8.5 Green Product

TSMC collaborates with upstream materials suppliers and downstream assembly and testing service providers to reduce product environmental impacts. We reduce the resources and energy consumed for each unit of production to provide our customers with more advanced, efficient, and ecological products. In addition to helping customers design low-power, high-performance products to reduce resource consumption over the product’s life cycle, TSMC practices clean manufacturing to provide additional green value for our customers.

TSMC-manufactured ICs are used in a broad variety of applications that cover various segments of the computer, communications, consumer, industrial and other electronics markets. Through our manufacturing, our customers’ designs are realized and applied to peoples’ lives. These chips make significant contributions to the progress of modern society. TSMC is honored that we can achieve profitable growth while providing products that increase environmental and social value. Below we list several examples of TSMC-manufactured products with significant contributions to society and the environment.

Environmental Contribution by TSMC Products

Providing New Process Technology to Achieve Much Lower Power Consumption

- The continuous development of TSMC’s advanced semiconductor process technologies realizes Moore’s law, which holds that process technology moves forward by one generation every 24 months. Each generation the line width of circuitry shrinks, making the circuits smaller and lowering the energy and raw materials consumed per unit area. At the same time, the smaller die size of the IC also means that it consumes less power. For example, our 28nm technology can accommodate approximately 4 times the number of electronic components as 55nm technology. ICs made with 28nm technology in active or standby mode consume roughly one fourth the power of 55nm products, based on our internal test results.
- TSMC continues to lead the foundry segment in technology, having achieved volume production at 28nm. Our 28nm process offering includes 28nm High Performance (28HP), 28nm High Performance Low Power (28HPL), 28nm Low Power (28LP), and 28nm High Performance Mobile Computing (28HPM). Among these technology offerings, 28HP, 28HPL, 28LP, and 28HPM have all been qualified and demonstrated first Silicon success in FPGAs, GPUs, CPUs, and mobile SoCs products. The number of customer 28nm production tape-outs has more than doubled compared with that of 40nm.

The TSMC 28nm process has surpassed the previous generation’s production ramp and product yield at the same point in time due to closer and earlier collaboration with customers. TSMC will continue to work towards providing our customers with more advanced, energy-saving, and environmentally friendly products.
- 28nm was the primary growth driver of TSMC in 2012. TSMC’s shipment of 28nm wafers increased thirty-fold in 2012 from its 2011 level, and 28nm annual contribution grew significantly from 1% to 12% of revenue, representing approximately NT$60 billion or US$2 billion in 2012. This reflects that TSMC’s advanced manufacturing process technology can help the company achieve profitable growth and save energy for the earth at the same time contributing to both TSMC and the global environment.

<table>
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<tr>
<th>Die Size Cross-Technology Comparison</th>
<th>Active Power Cross-Technology Comparison (TSMC 21 stage circuit, 1.1Vdd, 125°C)</th>
<th>Standby Power Cross-Technology Comparison (TSMC 21 stage circuit, 1.1Vdd, 125°C)</th>
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<td>Die size is shrinking while line width shrinks</td>
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Manufacturing Power Management ICs with the Best Efficiency for Customers

- TSMC’s world-leading manufacturing technology helps customers design and manufacture green products. The most notable green IC products are power management ICs. Power management ICs are the key component for all electronic devices’ power consumption, determining how electronic devices use power efficiently. TSMC’s analog power technology research and development team uses 6-inch and 8-inch wafer fabs to develop leading performance Bipolar-CMOS-DMOS and Ultra-High Voltage technology, producing industry-leading power management chips with more stable and efficient power supply as well as lower energy consumption for broadband applications in the consumer, communication, and computer markets.
- In addition to manufacturing service, TSMC also provides power-efficient design platforms to its customers. Using such design platforms, customers can develop energy-saving products to be manufactured by TSMC. For example, TSMC collaborates with a third-party IP partner to integrate their patented energy-saving technology and TSMC’s advanced manufacturing technology to provide a “Power Trim Service” to our customers.
- Power management IC generates material revenue contribution to TSMC’s industrial market segment. In 2012, TSMC’s HV/Power technologies collectively shipped more than 1 million wafers to customers.

