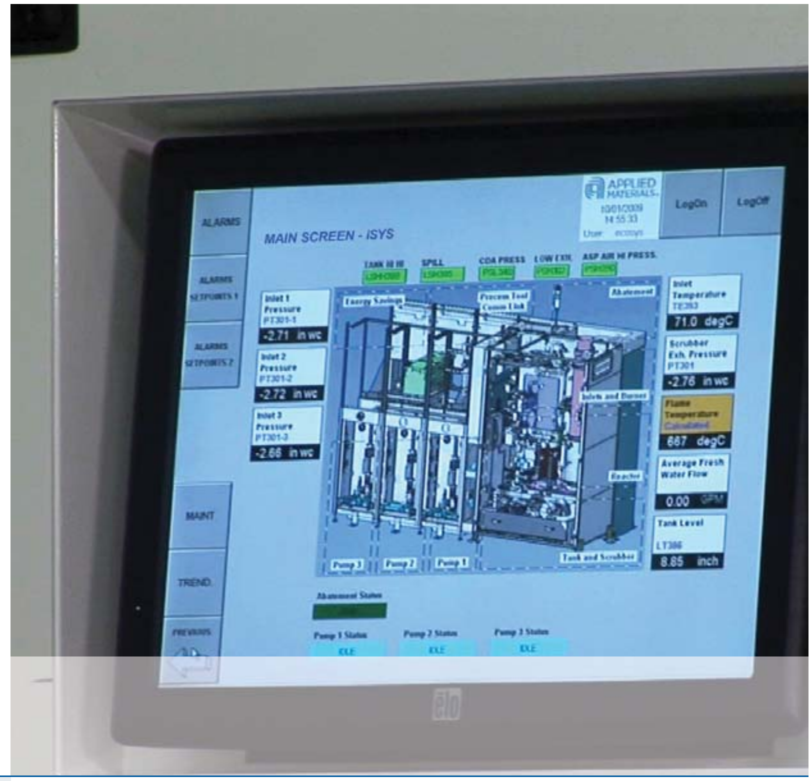
Bringing Efficiency to the Subfab



Vacuum pumps and point-of-use abatement units account for a significant portion of fab utility expense for CVD, etch and epitaxial deposition wafer processing. Reducing the utility consumption of these subfab components is an obvious method to reduce overall wafer processing cost.

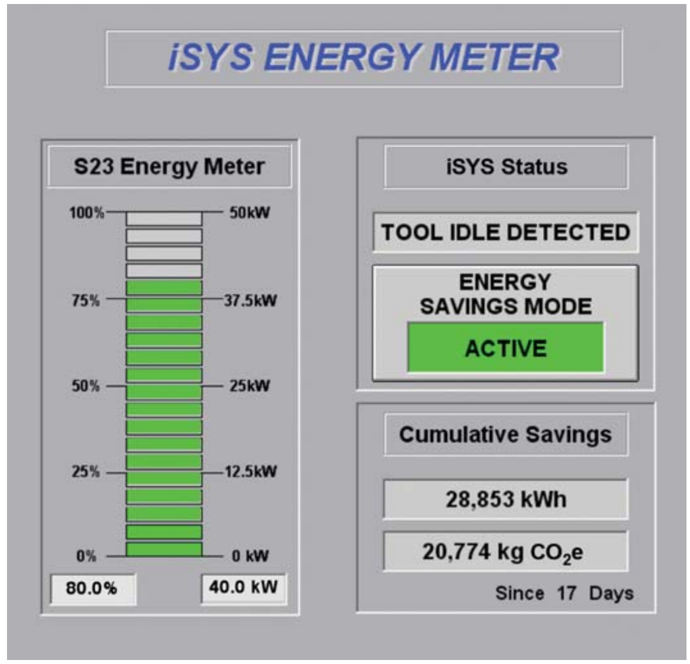
Although these subfab units are required for process chambers to function well, they do not directly benefit wafer processing performance. However, these units must operate continuously with virtually no downtime and without affecting the on-wafer performance of the processing tools they support. Given these principal requirements, pump and abatement manufacturers have focused development attention on reliability, and in the case of abatement, destruction efficiency. Little effort has been directed at overall operational efficiency of these units. The subfab can account for an inordinately high share of utility costs, especially during periods of low fab wafer loading when many process tools are idle but their supporting equipment is still operational.

