

Roundtable Meeting with Stakeholders

# Green Fab<sup>1</sup>—Requirements for a Good Semiconductor Factory

On June 27, 2007, we invited some of our stakeholders to a roundtable meeting to discuss the requirements for a good semiconductor factory. Specifically, we invited representatives of the following companies engaged in the upstream and downstream semiconductor manufacturing processes: semiconductor manufacturers, relevant equipment and component manufacturers, and a company engaged in the design and construction of clean rooms.

1. **Green Fab:** Meaning a factory/manufacturing process that is comprehensively environment-conscious

## Collaboration from the Upstream through Downstream Processes Is Essential

**Mr. Honma:** I would like to comment in my capacity as someone engaged in building semiconductor factories and production systems. As a result of the shift from 200-millimeter wafers to 300-millimeter wafers, the power consumed by semiconductor production equipment is increasing, and we are now required to save even more energy. For the environment, it is important to eliminate duplication and waste in semiconductor factories from a comprehensive viewpoint, but the environmental efficiency of individual parts and equipment in the semiconductor factory has already improved dramatically, and so we can no longer expect substantial improvements in environmental efficiency from them. In the past, semiconductor production equipment manufacturers and component manufacturers were independently developing products with lower environmental impact, including more energy-saving products downstream of the supply chain. From now, however, I believe that the three parties—semiconductor manufacturers, semiconductor production equipment manufacturers, and component manufacturers need to collaborate more fully by exchanging information that will enable us to reduce the environmental impact resulting from the manufacture of semiconductors.

**Mr. Iwaida:** I agree with Mr. Honma. I also feel strongly that these three parties together will be able to implement effective measures. Our company manufactures pneumatic devices used in semiconductor production equipment. Usually, we seldom have the opportunity to talk directly with the semiconductor manufacturers who are the end users of our products. We are only informed of the situation at the end user via the semiconductor production equipment

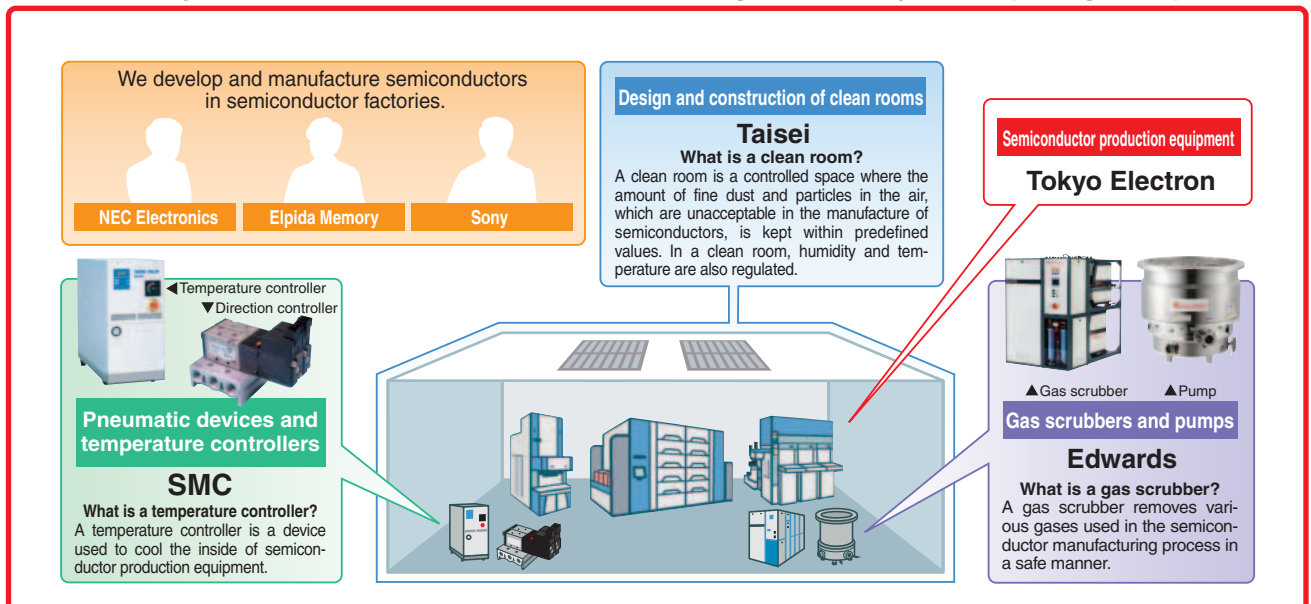
manufacturers. However, when we have the rare opportunity to visit the factory of a semiconductor manufacturer, we often find room for improvement at the factory, something which only component manufacturers would be able to see. For example, the pipe on a freezer might be too long and coiled up. Although the freezer is working hard to keep the temperature below zero, the long pipe is continuously giving out heat beside the freezer. Reducing this type of waste would help reduce the environmental impact of the factory, and roundtable meetings like this one are very useful for this purpose.

