5 | Environmental Dimension

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5.2 Global Climate Change
5.3 Water Resource Management
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Summary
TSMC’s environmental policy, as set down by Chairman Dr. Morris Chang, is to do our utmost to achieve environmental sustainability and to be a world-class company in environmental protection. TSMC’s strategies to achieve our environmental goals are to comply with regulations, strengthen recycling and pollution prevention, manage environmental risks, instill an environmental culture, build a green supply chain, and fulfill our corporate social responsibilities.

TSMC acknowledges responsibility for environmental protection. We not only comply with the environmental regulations of the locations where we operate, but also track new developments in global environmental issues, and take the lead in adopting new environmentally friendly measures. In addition to protecting the environment of our manufacturing sites in Taiwan and around the world, we lead our suppliers to establish a green supply chain. At the same time, TSMC also shares environmental protection knowledge and offers recommendations to government to face a variety of new challenges together. A summary of TSMC’s environmental protection approaches follows:

TSMC has a long-term record of assisting governments in establishing regulations, promoting projects and providing recommendations. We understand the concerns about environmental topics stakeholders have, including stakeholders in academia, media, customers, sustainable evaluation organization and environmental protection non-governmental organizations through participation of environmental sustainable activities and the mailbox in our company’s website. We have concluded that the most material environmental topics in 2014 are global climate change, TSMC’s water management and pollution prevention (Please refer to the concerned topics materiality analysis of the stakeholders in Chapter 2 “Stakeholder Engagement” in this report). Please refer to the related contents in this chapter for a summary of TSMC’s management approaches for these three topics follows:

Global Climate Change
TSMC treats climate change as one of our material enterprise risks. We continue to promote company-wide greenhouse gas inventory and verification, and perfluorinated compounds greenhouse gas emissions reduction. At the same time, we also collaborate with industry, government and academia on climate change adaptation, which includes flooding and drought risk assessment and prevention. TSMC joined EICC (Electronic Industry Citizenship Coalition) in the end of 2014. We hope to collaborate with other EICC members to promote climate change management of the supply chain to reduce environmental impacts of the supply chain and keeping a stable supply of raw materials.

Water Resource Management
TSMC’s goal is to be a leading global company in water resource management. Our water resource management policy is to promote water savings to reduce water usage per unit of production, and to promote collaboration between industries, government and academia to ensure that water shortages do not occur. Our strategy for reaching this goal is both to save water in daily operations and to adapt to water shortages, and implement these measures both internally and in our supply chain. Daily water management is first to save water in the production process, followed by water reclamation and recycling measures. In addition, an effective real-time online water resource management platform helps TSMC significantly reduce water consumption.

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 save production costs and protect the environment. Currently, all TSMC existing fabs are certified by ISO 14001. It is mandatory for all new manufacturing facilities to receive these certifications within 18 months after mass production.

5.1 TSMC’s Mid-to-long-term Environmental Protection Goals and Achievement Status
TSMC will continue expanding production capacity to fulfill global semiconductor demand. Although we have achieved the highest level of energy intensity performance in the global semiconductor industry and met an extremely challenging PFC emissions reduction goal over the past 10 years, we will continue improving our productive efficiency to reduce energy and resource consumption as well as our environmental impact. According to this, TSMC’s mid-to-long-term environmental protection goals are set as follows.
Greenhouse gas PFC reduction: Reduce PFC emission intensity to 30% below the year 2010 level by 2020 through adoption of best practices recognized by the World Semiconductor Council. Reduce the total GHG emission intensity to 18% below the year 2010 level by 2020.

Energy saving: Reduce power usage intensity to 2% below the year 2010 level by 2015; 12% below the year 2010 level by 2020.

Water saving: Reduce water usage intensity to 2% below the 2010 level by 2015; 30% below the year 2010 level by 2020.

Waste reduction: Achieve 95% waste recycling rate by 2015, and maintain above 95% by 2020.

The Achievement Status of Our 2014 Quantitative Environmental Goals Is as Follows:

TSMC continued to improve our energy saving, water conservation and waste reduction technology, and implemented this technology in our newly-constructed fabs.

- Greenhouse Gas-perfluorinated Compound (PFC) Emissions Reduction: After we achieved our PFC total emissions reduction goal in 2010, we continue to move forward on emissions reduction. PFC emissions per 8-inch wafer equivalent in 2014 were 4% less than 2013 due to our continuing reduction efforts.

- Energy Conservation: TSMC reduced power consumption per 8-inch wafer equivalent per mask layer by 3.5% from 10.2 kWh in 2013 to 9.8 kWh in 2014; 7.7% improvement compared to 2010, which has achieved mid-term energy saving goal.

- Water Conservation: TSMC’s water use per 8-inch wafer equivalent per mask layer in 2014 decreased by 10.1% compared to 2013 from 51.5 liters to 44.3 liters.

- Waste Reduction: Achieved a waste-recycling rate of 93%, in 2014, surpassing 90% for 6 consecutive years. In addition, our landfill rate is also less than 1% for 6 consecutive years.

5.2 Global Climate Change

TSMC Is Highly Concerned about Climate Change

Global climate change is a major environmental concern for the United Nations and governments around the world, as well as for TSMC. We continuously monitor global climate change and international response trends as one of our enterprise risk management items to be evaluated and controlled, with regular reviews by senior executives, and reports are made to the Audit Committee of the TSMC Board of Directors when special issues are encountered.

5.2.1 TSMC’s Climate Change Response Strategy

Climate Change Management Process

TSMC’s strategies for responding to climate change are to:

- Consider both climate change mitigation and adaptation
- Consider both green manufacturing and green products
- Consider both TSMC and its supply chain
- Integrate industry, government and academia to solve climate change issues
- Collaborate with industries & supply chain to tackle climate change through experience sharing

TSMC not only continues to inventory and reduce its own greenhouse gas (GHG) emissions, but also takes action on climate change adaptation in cooperation with industry, government and academia, including risk assessment and measures such as flood and drought control. These actions are supported by the PDCA cycle to manage its climate change strategy, which is organized in several steps: Continuous Monitoring, Risk Assessment/Mitigation and Opportunity Generation, Strategy/Tactics Preparation, Implementation, Performance Check, Benchmarking, and Strategy/Tactics Amendment.
measures have grown to gradually cover TSMC’s supply chain in recent years, and we monitor our progress in mitigation through product carbon footprints and water footprints. These measures also reduce operational risk for the Company caused by climate change, and help to fulfill the Company’s social responsibility.