The Applied iSYS integrated pumping and abatement system enables significant savings over traditional abatement and pumps in several areas including utility consumption, subfab footprint, and installation.

TOOL IDLE MODE REDUCES UTILITY CONSUMPTION

By integrating discrete components into these systems, substantial savings are achievable. The Applied iSYS integrated pumping and abatement system is designed to communicate with semiconductor processing tools via SECS/GEM communication ports. When a process tool is in idle mode, a signal is sent to the iSYS controller. The controller then puts the iSYS components into a reduced utility consumption mode. The amount by which each resource is reduced, called the turndown ratio, is developed for each processing tool and subfab component combination and verified through rigorous testing. When the processing tool returns to processing wafers, the iSYS controller can ramp the pumps and abatement quickly to full operation mode.

On average an iSYS system will save more than 20% of total utilities when compared to a typical subfab installation of standalone pumps and abatement. The actual savings may be substantially more, depending on the process tool utilization rates and the type of process. As an example, an iSYS in the Maydan Technology Center achieved energy savings of more than 30% (from 960–662MWh/yr) when connected to a 3-chamber Applied Producer GT CVD system operating at 70% uptime, 25% idle time, and 5% off time. Corresponding savings were achieved in PCW and nitrogen consumption.



▲ **FIGURE 1.** Energy usage is continuously monitored and recorded by iSYS.

iSYS ENERGY TRACKING

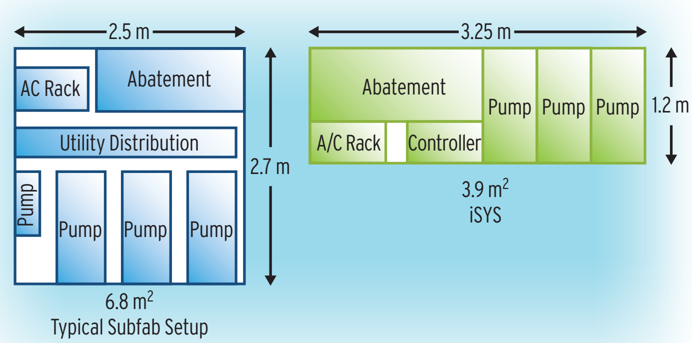
At the heart of the iSYS tool is the control system, which is integrated with the pumps, abatement, and utility distribution. Energy savings are continuously monitored and recorded, providing constant feedback on efficiency. While a typical abatement system runs at 100% all of the time, the iSYS controller modulates energy usage and monitors the savings in real time, letting the user know the amount of energy consumed. An energy meter showing the system currently using 80% of the energy that is normally used, using the SEMI S23 methodology can be seen in Figure 1.

In addition to the instantaneous monitoring, cumulative energy savings are also tracked. The energy savings are shown converted to global warming potential as a cumulative CO_2 reduction. This data may be useful for calculating carbon offset credits.