**Mr. Urano:** I think it necessary for all the companies involved in the upstream to downstream steps to collaborate to reduce the environmental impact generated over the entire semiconductor manufacturing process. Our company deals with exhaust systems,

### Participants in the Roundtable Meeting

● NEC Electronics Corporation	Mr. Michio Honma
● Elpida Memory, Inc.	Mr. Kazuhiro Tada
● Sony Corporation	Mr. Junichi Aoyama
● Edwards Japan Limited	Mr. Chiaki Urano
● Edwards Japan Limited	Mr. Masaharu Miki
● SMC Corporation	Mr. Katsuro Iwaida
● Taisei Corporation	Mr. Tomoo Gocho
● Taisei Corporation	Mr. Tsutomu Kobayashi

## Roles Played in the Semiconductor Manufacturing Process by Participating Companies





including vacuum pumps and gas scrubbers. Recently, various process gases have been introduced in the production process and I am afraid that the exhaust system is regarded as a “dust box” into which any kind of gas can be put and eventually rendered harmless. However, if different kinds of gases are mixed without being sorted out, they can easily solidify and this may cause the vacuum pump to halt. To prevent this, more nitrogen gas need to be injected. This will impose an extra load on the gas scrubbers and will result in an increase in environmental impact. However, if the production process is improved and the types of gases used and their flows are limited, the problem can be alleviated.

**Mr. Komiyama (TEL):** I am in charge of managing the clean rooms in the Tokyo Electron Group. It is true that process engineers working on semiconductor production equipment tend to increase gas flows to improve the process and as Mr. Urano has pointed out, this might impose an extra load on the exhaust system.

**Mr. Tada:** How about showing the process developers the adverse effect of increasing gas flows by using the check list that can be used for a design review?

### Semiconductor Manufacturers Need to Disclose More Information

**Mr. Urano:** I have long thought that Japanese semiconductor manufacturers do not seem willing to disclose information. For example, when constructing a new semiconductor factory, they will not disclose any information about which components from which manufacturers they are going to use in the new factory. After the individual pieces of equipment and components are delivered, piping routes are worked out on a case-by-case basis. As a result, the facility area in the clean room is like a jungle of pipes and signal



cables. I believe it important for semiconductor manufacturers to disclose more information in order to reduce their environmental impact and to improve the performance of the equipment.

**Mr. Kobayashi:** I completely agree with Mr. Urano. In designing a clean room, we have to predict the rate of operation according to given specifications. We are not provided with practical data about the clean room, including data on cooling water, air conditioning load, and exhaust air. If we are given more practical data, we will be able to contribute more to energy saving. For example, there are two methods of cooling: one uses water and the other uses air for cooling. If air is used for cooling, the energy consumed will be five or six times as large as the energy required for water cooling. However, we are not given the relevant information. Without the appropriate information, we cannot decide whether it is really necessary to use air for cooling, whether water could be used instead, or whether the air in the clean room should be used for the air cooling. If these kinds of problems with information disclosure are solved one by one, I believe we can contribute substantially to reducing the total environmental impact generated by semiconductor factories.

**Mr. Iwaida:** Information is really important. We component manufacturers manufacture products according to the specifications given by our customers without knowing the entire process flow. However, the specifications do not always reflect the reality. For example, we once made a temperature controller with a cooling ability down to minus 30 degrees centigrade. We delivered it to the end user’s factory and found out that the factory did not actually need that much cooling ability. If we say that a temperature controller with a cooling ability of minus 20 degrees centigrade is like the engine in a luxury car, a temperature controller with a cooling ability of minus 30 degrees is like the engine in a fighter aircraft. If we had the right information, we would not have had to make this kind of pointless effort.