### TSMC Climate Change Management Structure

#### Mitigation
- **Internal:** GHG Reduction, Energy/Water Saving, Green Building
- **External:** Require suppliers to conduct GHG reduction, energy and water saving programs
- **Climate change risk management:** Set up prevention and response capability for typhoon, flooding, drought, water/electricity supply interruption
- **Collaboration with industry, government and academy:** Collaborate with various fields to resolve flooding and water shortage problems in local area

#### Adaption
- **Climate change risk:** Improve distribution systems, prepare emergency procedures, and establish resilience plans
- **Collaboration with industry, government and academy:** Communicate with various fields to resolve flooding and water shortage problems in local area

### Monitoring Climate Change Risks in Three Dimensions

TSMC believes that climate change should be regarded as an important corporate risk, which must be controlled to improve our competitiveness. Climate change risks include legal risk, physical risk and other risks. Our control measures are as follows:

#### Regulatory Climate Risk Control:

Greenhouse gas control regulations and agreements of countries around the world are becoming more and more stringent. Enterprises are legally required to regularly disclose GHG-related information, and also limit GHG emissions. The cost of production, including materials and energy, may also grow along with future legal requirements such as carbon or energy taxes. TSMC continues to monitor legislative trends and communicate with various governments through industrial organizations and associations to set reasonable and feasible legal requirements. We have developed a Regulation Identification System on the TSMC ESH Platform. The content, impact and relevant actions of new or revised ESH regulations are posted on the system. All TSMC fabs will implement follow-up actions for mitigating the regulatory risks.

#### Physical Climate Risk Control:

Abnormal climate caused by the greenhouse effect has increased the frequency and severity of climate disasters each year. Storms, floods, drought, and water shortages are occurring more frequently, causing considerable impact on business operations and supply chains. TSMC believes that climate change control should take into account both mitigation and adaption, and this requires cooperation between industry and government to reduce risk. Therefore, in addition to water-saving measures at our own facilities and those of our upstream and downstream partners, TSMC is also leading the industry to collaborate with central government agencies and conduct a project to assess and mitigate climate natural disaster risk in three Taiwan Science Parks. This project also aims to establish a response and reporting system which can be effectively integrated with disaster relief resources. In order to ensure electricity and raw water supplies, TSMC participates in the Taiwan Science Park Industrial Union Experts Committee platform, and is actively involved in the meetings with Taipower Company and the Taiwan Water Corporation to discuss supply and allocation for response issues.

TSMC executed flood potential analysis and risk mitigation for our fabs located in the area of low altitude. TSMC has completed flood risk assessment and improvement for risk mitigation after striving in 2014.

#### Other Climate Risk Controls:

Climate change is an issue of concern to the global supply chain, necessitating energy conservation, carbon reduction, and disaster prevention. The Electronic Industry Citizenship Coalition (EICC) has also required members’ suppliers to disclose GHG emissions information. TSMC not only discloses our own GHG emissions information each year, we also assist and require our suppliers to establish a GHG inventory system and conduct reduction programs. TSMC’s suppliers are required by TSMC to submit GHG emissions and reduction information as an important index of sustainability scoring in our procurement strategy.
TSMC joined the Electronic Industry Citizenship Coalition (EICC) as an applicant member at the end of 2014. In addition to adopting the EICC Code of Conduct to measure the Company’s own continuous improvement in social, environmental, and ethical performance, TSMC will also progressively apply the Code of Conduct to our major suppliers, supporting them with EICC tools and standards. TSMC looks forward to working and sharing with the other members of the Coalition for having a major positive influence on supply chain.

Several negative consequences including impact on finances, reputation and brand will affect TSMC if any significant non-compliant event occurs or main operation facilities are damaged by natural disasters. TSMC not only meets local and international code requirements, but also surpasses these requirements to reach higher environmental performance, and then shares its experience with industries for the common good.

### Identification and Control Climate Change Risks in Three Dimensions

<table>
<thead>
<tr>
<th>Risk</th>
<th>Risk Identification</th>
<th>Risk Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulatory Risk</td>
<td>• The impact of new regulations</td>
<td>• Continue to monitor legislative trends</td>
</tr>
<tr>
<td></td>
<td>• The cost of production, including materials and energy, may grow along with future legal requirements such as carbon or energy taxes</td>
<td>• Communicate with governments through industrial organizations and associations to set reasonable and feasible legal requirements</td>
</tr>
<tr>
<td>Physical Risk</td>
<td>• Increase frequency and severity of climate disasters - storms, floods, drought, and water shortages</td>
<td>• Water-saving measures</td>
</tr>
<tr>
<td></td>
<td>• Increase frequency and severity of climate disasters - storms, floods, drought, and water shortages</td>
<td>• Raise the foundation height of newly constructed fabs</td>
</tr>
<tr>
<td></td>
<td>• Install gates for stopping flood for the fabs located in low altitude areas</td>
<td>• Collaborate with central governments to assess and mitigate climate natural disaster risk in three Taiwan Science Parks</td>
</tr>
<tr>
<td></td>
<td>• Collaborate with central governments to assess and mitigate climate natural disaster risk in three Taiwan Science Parks</td>
<td>• Execute flood potential assessment because of climate change and develop risk mitigation mechanism</td>
</tr>
<tr>
<td>Other Risk</td>
<td>• Corporation Reputation</td>
<td>• Not only meet local and international code requirements, but also surpass the requirements to reach higher environmental performance, then share experience with industries for the common good</td>
</tr>
<tr>
<td></td>
<td>• The mitigation and adaptation ability of climate change in supply chain</td>
<td>• Assist and require TSMC suppliers to establish a GHG inventory system and conduct reduction programs</td>
</tr>
</tbody>
</table>

