

# EDITORIAL

## WHAT CAN SEMICONDUCTOR FABS DO FOR THE GREEN EARTH?

Energy consumption for semiconductor factories has always been a sore point for environmental conservation. A study conducted by the European Union indicates that manufacturing a car generates less waste and uses fewer resources than manufacturing a laptop computer. Eight hundred kilowatt hours of electricity is used to manufacture one 200-mm semiconductor wafer, according to a topical report compiled by the Pacific Northwest Pollution Prevention Resource Center in 1999. Ironically, energy is cheap. The cost in Taiwan per kilowatt hour is about 3.6 NTD corresponding to US\$0.12, granted that the price is dictated by politics and may be raised momentarily to reflect the actual cost. The total energy cost to produce one 200-mm wafer is US\$96 according to the price given here, while that wafer can sell for thousands of dollars according to the report. The situation of 300-mm wafers in 2008 is similar.

Raw input energy for a 300-mm wafer from an ArF immersion scanner running at 150 wph is about 1.8 kW h assuming that the scanner needs 165 kW of power. An EUV scanner is projected to require 640 kW for 100 wph by the manufacturer, assuming a resist sensitivity of 10 mJ/cm<sup>2</sup>. The raw energy for exposure per wafer is 10.4 kW h accordingly. Using resist sensitivity three times higher to achieve the bare minimum required line width roughness raises the raw energy to 31.2 kW h. When the collector efficiency is 2% instead of 7.5% and Sn conversion efficiency is 2% instead of 5%, the raw energy jumps

to 293 kW h. The raw energy cost to expose a wafer at these four scenarios is \$0.21, \$1.21, \$3.62, and \$34, respectively. For 20 critical layers, the raw energy cost per wafer is \$4.20, \$24.20, \$72.40, and \$680, respectively. The cost in the last two cases starts to be a problem. Given that the assumption of the last case can be pessimistic, the realistic raw energy cost for exposure per wafer will probably be between \$100 and \$200.

What is the impact on the green earth? For arguments sake, if we use 800 kW h per wafer and scale it up to a 40,000-wafer-per-month fab, the fab needs 43.8 MW. To expose these wafers for 20 critical layers at 100 wph requires 18 exposure tools and raw power for exposure, 11.6, 34.8, or 326 MW depending on the pessimism for the technology. The factory needs to add 26%, 79%, and 743% power capacity, respectively. The realistic scenario is probably doubling or tripling the factory power. The answer for a green-earth-conscientious fab is obvious.

Happy reading!

**Burn J. Lin**  
Editor-in-Chief