**Mr. Kobayashi:** In the future, we would like to provide our customers with clean rooms equipped with a function to reduce chemical pollutants, which will in turn reduce the load on the filters. We also want to offer energy-saving technologies for air conditioning systems. However, there are limits to what we can do working on our own. If we have opportunities to exchange information like at today’s meeting, I think we will be able to propose more ideas and technologies for energy conservation.



**Michio Honma**

NEC Electronics Corporation



**Kazuhiro Tada**

Elpida Memory, Inc.



**Junichi Aoyama**

Sony Corporation



**Chiaki Urano**

Edwards Japan Limited

### We Need to Overcome Organizational Boundaries to Reduce Our Environmental Impact.

**Mr. Honma:** In reducing the environmental impact caused by our factories, we face the problem of organizational boundaries—each organization, department, and employee foolishly limits the scope of their jobs and tend not to think beyond the range of their own jobs. We may need to remove these boundaries if we want to make more improvements.

**Mr. Gocho:** I fully agree with Mr. Honma’s opinion that we need to overcome organizational boundaries. In the construction industry, too, we have boundaries between the building and civil engineering sectors and between the sections working on air conditioning and structural designing. In the past, many people would express their opinions of the job being done by other departments, but now this is rare, perhaps because their scope of work is too clearly defined. As a designer and constructor of clean rooms, in the future we would like to ask semiconductor production equipment manufacturers questions like “Is it really OK to set the temperature of the cooling water at 25 degrees centigrade?”

**Mr. Ibuka (TEL):** There are indeed organizational and personnel boundaries. I think it necessary to create a model of collaboration between organizations based on the concept of “total optimization.”

### No One Has a Comprehensive Overview of the Factory Equipment.

**Mr. Kaneko (TEL):** I am afraid semiconductor factories are producing substantial amounts of wasteful exhaust. Also, there are some cases in which semiconductor production equipment can actually be operated using only around 60% of the specified amount of energy. So I think it is important for us semiconductor production equipment manufacturers to study how we can reduce wasteful operations.

**Mr. Aoyama:** When we build a new factory, the department in charge of construction gathers data on cooling water, facilities, and electricity separately from those who will run the factory and fixes the specifications based on that department’s experience and intuition. But in fact, no one knows the real electrical capacity required. There is no one who can oversee the construction in a comprehensive way. In the power industry and the steel manufacturing industry, some companies have started to monitor the efficiency of their equipment while it is in use in real time to maintain high efficiency over an extended period. In the semiconductor manufacturing industry as well, things need to be done not only to ensure the perfect finish on a wafer but also to improve the efficiency of the semiconductor production equipment.







**Masaharu Miki**  
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**Katsuro Iwaida**  
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**Tomoo Gocho**  
Taisei Corporation



**Tsutomu Kobayashi**  
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**Mr. Urano:** In order to make the entire semiconductor manufacturing process more energy-saving, it would be necessary to take the exhaust system, valves, and cooling system into consideration from early on in the design stage, in addition to making individual components capable of saving greater amounts of energy by adopting pumps and temperature controllers that use lower amounts of energy. This will also limit the unnecessary use of gas and contribute to energy conservation.

**Mr. Miki:** Pump manufacturers think that energy conservation can be achieved by skillful pump layouts and skillful piping configurations. Energy-saving can be implemented efficiently if it is started back at the initial stage of construction of the factory and we have been putting forward proposals to do this for the last 10 years. But our proposals have not yet been widely accepted.

**Mr. Kaneko (TEL):** It is true that semiconductor manufacturing factories do not pursue total optimization from scratch: instead, they seem to want to pursue energy conservation and environmental friendliness by simply combining optimal components. For example, they think that they can reduce their energy use simply by improving the performance of individual components. Semiconductor manufacturers need to manage their factories in a more comprehensive manner and semiconductor production equipment manufacturers must have the strength to put proposals to semiconductor manufacturers and persuade them to accept their proposals. Otherwise, semiconductor production equipment manufacturers cannot show a good example to the manufacturers of their equipment components. The three parties must rely on mutual communication and understanding to ensure the consistency of the factory facility as a whole.