### Climate Change Opportunities

TSMC believes that a company can increase its competitiveness and create opportunities through good climate change risk control. Therefore, TSMC continues to conduct energy saving and carbon reduction related projects to create opportunities as follows:

- **Regulatory Climate Opportunities:**
  The Taiwan Environmental Protection Administration (EPA) has set up a Greenhouse Gas (GHG) Early Reduction Project to encourage enterprises that have conducted voluntary GHG reduction before the GHG Reduction Act becomes effective to gain carbon credits through application. Enterprises can use their approved carbon credits for future GHG emission offsets or trading. TSMC began voluntary GHG emission reduction in 2000, and has reduced greater than 5.28 millions of tons of carbon dioxide equivalents over more than a decade. In early 2015, the GHG reduction of TSMC fabs in the past years has passed the review by the Taiwan EPA for early GHG reduction credits, which can serve as future GHG offsets for our company.

- **Physical Climate Opportunity:**
  Wafer Product: Climate change has caused energy saving and carbon reduction to become a major issue for electric and electronic products, and also a major requirement for TSMC customers. TSMC continues to develop advanced semiconductor technology in line with Moore’s Law, lowering the energy and raw materials consumed per unit area in the manufacturing stage, and also lowering the power consumption in product use stage, which has continued to reduce product carbon, water and other environmental impact footprints.

Green Business Opportunity: There is growing global demand for...
green energy due to climate change. Since 2009, TSMC has engaged in researching, developing, designing, manufacturing and selling of solar-related technologies and products. In 2011, TSMC established “TSMC Solar Ltd.” to continue to engage green energy business.

- Other Climate Opportunity:

TSMC believes that risk mitigation and opportunity generation can strengthen TSMC competitiveness and also contribute to operation stability, increased revenues and sustainable development. TSMC joined EICC (Electronic Industry Citizenship Coalition) at the end of 2014. We collaborated with other members of EICC to promote climate change management of the supply chain for keeping a stable supply of raw materials and contributing to the minimization of environmental impact.

**Greenhouse Gas Inventory**

TSMC believes reducing GHG emissions is a key method for mitigating global warming and climate change, and conducting an inventory provides supporting data for reduction. An accurate inventory allows us to set priorities and reduction goals, raise the efficiency of the reduction process, and confirm reduction results. Therefore, we believe it is better to inventory greenhouse gases as early as possible.

TSMC believes that a company must know its actual GHG emissions as the first step toward energy conservation and carbon reduction, and has made this reduction an important part of its green supply chain since 2008. In addition to organization-level inventory, TSMC has also extended carbon inventories to our supply chain. In doing this, TSMC can establish a capability for product-level carbon footprint inventory and carbon management, thus increasing the competitive advantage of the products we manufacture. These efforts have won recognition from government, domestic and international environmental groups, major investors, and customers.

TSMC’s GHG emissions can be categorized into Scope 1, 2 and 3 sources. Scope 1 emissions are the direct emissions of TSMC fabs including process gases (PFCS, HFC, N2O, CH4, and CO2), fuel such as natural gas, gasoline and diesel, and fugitive emissions from septic tanks and firefighting equipment. Scope 2 emissions are mainly indirect emissions such as purchased electricity and steam. TSMC does not purchase steam. Therefore, our scope 2 emissions are primarily from purchased electricity. Scope 3 emissions are mainly indirect emissions including employee business travel, product and raw material transportation, suppliers’ manufacturing, and waste disposal. Scope 1 and 2 emissions are calculated according to our annual inventory data; Scope 3 emissions are estimated by: (1) Statistical data: employees’ business travel distances, and fuel consumed by shuttle buses and product shipping. (2) Carbon footprint database: raw materials production and transportation, waste disposal and transportation.

In 2005, TSMC set up a procedure of GHG emissions inventory for each TSMC fab in Taiwan. Each fab is required to complete scope 1 and scope 2 GHG emissions inventory of the previous year and to receive official ISO 14064-1 certification issued by an external verification party. TSMC also set up a dedicated internal ESH information system for each fab to register GHG inventory data regularly.
TSMC Scope 2 GHG Emissions

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Oversea Sites (Ton CO2e)</th>
<th>Total Taiwan Sites (Ton CO2e)</th>
<th>Total All Sites (Ton CO2e/8&quot;EQ-Layer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>208,966</td>
<td>2,048,718</td>
<td>2,257,684</td>
</tr>
<tr>
<td>2011</td>
<td>275,819</td>
<td>3,211,022</td>
<td>3,486,841</td>
</tr>
<tr>
<td>2012</td>
<td>304,216</td>
<td>3,738,599</td>
<td>4,042,815</td>
</tr>
<tr>
<td>2013</td>
<td>292,746</td>
<td>2,511,022</td>
<td>2,803,768</td>
</tr>
<tr>
<td>2014</td>
<td>303,986</td>
<td>3,109,172</td>
<td>3,413,158</td>
</tr>
</tbody>
</table>

Note: TSMC Taiwan fabs’ scope 2 GHG emissions have been revised according to the newest electricity emission factor announced by the Bureau of Energy, Ministry of Economic Affairs, R.O.C.

GHG Information Disclosure

TSMC takes a pro-active attitude towards carbon disclosure, and publicly discloses climate change information through a variety of channels. We constantly review ourselves and obtain recommendations from external parties through continuous information disclosure. The related disclosure channels are as follows:

- Since 2006, TSMC voluntarily reports GHG inventory data to the Taiwan Semiconductor Industry Association (TSIA) and the Taiwan Environmental Protection Administration (EPA), Executive Yuan.
- Since 2005, TSMC has been participating in an annual survey held by the nonprofit Carbon Disclosure Project (CDP), which includes GHG emission and reduction information for all TSMC fabs, subsidiaries, joint ventures, and overseas offices. TSMC also takes further action to review the regulatory, natural disaster, financial, and operational risks and opportunities created by global climate change. The related information is disclosed on the CDP website.
  - TSMC has disclosed GHG emissions and reduction-related information for evaluation by the Dow Jones Sustainability Index every year since 2001.
  - Our GHG-related information has been disclosed in this CSR report on our company website annually since 2008. TSMC also provides information to customers and investors upon request.