Green Manufacturing with Lower Energy Consumption

- TSMC continues to develop manufacturing technology to provide more advanced and efficient manufacturing services. These improvements aim to reduce per-unit energy and resource consumption and pollutant generation, and also lower energy consumption and pollution in the product use stage. Our clean production provides great economic benefit for us by cost reduction through lower energy consumption. Regarding the total benefit realized through our green manufacturing in 2012, please refer to page 99, “Environmental Accounting”.

Social Contribution by TSMC Products

Providing Mobile and Wireless Chips to Enhance Mobility & Convenience

- The rapid growth of smartphones and tablets in recent years reflects strong demand for mobile devices. Mobile devices offer remarkable convenience for people, and TSMC contributes significant value to these devices. For example, (1) New process technology helps chips provide faster computing speed in a smaller die area, leading to smaller form factors for these electronic devices. In addition, SoC (System on Chip) technology can integrate more functions in one chip, reducing the total chip volume in electronic devices, which also leads to a smaller form factor. (2) New process technology helps chips consume lower energy. People can therefore use mobile devices for a longer time, increasing its convenience. (3) With wireless connectivity chips, people can use wireless connections such as internet and GPS to communicate with each other and work anytime and anywhere, significantly improving the mobility of modern society.
- Mobile-related products, such as Baseband, RF Transceiver, AP (Application Processors), WLAN (Wireless Local Area network), NFC (Near Field Communication), Bluetooth, GPS (Global Positioning System) and others represent more than 30% of TSMC annual revenue, reaching more than NT$150 billion or US$5 billion in revenue this year. TSMC’s growth in recent years was largely driven by the growing global demand for these mobile IC products.

Enhancing Human Health and Safety with MEMS (Micro Electro Mechanical Systems)

TSMC-manufactured ICs are widely used in medical treatment and health care. Through our advanced manufacturing technology, more and more medical IC products have emerged in the market, providing major contribution to modern medical development. Our MEMS products are already used in practical advanced medical treatments. Moreover, MEMS can be widely used in personal health care, such as early warning systems to prevent the elderly from being injured by falls, systems for detecting changes in personal physiology, car safety system, and others, enhancing human health and safety from many aspects.

TSMC Collaborates with Suppliers to Reduce Product Environmental Impact Footprints

TSMC’s products take both quality and environmental impact into account. We believe that green products need to consider the entire product life cycle, including raw material mining, transportation, product manufacturing, use, and waste disposal to thoroughly evaluate environmental impact. The product carbon footprint, water footprint, or other environmental impact footprints are important indicators in the environmental performance of products.

Therefore, we require good hazardous substance management, pollution prevention, energy saving, waste reduction and other clean production measures in our own factories. We also require and assist suppliers to do so, and even require suppliers to require their suppliers to do so, in order to establish a green supply chain.
Standards Compliant with or Surpassing International Product Environmental Laws

● Product Hazardous Substance Management
By practicing QC 080000, TSMC ensures that products comply with regulatory and customer requirements, including:

The EU Restriction of Hazardous Substance (RoHS): Restriction of hazardous substances in electric products including Lead (<1,000ppm), Cd (<100ppm), Hg (<1,000ppm), Cr6+ (<1,000ppm), PBB (<1,000ppm) and PBDE (<1,000ppm). In 2011, the new RoHS 2.0, 2011/65/EU has not changed restricted substances and Lead is exempted for the semiconductor bumping process. All TSMC products are compliant with EU RoHS. The bumping process still requires lead due to technology constraints. TSMC continues to develop "Lead-free" bumping to fulfill customers’ needs.