### Use of Life Cycle Assessment (LCA)<sup>2</sup> to Promote Energy Conservation

**Mr. Aoyama:** We can use LCA to do this. Using LCA, we can get a comprehensive understanding of the effects of an improvement. For example, we can identify the reduction in CO<sub>2</sub> emissions throughout the process achieved by introducing a gas scrubber. Comprehensive measures can be taken more easily for new production lines and so the construction company can make a comprehensive proposal on an energy-saving line in addition to just simply constructing a new building. Of course we can also make existing lines more energy-saving using LCA. When our company renovated a factory, we implemented measures to substantially reduce power consumption and the money we invested in this ini-



tiative will be recovered over a relatively short period.

**Mr. Ibuka (TEL):** I regard LCA as a “double-edged sword,” which can simultaneously help and hinder us. With LCA, any semiconductor manufacturer can identify the amount of energy used and so unless we, in proposing the use of LCA, are first past the post with the use of LCA, our competitors will make good use of LCA to gain customers. So it is important to encourage information sharing, while at the same time remaining vigilant of the effect that information sharing may have on competition in the market.

**2. Life Cycle Assessment (LCA):** Method to assess the environmental impact of a product throughout its life cycle from production to recovery and reuse.

### Encouraging Discussions between Upstream and Downstream Companies

**Mr. Honma:** I have been participating in a variety of improvement projects recently and this experience has helped me to recognize one thing. There are multiple layers in the supply chain for semiconductors, and it is not really necessary to encourage collaboration between companies on two layers that are far apart from each other in the supply chain. Usually, a lot of improvement can be made by collaboration between companies in two adjacent layers. However, it is essential to have a consultant who questions the status quo of the entire supply chain. I believe small improvements can produce great results if they are implemented in the form of projects.

**Mr. Ibuka (TEL):** We held individual forums with suppliers on PFC gas.<sup>3</sup> Open forums with these companies and the forums held by industry associations are indeed effective.



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**Mr. Honma:** It would be better to draw a clear line between information that must be kept confidential and technologies that can be transferred. In other words, there are topics that can be discussed in a relatively open manner at the meetings of JEITA<sup>4</sup> or SEMI and those that should be discussed among limited participants, for example by members of a consortium.

**Mr. Aoyama:** Even if each company conducts its own environmental activities, the effects will be limited and I think that we can conduct activities appropriately within the framework of JEITA. Component manufacturers, too, can more easily engage in environmental activities if they are led by JEITA. Every semiconductor manufacturer in the world is aware of its environmental responsibilities. We do want to disseminate environmental information and cooperate with equipment and component manufacturers to protect the environment.

3. **PFC gas (perfluorocarbon gas):** A greenhouse gas used in the semiconductor manufacturing process as a CFC substitute

4. **JEITA:** Japan Electronics and Information Technology Industries Association

### Making the Environmental Performance of Equipment Invisible

**Mr. Tada:** I think we should make the environmental performance of semiconductor production equipment invisible. By that, I mean to incorporate the environmental functions as an integral part of the equipment. For example, we could make the equipment inoperable if the environmental functions are deactivated. We should meet the following requirements for our products in this order of priority: (1) introduction of advanced manufacturing process technologies;

(2) high operational productivity; and (3) voluntary contribution to environmental and energy conservation. Environment-friendly and energy-saving functions tend to be low-priority functions, and we aim to build these undervalued functions invisibly into our products.

**Mr. Kaneko (TEL):** To make environmental functions invisible sounds great. To deactivate the equipment if the environmental and energy-saving functions are removed is also a good idea.

**Mr. Tada:** Sales of semiconductor production equipment will increase in the NICs in the future and it is highly probable that customers in these countries will demand that we remove the low-priority environmental functions due to cost reduction. However, to reinforce the need to reduce environmental impact across the world, it will be better if we provide these customers with equipment in which environmental functions are inseparably integrated with the manufacturing process technologies and functions to improve productivity.