5.2.2 Climate Change Mitigation
GHG Emission Reduction

- Achievement of Our 10-Year PFC Emission Reduction Commitment
  The semiconductor manufacturing process generally uses perfluorinated compounds (PFCs) such as CF4, C2F6, SF6, NF3, CHF3, C3F8, and C4F8, which are the major greenhouse gas emissions from the manufacturing process. After many years’ effort, TSMC has achieved its goal of reducing perfluorinated compound emissions to 10% below the average emission level of 1997 and 1999. This emission target remains fixed as TSMC continues to grow and construct new fabs, and has been a great challenge to us.

- Extending Our Green Building and Energy Conservation Projects
  Since TSMC’s Scope 2 GHG emissions are primarily from purchased electricity, continued promotion of green building and energy conservation projects can continue to reduce our Scope 2 GHG emissions. Please refer to the green building and energy conservation sections in this report for details.

From Green Building to Sustainability

Step One: Integrating Ecosystem, Life, and Manufacturing to Build Green Campus

Green Building Certification

TSMC began promoting green buildings in 2006, and committed to designing and building all new fabs and office buildings according to Leadership in Energy and Environment Design (LEED) and Ecology, Energy Saving, Waste Reduction, and Health (EEWH) standards. In addition, the Company also introduces green building concepts to existing buildings to improve their environment and efficiency. Currently, TSMC has received 16 LEED certifications, seven EEWH Taiwan green building certifications, and three intelligent building certifications. The next focus of TSMC’s efforts are intelligent green campuses, which aim to incorporate mature products from the Internet of Things and continue to strive for green, intelligent, healthy, and sustainable buildings.
## Green Campus Master Plan

TSMC’s first green campus project in the region, targets to transform Fab12 in Hsinchu, Fab15 in Taichung, and Fab 14 in Tainan into green campuses. These green campuses emphasize sharing of energy, resources, efficient energy conservation of electricity and water, as well as improving waste reduction, and recycling to reduce cost. They also emphasize comprehensive site planning to integrate green fields, enliven natural landscapes, and restore local ecology so that the natural environment prospers along with industrial growth.
With the goal of reducing carbon-dioxide emissions, TSMC adopts sustainable landscape construction and design in the establishment of the green campus; We establish a native ecological system, to create an environment suitable for a wild range of indigenous species and vegetation. Presently, we have four goals and 12 objects to develop natural ecology.

### TSMC Green Environmental Objects List

<table>
<thead>
<tr>
<th>Goals</th>
<th>Objects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native Plants Restoration</td>
<td>• Identify the species and cooperate with National Museum of National Science</td>
</tr>
<tr>
<td></td>
<td>• Focus on endangered species of native plants, and intend to build suitable environment in each site</td>
</tr>
<tr>
<td></td>
<td>• Taiwan Lily Restoration</td>
</tr>
<tr>
<td>Native Butterfly Conservation</td>
<td>• Connect Routing Routes of Purple Crows</td>
</tr>
<tr>
<td></td>
<td>• Food for butterflies of China is considered, and designed in landscaping, in order to attract butterflies to visit</td>
</tr>
<tr>
<td></td>
<td>• Build suitable habitat for butterflies</td>
</tr>
<tr>
<td>Dynamic Ecological Site</td>
<td>• Sustainable Green Landscaping Design</td>
</tr>
<tr>
<td></td>
<td>• Use compost to increase the capacity of land</td>
</tr>
<tr>
<td></td>
<td>• Avoid using insecticide in the campus</td>
</tr>
<tr>
<td></td>
<td>• To build sustainable working environment by multi-logical species and design</td>
</tr>
<tr>
<td>Promotion of Environmental Education</td>
<td>• Ecological Visit tour for students</td>
</tr>
<tr>
<td></td>
<td>• Green Building Experience sharing event</td>
</tr>
</tbody>
</table>

**Step Two: Sustainable Landscape Construction**

With the goal of reducing carbon-dioxide emissions, TSMC adopts sustainable landscape construction and design in the establishment of the green campus; We establish a native ecological system, to create an environment suitable for a wild range of indigenous species and vegetation. Presently, we have four goals and 12 objects to develop natural ecology.
Step Three: Promotion of Green Sustainability

Intelligent and Green Campus External Visits

TSMC's certified green buildings have hosted a number of visitors for on-site tours. In 2014, guests included USGBC Vice President Jennivine Kwan, the Tainan City Government, the Central Taiwan Science Park Bureau, the National Taiwan University EMBA program, the National Chiao Tung University Graduate Institute of Architecture, Chunghwa Telecom, Yulon Motors, Shinkong Insurance, and others totaling 1,047 people.

**Annual Statistic Data of Green Campus Tour Participant**

<table>
<thead>
<tr>
<th>Year</th>
<th>Annual Visitor Number</th>
<th>Cumulated Visitor Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>129</td>
<td>129</td>
</tr>
<tr>
<td>2008</td>
<td>482</td>
<td>611</td>
</tr>
<tr>
<td>2009</td>
<td>1,219</td>
<td>1,830</td>
</tr>
<tr>
<td>2010</td>
<td>2,119</td>
<td>3,948</td>
</tr>
<tr>
<td>2011</td>
<td>3,163</td>
<td>7,110</td>
</tr>
<tr>
<td>2012</td>
<td>4,548</td>
<td>11,658</td>
</tr>
<tr>
<td>2013</td>
<td>6,297</td>
<td>17,955</td>
</tr>
<tr>
<td>2014</td>
<td>7,346</td>
<td>25,301</td>
</tr>
</tbody>
</table>

Energy Use Status

TSMC total energy consumption in 2014 was 28,498 trillion Joules. The majority is power usage, which is about 95% total energy consumption. Secondary is natural gas, which is about 5% total energy consumption. Diesel consumption is less than 0.05% total energy consumption. Among them, our renewable energy is mainly from solar panel with 5.65 million Joules production and is used in our facilities.
Energy Conservation Measures

- **Energy Conservation in Taiwan**
  TSMC’s primary source of energy is electric power, followed by natural gas. Consumption of other types of energy is negligible. As Taiwan’s land area is small, and the development of renewable energy is limited, electric power currently comes primarily from coal and gas-fired generators, which emit large amounts of CO2 despite efforts by the power company to improve efficiency. In response to this, the Taiwan government is conducting a renewable energy project focusing on expansion of wind and solar power, and TSMC is pleased to see this development. Before the completion of this government project, energy conservation is an important part of CO2 emission reduction for industries in Taiwan. TSMC has consistently promoted energy conservation at all its facilities, reducing CO2 emissions while saving costs at the same time.