Halogen-free electronic products: In general, our customers request the concentration of Bromine and Chlorine in products to be less than 900ppm each, and less than 1,500ppm in total. All TSMC products are in compliance.

Perfluorooctane Sulfonates (PFOS) restriction standards: TSMC has completely phased out PFOS from its process since 2010.

EU REACH (Registration, Evaluation, Authorization and Restriction of Chemicals) directive: All TSMC products are compliant with the REACH dangerous chemicals and SVHC (Substance of Very High Concern) limits.

EU Waste Electrical and Electronic Equipment (WEEE) Directive: This regulation requires the recycling of electronic final products. TSMC’s chips are recycled along with electronic final products after use by consumers.

In addition to current global regulations and customer requirements, TSMC continues to monitor international regulation trends to prepare for response.

Leading Upstream and Downstream Partners to Complete a Supply Chain Product Carbon Footprint
TSMC continues to require that suppliers set up greenhouse gas (GHG) inventory procedures, and assists them in doing so. First, we led suppliers to complete the industry’s first IC Product Category Rule and Environmental Product Declaration in 2009, then led upstream and downstream partners to complete 12-inch wafer and packaged integrated circuit product carbon footprints, which passed third-party certification based on the British PAS2050 product carbon footprint standard in February 2011. In November 2011, our 8-inch wafer also passed PAS2050 carbon footprint certification. We completed 6-inch wafer carbon footprint certification in 2012, and can fulfill all customers’ requirements.

Monitoring Semiconductor Product Water Footprint
There has been much global discussion of water risk management and product water footprints, and these issues have been included in surveys by the Dow Jones Sustainability Indexes and the Carbon Disclosure Project. However, there are currently no international standards for product water footprints. TSMC has always viewed water as a precious resource, and has for many years required our own plants and those of our suppliers to conserve water. In addition to including a water footprint as well as other environmental impact footprints in the 2009 integrated circuits Type III Environmental Product Declaration, TSMC also includes water footprint calculation data in our supplier questionnaire. We will continue tracking international water footprint standards and prepare for new developments. In 2012, TSMC Fab 12 collaborated with 5 major suppliers and completed a 12-inch wafer product water footprint and received external certification.
Product Packing Materials Management and Reduction

TSMC uses recyclable plastic and paper as packing materials for shipping products. These packing materials comply with EU regulations requiring lead, cadmium, mercury and chromium (IV) concentration of less than 100ppm, and also contain no polyvinylchloride (PVC).

We reuse packing materials as much as possible to control usage. TSMC recycles packing materials from products shipped to customers and testing and assembly facilities for reuse after cleaning. Packing materials from raw wafers are also reused in product shipping. Our wafer shipping boxes are completely made from reused sources. These measures have reduced both packing material consumption and waste generation.

8.6 Pollution Prevention

TSMC believes that pollution prevention is one of a corporation’s most important responsibilities. TSMC’s pollution prevention is based on the ISO 14001 environmental management system, and uses the “Plan-Do-Check-Act” management model to promote continuous improvement. We believe that conserving raw materials, energy, and resources as well as reducing waste and pollutants both saves production costs and protects the environment.

Pollution Prevention is the Bottom Line

Taiwan has very limited land, large population, and high density of industrial factories. Therefore, some of its environmental regulations may be among the strictest in the world. To address increasingly stringent environmental standards, TSMC has established good communication channels with the government, and participates in discussions in the early stages of legislation to facilitate reasonable and feasible standards. Each plant also performs assessments to evaluate conformity to new standards, and improvement and preventive measures are taken immediately if nonconformance is discovered.

TSMC has established comprehensive management and operations procedures for pipe-end treatments such as air and water pollution controls, and ensures these procedures are carried out precisely. TSMC has also installed monitoring systems on the discharging sides of pollution control facilities for online monitoring. Facility personnel follow emergency response and reporting procedures to take proper actions if operating conditions diverge from preset limits.