### Pursuit of Profit Will Result in a Reduction in Environmental Impact.

**Mr. Aoyama:** Now, I would like to ask one question: what are the basic requirements for a good semiconductor manufacturing factory? I think FPD factories in Japan represent the most useful example. These factories are excellent in terms of harmony with the local environment and also in terms of creating local employment and returning profit to the local communities in the form of taxes. Their products do contribute to energy conservation and the factories producing these products help improve the corporate image of the companies that own the factories.

**Mr. Miki:** Generally, good factories input the minimum required amount of resources and output the maximum values and profits with low emissions. This is consistent with the concept of Green Fab.

**Mr. Iwaida:** I agree with the idea that environmental measures will lead to profit making. Many of our users are small factories and some of them are not environmentally aware. If, however, the most effective way to recommend energy-saving products is to show how much money they can save by reducing their annual power consumption. The use of energy-saving products will of course contribute to reducing the environmental impact.





**Mr. Aoyama:** I agree with Mr. Iwaida. It is indeed wrong to think that environmental measures and profit are not compatible. Environmental efforts will help companies make more profit. If you can make a greater number of products with the minimum amount of materials, you will generate more profit. We must make everyone understand this obvious fact.

**Mr. Hoshi (TEL):** Even if they are not initially designed to promote environmental conservation or energy saving, other improvements sometimes contribute to reducing the environmental impact. For example, downsizing efforts designed to reduce costs might eventually contribute to energy conservation. We are committed to technological development using our experience of achieving strict cost reduction targets one after another.

### Semiconductors Contribute to an Energy-Saving Society.

**Mr. Aoyama:** I referred to FPD factories in Japan as an example of good factories. But the general public does not have a specific image of products manufactured at semiconductor manufacturing factories. Although semiconductors are incorporated into products sold on the market and contribute to energy conservation, people do not have a specific product image for semiconductors, unlike LCD televisions, for example. So I think it is important to more widely publicize how useful semiconductors are to society at large.

**Mr. Kobayashi:** In June 2007, the Tokyo Metropolitan Government announced a 10-year project to achieve a 25% reduction in Tokyo's CO<sub>2</sub> emissions over the 2000 level by 2020. The government also has an emissions trading plan. What influence do you think these initiatives will have on the semiconductor industry?

**Mr. Tada:** If the general public becomes more aware of the contribution that semiconductors make to energy conservation, semiconductor manufacturing factories will surely be able to receive emission rights through the Clean Development Mechanism (CDM) and Joint Implementation (JI). Semiconductors do contribute to reducing the environmental impact caused by products such as home electrical appliances; at least 50% of that reduction is thanks to the use of semiconductors. The semiconductor industry is therefore entitled to receive emission rights equivalent to the amount of their contribution.

**Mr. Ibuka (TEL):** Today we discussed energy conservation in semiconductor manufacturing. I think it is extremely important to publicize more widely the contribution to energy saving using semiconductors. In the semiconductor supply chain, we should remain aware of the importance of highlighting the environmental effectiveness of semiconductors to end users in formulating our business strategies.

We have had meaningful discussions today. I hope that we will have similar opportunities in the future.

### In response to the roundtable meeting

The Tokyo Electron Group held its first roundtable meeting for its environmental and social report in 2004, participated in by people responsible for the environment and safety within the Group. Subsequently in 2005, we held our second roundtable meeting, inviting the Group's employees responsible for sales, development, and design. In 2006, we held our third roundtable meeting, and invited our customers. For our fourth meeting held this year, we invited representatives from Sony Corporation, Elpida Memory, Inc., NEC Electronics Corporation, who are our customers, Edwards Japan Limited and SMC Corporation, who are manufacturers of components for semiconductor production equipment, and Taisei Corporation, a designer and constructor of clean rooms. The meeting provided EHS managers at these companies with a great opportunity to exchange information on comprehensive energy-saving measures for clean rooms.

At the meeting, participants recognized once again the necessity of reducing environmental impact across the entire supply chain and proposals were made by some participants to hold this kind of meeting regularly for information exchange. The meeting was therefore very meaningful. The meeting also gave us an opportunity to reconfirm how important it is to make reducing the environmental impact generated by the products of our Group and customers into one of our business objectives. We should make concerted efforts with everyone involved to attain that objective.

We will continue to ask a variety of people for their opinions and examine ways in which we can make it easier for our Group to design environmentally conscious products.

Masaki Kaneko  
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