- **Power Consumption Records**
  TSMC continuously promotes energy saving and primarily focuses on facilities systems. In the past two years, we have also increased our efforts to reduce consumption by manufacturing equipment. The power consumption density as calculated by wafer area is highly dependent on photo mask layers and production ramp-up in new

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**TSMC Energy Consumption**

<table>
<thead>
<tr>
<th>Year</th>
<th>Natural Gas Consumption</th>
<th>Power Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>1,005</td>
<td>15,145</td>
</tr>
<tr>
<td>2011</td>
<td>1,148</td>
<td>17,215</td>
</tr>
<tr>
<td>2012</td>
<td>1,162</td>
<td>19,025</td>
</tr>
<tr>
<td>2013</td>
<td>1,339</td>
<td>22,424</td>
</tr>
<tr>
<td>2014</td>
<td>1,520</td>
<td>27,162</td>
</tr>
</tbody>
</table>

**TSMC Energy Intensity**

<table>
<thead>
<tr>
<th>Year</th>
<th>Energy Intensity (Million Joules/NTD Revenue)</th>
<th>Energy Intensity (Million Joules/USD Revenue)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>0.0385</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>0.0430</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>0.0415</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>0.0398</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>0.0376</td>
<td></td>
</tr>
</tbody>
</table>

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**Note:**
1. TSMC’s annual power consumption is based on monthly power companies’ bills, the conversion unit is 1 kWh = 3.6 million joules.
2. TSMC’s annual energy consumption is based on monthly natural gas companies’ bills, the conversion unit is 1 cubic meter of natural gas = 37.26 million joules.
3. TSMC’s annual diesel consumption is less than five ten thousandths, not shown on the chart.
fab. According to the energy consumption goal of International Technology Roadmap of Semiconductors (ITRS) and the statistical data of World Semiconductor Council (WSC), the complexity of logic ICs (foundry’s major product) is higher than standard memory and results in higher power consumption. TSMC is nonetheless one of the semiconductor industry’s most energy-efficient companies, and continues to implement additional power-saving measures. TSMC reduced its power consumption per 8-inch wafer equivalent per mask layer by 3.5% from 10.2 kWh in 2013 to 9.8 kWh in 2014.

<table>
<thead>
<tr>
<th>Category</th>
<th>Energy Saving Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utility</td>
<td>• Via Big data algorithm to find the best operation mode of chill water systems and process cooling water system</td>
</tr>
<tr>
<td></td>
<td>• Using high thermal insulating material covering the exhaust pipe and equipment</td>
</tr>
<tr>
<td></td>
<td>• Lowered CDA pressure according to equipment’s minimum requirements</td>
</tr>
<tr>
<td></td>
<td>• Install of distributed chiller by high efficiency central supply Process Cooling Water</td>
</tr>
<tr>
<td></td>
<td>• Bypass Venturi vacuum generator to Process Vacuum system, saving compressed dry air consumption</td>
</tr>
<tr>
<td></td>
<td>• To minimize energy consumption, dynamically adjusted chill system settings according to the seasons and atmospheric conditions</td>
</tr>
<tr>
<td></td>
<td>• Change to low energy consumption LED lighting in non-cleanroom areas</td>
</tr>
<tr>
<td></td>
<td>• Replace low-efficiency Uninterruptible Power Supply with high-efficiency types</td>
</tr>
<tr>
<td></td>
<td>• Installed Automatic Tube Cleaning Systems and added Polanized Refrigerant Oil additive to enhance chillers’ heat exchange efficiency</td>
</tr>
<tr>
<td></td>
<td>• Adopt ceramic layer coating technology to improve old pumps high energy loss problem caused by coarse surfaces</td>
</tr>
<tr>
<td></td>
<td>• Optimize energy efficiency of cooling tower by using tailor-made high-efficiency blades</td>
</tr>
<tr>
<td></td>
<td>• Reduce energy loss caused by clogging or blade deformation by using bio-tech coating to reduce the fouling in wet scrubbers</td>
</tr>
</tbody>
</table>

**Major Power-Saving Activities in 2014**

In 2014, TSMC continued to successfully complete a number of energy conservation programs in facility systems as well as process equipment. Although energy-saving measures for process equipment may impact production, we were able to achieve our goal for process equipment power conservation. Major activities are listed as below:

**TSMC Power Consumption**

<table>
<thead>
<tr>
<th>Year</th>
<th>Power Consumption (Overseas)</th>
<th>Power Consumption (Taiwan)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>3,884</td>
<td>5,072</td>
</tr>
<tr>
<td>2011</td>
<td>4,382</td>
<td>5,782</td>
</tr>
<tr>
<td>2012</td>
<td>4,000</td>
<td>326</td>
</tr>
<tr>
<td>2013</td>
<td>4,564</td>
<td>467</td>
</tr>
<tr>
<td>2014</td>
<td>4,782</td>
<td>7,089</td>
</tr>
</tbody>
</table>

**TSMC Unit Power Consumption**

<table>
<thead>
<tr>
<th>Year</th>
<th>Power Consumption per Wafer-layer (kWh/8”wafer-layers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>10.6</td>
</tr>
<tr>
<td>2011</td>
<td>10.7</td>
</tr>
<tr>
<td>2012</td>
<td>10.5</td>
</tr>
<tr>
<td>2013</td>
<td>9.8</td>
</tr>
<tr>
<td>2014</td>
<td>9.8</td>
</tr>
</tbody>
</table>

Note:
1. The statistical data for power consumption includes all mass production wafer fabs in Taiwan, as well as all overseas fabs, packing and testing facilities, bumping, EBO, R&D, and power consumed by non-production activities.
2. The statistical data for unit power consumption density is for the power usage of mass production wafer fabs in Taiwan and overseas. Beginning in 2009, this index was rationalized by introducing a layer index due to product complexity.

