it will be equivalent to creating a huge oil field.

Two Challenges Overcome

Why then has the diffusion of solar cells not made progress thus far?

Katayama: There were two problems. One is that the world has not wanted it so far. Ten years ago, solar cells attracted very little attention, but today, we are being approached from all over the world for talks on our plant in Sakai. Partly as a measure against global warming, national policies to purchase power generated with reusable energy for high prices are spreading in Europe, some parts of the United States and South Korea. It is because people have realized that this is a huge energy oil field. If we think about the Earth's environment, we cannot continue to burn fossil fuel. As environmental regulations at the national level are about to be imposed, demand for solar cells has been rising vigorously. The second problem was the high power generation cost of solar cells. When thin-film solar cells of the 1-gigawatt class are mass-produced, we can see the prospect of cutting the cost of solar power generation to the average cost of ¥23 per kilowatt for commercial power use. It will be more expensive than nuclear power generation, but we are now more or less sure that the generation cost can be cut to the level of commercial-use electricity around 2010. Demand has been rising rapidly and also thanks to technological advances, the cost has come down to a matching level. We can now confidently ask that solar cells be installed on every rooftop around the world.

Technology Accumulated by LCD Panels

We understand your production technology developed for LCD panels is also your strength?

Katayama: In the past, it was impossible to build a giant solar cell plant. The production capacity of an ordinary solar cell plant is at most 100 megawatts a year. Our present annual combined production capacity of several production lines is 710 megawatts. Meanwhile, the production capacity of the Sakai plant is 1 gigawatt, which is incredible for those concerned with solar cells. Thin-film solar cells are becoming an equipment-oriented industry. We operate a plant by placing side by side equipment for the production of enormous thin films. For LCD panels, we place thin-film silicon on mother glass to make transistors. Sharp has increased the size of mother glass substrate to the sixth, eighth and 10th generations. For thin-film solar cells, we have to use very large glass substrates to attain the scale of the new Sakai plant. The technology to place thin-film silicon on a sheet of glass is very similar to that used for LCD panels. Sharp has accumulated its production technology for very large-size LCD panels at its Kameyama plant. This has made us confident enough to operate a giant solar cell plant in the same compounds as our LCD panel operations in Sakai. None of our global rivals has the technology to produce thin-film solar cells on this scale. We are able to build a giant factory for thin-film solar cells as Sharp's operations have dealt with enormous glass substrates and precisely because we have accumulated production technology that uses tremendously enormous equipment at our LCD operations at the Kameyama plant.

You mean your rival firms are not able to make such giant plants?

Katayama: A plant like this can only be realized by utilizing all of the mass production technology developed in Japan for large-size LCD panels and sophisticated thin-film solar cells. A 1-gigawatt plant cannot be operated just by lining up equipment. We must consider, for example, how large glass should be supplied and transported; how to supply monosilane gas that becomes a raw material for LCD panels and thin-film solar cells; how huge numbers of pieces of equipment are to be maintained; how to maintain their performance, etc..

Advantage of Low Silicon Consumption

Thin-film solar cells have the advantage of low consumption of their material, silicon.

Katayama: This is an era of the environment. Without doubt, global warming is bound to generate huge demand for solar cells. There are two problems in meeting this demand. One is their cost. We have found a means of solving this problem. The other is the massive supply system to meet growing demand. At present, crystalline-type solar cells account for 90% of the world's total shipments. However, silicon prices have been surging and over the past two years, silicon prices have quadrupled. But the amount of raw materials for thin-film solar cells is only a 100th of that for crystalline-type solar cells. If we maintained the past pattern in which the crystalline type was the mainstream, we would not be able to meet the huge global demand. However, I think thin-film solar cells have changed this situation.

How does Sharp plan to contribute to the world with its thin-film solar cell technology?

Katayama: Europe has set a goal to cover 20% of total power demand with renewable energy by 2020. Solar power is expected to supply 5% of the total, or a quarter of the renewable energy supply. If we are to cover 5% of world energy needs with solar power, we need a global solar power generation system capable of producing 1,280 gigawatts. That is to say, more than 1,000 solar cell plants, each with 1-gigawatt capacity, need to be built around the world. Sharp alone is unable to do this. We think everyone may utilize Sharp's technology.

What humankind is seeking is how to do with environmental measures in the next 30-40 years. We would like to contribute to the world by making use of the technology developed so far by Sharp. This is an idea full of dreams.

World Will Change, Sharp Will Change, Too

Can't we say that LCD panels and thin-film solar cells are successful examples of a vertical-integration model of production technology? As competition with the emerging countries becomes increasingly fierce, I believe this to be an important point in order for Japan's manufacturing industries to maintain their presence in the world.

Katayama: This type of production technology is indeed Japan's strength. Until now, Sharp has been said to be represented by LCDs. Its brand image has been boosted by its final products such as AQUOS (TVs) and mobile phones. It is plants that have underpinned such manufacturing. These plants had outstanding engineers and had tremendous production technology. Without such engineers' ability our Sakai plant will not be able to produce thin-film solar cells. The strength of Japan's manufacturing lies there. Japan has been depending on imports for a considerable amount of energy. However, if we succeed in producing solar cells, we will be able to become a company or a country that is capable of producing and exporting energy. What is very important for Japan as well is that it will be able to contribute to the world in the solar cell industry. We will make a major contribution to the world in terms of solar cells, including environmental aspects.

It is indeed a paradigm change. Has employee awareness changed dramatically at Sharp?

Katayama: It has been 27 years since I joined the company, and for the first five years I was in charge of thin-film solar cells. I was assigned to the central research laboratory as a new recruit, worked on thin-film solar cells and built a plant. As we were ahead of the times, there was no demand for thin-film solar cells then, except perhaps for desktop calculators. In those days, there were a lot of problems in terms of cost and the performance of solar cells deteriorated over time. The team was disbanded and I was reassigned back to the central research laboratory to begin working on LCDs. The members from those days take a major role now in the LCD business. The technology for thin-film solar cells of that time was useful for the launching of LCD panels. Twenty years since then, I became the president of the company in April last year. Until then, I had been firmly convinced that it would be impossible to mass-produce thin-film solar cells and that crystalline silicon would become the mainstream. However, I invited a solar cell engineer who was my former colleague to ask him about thin-film solar cells and had him show me equipment. For 20 years, they had worked in silence on technology development. In order to keep the technology from leaking to outsiders, they continued research without even making any report to academic societies. That is the background behind our decision to build our new thin-film solar cell plant in Sakai. The accumulation of such technologies now serves as the foundation for our new giant thin-film solar cell plant.

It has been a year since you became president, but you seem to have begun to dramatically steer your company's business.

Katayama: If I had talked this way 10 years ago, no one would have listened to me. The world has changed during the past decade, so Sharp should also change. For engineers, I think Sharp is a comfortable company to work for. We once suspended thin-film business, but allowed R&D to continue. This is something that may not occur at other companies. The core of Sharp is technology. Engineers can do work on the basis of freewheeling thinking. I believe this is why Sharp is where it is today. JS

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