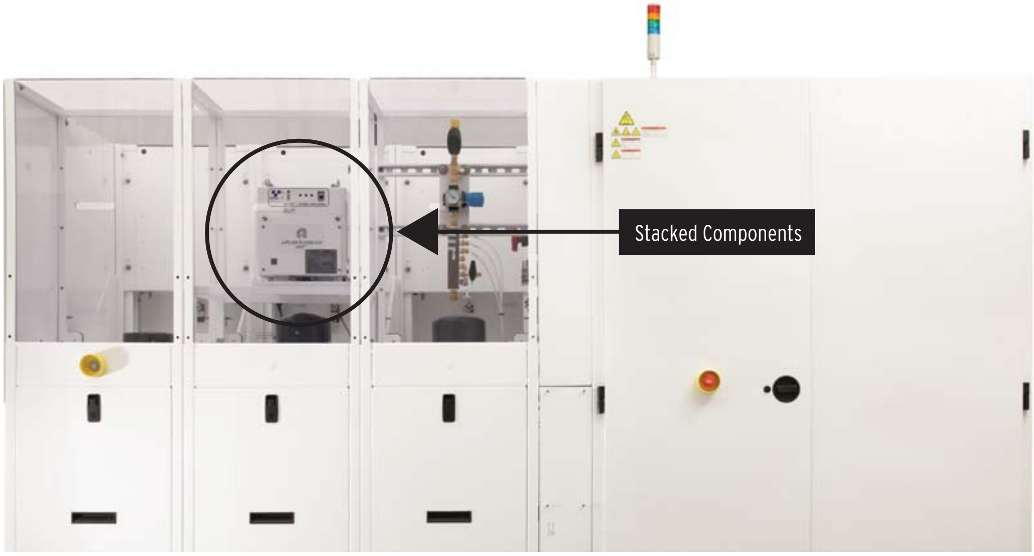
FOOTPRINT AND SERVICEABILITY

Increasingly complex semiconductor process tools require additional subfab support systems, leading to competition for subfab space. In recent years the sum of the area required for subfab components for etch and CVD systems has increased to the point where more space is required for subfab components than for the actual process tools. This demand has forced fabs to have mezzanine levels or extended subfabs.

By coherently assembling major components, including peripherals such as AC racks, and stripping redundant components, the iSYS design can greatly reduce the subfab footprint for each tool while optimizing serviceability. An example of a traditional discrete component subfab layout and the equivalent iSYS system is shown in Figure 2. The iSYS system requires 40% less subfab area.



▲ **FIGURE 2.** The integrated design of the iSYS system can reduce subfab footprint by over 40%.



▲ **FIGURE 3.** Stacked transfer chamber pumps save space while maintaining serviceability.

Lightweight, low maintenance components such as small transfer chamber pumps (Figure 3), can be stacked to save footprint. Components requiring regular attention, such as process chamber pumps are easily accessed from both the front and rear.

FLEXIBLE ARCHITECTURE

Semiconductor equipment manufacturers have identified suitable subfab components to use with their processes. In addition, many fabs have tuned their wafer processes to work with a given set of subfab equipment. Combining these two sets of best practices, a matrix of optimized process tool and subfab components can be created (Table 1). By following these rules the subfab can be optimized with the most suitable pumps and abatement systems for a given process to provide reliable operation and the lowest cost of ownership.

The flexible architecture of the iSYS system can accept components from multiple sources. The system is easily configured to suit individual customer practices and process tool requirements. In cases where a customer requests a type of pump that is not already qualified, a simple redesign and qualification process has been developed.

SIMPLIFIED INSTALLATION

An integrated system reduces the number of connections that must be made, which greatly simplifies installation.

Installation Task	Time (hrs)
Modules located, system assembled, utilities connected	9.5
System start up / conditional use	11
Process on / full use	3

▲ **TABLE 2.** iSYS simplifies installation, reducing installation time to about 24 hours.

Process Tool Type	Abatement Capacity	Pump Capacity
High flow CVD	Large	Large
Low flow CVD	Medium	Medium
PFC-containing etch	Medium	Low
Standard etch	Medium	Low
Diffusion	Large	Large

▲ **TABLE 1.** Abatement and pump capacities should be tailored to process tool type.

A typical set of subfab components requires over 60 connections for installation. Forelines, exhaust lines, water lines, power lines, communications cables, and racking all require installation customized to the particular combination of subfab components and process tool. A typical subfab installation may take up to one week to complete.

With the iSYS integrated subfab system, the number of connections can be reduced by more than 70%. Data from a recent installation confirmed that the simplified design of the iSYS system, enables installation in less than 24 hours (Table 2).

CONCLUSION

Integrated subfab component systems such as the Applied iSYS system can offer chip manufacturers significant cost savings. Consolidating multiple discrete components into a single integrated unit can offer installation time of less than a day and reduce subfab footprint by up to 40%, while the system's ability to sense tool loading enables a reduction in energy consumption of over 20% in the subfab with similar savings in resource utilization. ■

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