[continues on next page]
### Category | Energy Saving Approach
--- | ---
**Utility** | Replace low energy efficiency pumps with high efficiency types for water treatment systems
| Adopt high efficiency control for non full-load operating equipment
| Adopt high flux air filter to reduce pressure loss in cleanroom
| Replace nitrogen used in local scrubbers with compressed air to reduce indirect energy consumption
| Retrofit chillers' flow control to be frequency adjustable from original constant and full flow design
| Optimize outlet temperature of Makeup Air Unit to reduce energy consumption

**Production** | Adopt high-efficiency vacuum pump according to process characteristics to improve energy efficiency
| Reduce nitrogen usage of dry type vacuum pump to reduce indirect energy consumption
| Replace nitrogen usage in lithography process equipment by compressed air to reduce indirect energy consumption

### Direct Energy Use Status

TSMC’s direct energy consumption includes natural gas and diesel fuels. In TSMC, natural gas is mainly used for boilers and Volatile Organic Compounds (VOC) treatment systems, and diesel fuel is used for emergency power generators and fire pumps. TSMC reduced average natural gas consumption per 8-inch wafer per mask layer from 0.058 m³ in 2013 to 0.054 m³ in 2014, a reduction of approximately 7.6%, which shows gradual reduction of natural gas consumption per wafer.

### TSMC Natural Gas Consumption

<table>
<thead>
<tr>
<th>Year</th>
<th>Natural Gas Consumption (Taiwan)</th>
<th>Natural Gas Consumption (Overseas)</th>
<th>Unit: Thousand NM³</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>8,196</td>
<td>9,255</td>
<td>18,770</td>
</tr>
<tr>
<td>2012</td>
<td>9,216</td>
<td>23,413</td>
<td>32,629</td>
</tr>
<tr>
<td>2013</td>
<td>8,171</td>
<td>27,763</td>
<td>35,934</td>
</tr>
<tr>
<td>2014</td>
<td>8,314</td>
<td>32,726</td>
<td>41,040</td>
</tr>
</tbody>
</table>

### TSMC Unit Natural Gas Consumption

<table>
<thead>
<tr>
<th>Year</th>
<th>Nm³/8” wafer-layers</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>0.065</td>
</tr>
<tr>
<td>2011</td>
<td>0.066</td>
</tr>
<tr>
<td>2012</td>
<td>0.064</td>
</tr>
<tr>
<td>2013</td>
<td>0.058</td>
</tr>
<tr>
<td>2014</td>
<td>0.053</td>
</tr>
</tbody>
</table>

### Diesel

Diesel is primarily used in emergency power generators and fire pumps, which are only engaged during power supply disruptions, emergencies, and scheduled tests. Diesel is not a direct energy source for production and we used about 304,000 liters in 2014.

### Major Natural Gas-Saving Activities in 2014

TSMC strives for natural gas conservation by improving boilers and Volatile Organic Compounds (VOC) treatment systems by reducing heat loss, replacing heat sources, heat recovery and efficiency improvement. Major activities are listed as below.

### Energy Saving Approach

- Eliminating heat loss of hot water conveyance by replacing boiler water humidifier to air washer
- High efficiency heat pump to replace the boiler as a heat source
- Costing towers low-temperature waste heat recovery for preheating city water
- Air compressor high-temperature waste heat recovery for heating ultra-pure water
- Installation of 3rd heat recovery system for natural gas saving
- Installation inverter for system Zeolite rotator desorbed process
5.2.3 Climate Change Adaption
Collaborating with the Central Government to Evaluate and Control Climate Change Risk in Science Parks

TSMC and other semiconductor companies gained the support of the Science Park Industrial Association, Science Park Administration, National Science Council, Water Resources Agency, Taxpower, and Taiwan Water Corporation to reevaluate risks caused by climate change and extreme weather, including: interruptions to water supply, power supply, gas supply, transportation and communication, as well as flood damage, wind damage, and drought. These re-evaluations will be used to develop response and improvement programs for implementation in the Hsinchu, Tachung and Tainan Science Parks.

The core considerations of the climate change risk assessment project for the Hsinchu, Central, and Southern Taiwan Science Parks are:
• The risks of typhoons and flooding
• Long-term drought risks
• Climate change risks that may lead to the restriction of industrial development

Climate change risk control strategy:
• Mid-term and long-term risk control
• Disaster emergency response
• Establishing related reference standards for future new construction

Note: Our major raw material suppliers account for 80% of total raw materials purchased by TSMC.

5.2.4 Supply Chain Climate Change Management
TSMC not only engages in climate change management but also requests and assists suppliers to follow. Our measures are below:
• Energy Saving and Carbon Reduction Management: TSMC’s major raw material suppliers are required to collect carbon inventory data in their manufacturing plants, encouraged to develop a product-based carbon footprint and provide carbon reduction performance data.
• Water Resources and Water Management: TSMC’s major raw material suppliers are required to collect water inventory data in their manufacturing plants, encouraged to establish a water footprint, and to provide a specific water resource management plan.
• Climate Change Risk Management: Due to the increased risk of storms, water shortage, flooding and transportation and communication disruption in recent years resulting from global climate change, we require our major raw material suppliers to prepare contingency plans, such as support from overseas production, to reduce the impact of such an event. Our first-tier suppliers are also required to manage their suppliers.

5.3 Water Resource Management
Water Resource Management Is One of TSMC’s Top Issues in Climate Change
Water resource management is getting more important in most countries due to the detrimental impact of global climate change. The difference of rainfall between dry and rainy season in Taiwan has become increasingly extreme, and the risk of droughts and floods has become more apparent. These trends highlight the importance of water resource management, water saving and water shortage emergency response. TSMC has always strived to conserve water as much as possible, and we have made considerable achievements in the past 20 years. By lowering water consumption and increasing our recycling rate, our water usage per wafer has become a benchmark for global peers, and has led Taiwan’s semiconductor companies to achieve the lowest average water consumption in the world. TSMC is aware that extremes in average rainfall are the result of global warming and climate change. These issues may require decades to resolve, and during that time, water resource management is a necessary part of TSMC’s corporate climate change risk management and disaster adaptation. In addition, TSMC also acknowledges that water resource management requires very close collaboration with the government when compared to other climate change response measures. The combination of these factors has led TSMC to establish its water resource management policy and strategy.

TSMC Water Resource Management Policy and Strategy
TSMC’s goal is to be a leading global company in water resource management. Our water resource management policy is to promote water savings to reduce water usage per unit of production, and to promote collaboration between industries, government and academia to ensure that water shortages do not occur. Our strategy for reaching this goal is both to save water in daily operations and to adapt to water shortages, and implement these measures both internally and in our supply chain. TSMC’s daily water management is first to save water in the production process, followed by water reclamation and...
recycling measures. In addition, an effective real-time online water resource management platform helps TSMC significantly reduce water consumption.

TSMC’s core water resource management activities are focused on:

- Collaborating with the central government to evaluate the climate change risk of Taiwan’s Science Parks, and to adopt measures reducing the impact of extreme climate disasters, beginning with basic infrastructure.
- Collaborating with the local government, public utilities, and other companies to coordinate local water resource allocation and share experience.
- Sharing TSMC’s water saving experience to help other industries understand the importance of water resource risk and conduct water conservation together.
- Promoting internal and supply chain water inventories, conserving water, establishing a water footprint, and setting up water saving goals.

**Water Resource Risk Mitigation and Adaptation**

TSMC believes that water risk is one of our major operation risks, which must be monitored and controlled to improve our competitiveness. Water risks include regulatory risk, physical risk and other risks. Our control measures are shown as following table:

<table>
<thead>
<tr>
<th>Risk</th>
<th>Risk Identification</th>
<th>Risk Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulatory Risk</td>
<td>The impact of new regulations</td>
<td>Continue to monitor regulatory trends</td>
</tr>
<tr>
<td>Physical Risk</td>
<td>Increasing frequency and severity of storms, floods and drought</td>
<td>Increase water stress or scarcity</td>
</tr>
<tr>
<td>Other Risk</td>
<td>The mitigation and adaptation ability of climate change in supply chain</td>
<td>Assist and require TSMC suppliers to establish Water Management concepts and a management system</td>
</tr>
</tbody>
</table>

**Collaboration with Local Authorities in Water Allocation and Conservation**

Since water resources are inherently local, TSMC shares its water-saving experiences with other semiconductor companies through the Association of Science Park Industries to promote water conservation. At the same time, TSMC collaborates with the Science Park Administration to discuss raw water allocation and emergency response plans for water shortages. TSMC has also successfully resolved many water quality issues, including wastewater ammonia nitrogen reduction. In addition, we continue to hold technical forums to discuss water reclamation and assist small facilities in the Science Park to perform good water resource management in order to achieve the Science Park’s goals and ensure long-term balance of supply and demand.

**Actively Sharing Experience with External Parties**

In recent years, TSMC and the Water Resource Agency of the R.O.C. Ministry of Economic Affairs jointly held a Water Recycling & Saving Demonstration in TSMC fabs located in Northern, Central and Southern Taiwan to share our experience and lead improvement in the water-saving performance of Taiwan industries.

**Proactively Identifying and Responding to Water Resource Risk**

TSMC understands that climate change can cause flooding and drought. We took the following actions to respond to water resource risks:

- Identified short-term and long-term water resource risks of the Science Parks in northern, central and southern Taiwan, where our fabs are located.
- Developed and executed short-term and long-term water resource risk mitigation projects such as wastewater recycling.
- Continuing to conserve water consumption in each fab.
Total Water Usage
The primary water source for all TSMC fabs in Taiwan is city water supplied by Taiwan Water Corporation, a few are from rain water and wastewater treatment systems, and toilet water. Secondary uses of water are also optimized to reduce make-up water quantity. In order to fully utilize water drainage from the manufacturing process, TSMC separates drain pipes into more than 20 categories based on their characteristics and more than 15 categories of treatment systems.

TSMC Water Consumption

<table>
<thead>
<tr>
<th>Year</th>
<th>Water Consumption (Taiwan)</th>
<th>Water Consumption (Overseas)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>3.47</td>
<td>22.30</td>
</tr>
<tr>
<td>2011</td>
<td>3.22</td>
<td>26.30</td>
</tr>
<tr>
<td>2012</td>
<td>3.44</td>
<td>25.80</td>
</tr>
<tr>
<td>2013</td>
<td>3.47</td>
<td>29.70</td>
</tr>
<tr>
<td>2014</td>
<td>3.27</td>
<td>26.70</td>
</tr>
</tbody>
</table>

Unit: Million Cubic Meter

Note:
1. TSMC annual water consumption statistic is calculated according to monthly water bill from the Water Company. The statistical data for water consumption includes all fabs in Taiwan, as well as all overseas fabs, packing and testing facilities, bumping, EBO, EJU, and water consumed by non-production activities.
2. The statistical data for unit water consumption density is for the water usage of wafer fabs in Taiwan and overseas. Beginning in 2009, this index was rationalized by introducing a layer index due to product complexity.

TSMC’s facilities collect process water discharges through independent drainages, and reuse the water for the manufacturing process or air-conditioner condensed water. TSMC’s water use per 8-inch wafer equivalent per mask layer in 2014 decreased by 10.1% compared to 2013 from 51.5 liters to 46.3 liters.

Water Conservation – Reduction and Recycling
TSMC’s facilities collect process water discharges through independent drainages, and reuse the water for the manufacturing process or secondary uses after treatment. These secondary uses, which do not come into human contact, include make-up water of cooling towers and wet scrubbers, cleaning water for sludge dewatering filters in wastewater treatment systems, and toilet water. Secondary uses of water are also optimized to reduce make-up water quantity. In order to fully utilize water drainage from the manufacturing process, TSMC separates drain pipes into more than 20 categories based on their characteristics and more than 15 categories of treatment systems.

TSMC is a fast-growing company, and in addition to adopting a minimum process water recycling rate of 85%, we also select low water consumption process tools, implement process water drainage segregation, set up process water reclamation systems in new factory construction, and continue promoting water-saving measures after mass production. The purpose of these measures is to reduce our raw water demand. TSMC also cooperates with industry experts to implement new technology for water reuse, such as reclaiming oxide slurry and reusing wastewater from refined oxide slurry.

Major Water Saving Measures in 2014
Since 2008, a number of TSMC fabs have achieved a process water recycling rate of higher than 90%, leading the global semiconductor industry. Our fabs in Taiwan total process water recycling rate reached 87.6% in 2014, which met or exceeded the criteria set by the Science Park Administration and also exceeded the worldwide semiconductor industry standard. TSMC’s major water saving measures are as follows:

- TSMC Water Consumption
- TSMC Unit Water Consumption

Note:
1. TSMC annual water consumption statistic is calculated according to monthly water bill from the Water Company. The statistical data for water consumption includes all fabs in Taiwan, as well as all overseas fabs, packing and testing facilities, bumping, EBO, EJU, and water consumed by non-production activities.
2. The statistical data for unit water consumption density is for the water usage of wafer fabs in Taiwan and overseas. Beginning in 2009, this index was rationalized by introducing a layer index due to product complexity.

Water Conservation – Reduction and Recycling
TSMC’s facilities collect process water discharges through independent drainages, and reuse the water for the manufacturing process or air-conditioner condensed water. TSMC’s water use per 8-inch wafer equivalent per mask layer in 2014 decreased by 10.1% compared to 2013 from 51.5 liters to 46.3 liters.
In 2014, we saved a total of 56,220,000 cubic meters of water, which can provide a town with a population of 620,000 with one year of water, or more than 1.75 times the volume of Hsinchu’s Baoshan Reservoir II.

### TSMC Water Conservation Performance in Recent 5 Years

<table>
<thead>
<tr>
<th>Item</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Process Water Recycling Rate (%) 1</td>
<td>84.1</td>
<td>84.6</td>
<td>86.5</td>
<td>86.9</td>
<td>87.6</td>
</tr>
<tr>
<td>Process Water Saved (Million m³) 2</td>
<td>36.64</td>
<td>37.73</td>
<td>53.37</td>
<td>52.23</td>
<td>56.22</td>
</tr>
<tr>
<td>Water Saved, Measured by Standard Swimming Pools 3</td>
<td>13,866</td>
<td>15,094</td>
<td>21,347</td>
<td>20,918</td>
<td>22,490</td>
</tr>
<tr>
<td>Water Saved, Measured by the Full Capacity of Baoshan Reservoir II 4</td>
<td>1.08</td>
<td>1.17</td>
<td>1.64</td>
<td>1.63</td>
<td>1.75</td>
</tr>
<tr>
<td>Process Water Saving/Total Water Usage</td>
<td>1.53</td>
<td>1.55</td>
<td>2.07</td>
<td>1.77</td>
<td>1.61</td>
</tr>
</tbody>
</table>

**Note:**
1. Average process water recycling rate is defined by the Science Park Administration.
2. A standard 50x25x2m swimming pool contains up to 2,500 cubic meters of water.
3. Baoshan Reservoir II is the major reservoir serving Hsinchu Science Park and the full capacity is 32.18 million cubic meters.

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**Water Saving Achievements and Process Recycling**

TSMC separates drain pipes into more than 20 categories based on their characteristics.
5.4 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 save production costs and protect the environment.

Legal Compliance and 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 legal standards, and improvement and preventive measures are taken immediately if nonconformance is discovered to ensure fully compliant.

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 to avoid environmental pollution and violating legal requirements. TSMC and subsidiaries had no significant chemical leaks, environmental penalties, or fines in 2014.

Assisting Non-semiconductor Subsidiaries in Early Pollution Control

TSMC assists its non-semiconductor subsidiaries TSMC Solar, in assessing risk for their specific wastewater, air emissions, wastes, and chemicals to reduce their environmental impacts.

Resource Recycling is Our Consensus

For waste management, TSMC has transitioned from traditional “treatment and disposal” to a concept of effective resource management, and implements this concept in daily operations. We manage waste as a resource, categorize and collect waste at the source, raise waste recyclability, and also collaborate with waste treatment and recycling facilities to search for or develop possible recycling measures to reduce the amount of waste sent to incinerators and landfills. In addition, TSMC actively collaborates with raw material suppliers to reduce chemical usage and waste chemicals. We also study the feasibility of waste recycling by raw materials suppliers to reach our goal of sustainable resource recycling.

5.4.1 Source Reduction – Raw Materials Usage Reduction

TSMC seeks to optimize processes to minimize raw material use and waste production, protecting the environment while reducing costs at the same time. TSMC has a designated unit that periodically reviews raw materials reduction performance. Internally, we optimize our process recipe for raw material usage, which can not only reduce production cost but also reduce the generation of pollutants and wastes. Externally, we require our process tool suppliers to review and minimize their chemical usage step by step.

TSMC uses raw wafers as a major direct material in its manufacturing process. Raw wafers are composed of very high purity silicon, and cannot be recycled for wafer manufacturing processes. However, control wafers used for monitoring process conditions are reclaimed for reuse. We estimate one control wafer can be reused 10 times, which reduces both cost and waste.
5.4.2 Water Pollution Control

Strategy of Segregated Treatment, Strict Monitoring, and Environmental Protection before Production

TSMC’s water pollution control strategy is first to reduce pollutants in process wastewater, followed by water recycling and treatment of pollutants in water. Effluent water quality must be better than or compliant with governmental standards. TSMC’s major water-using process is an ultra-pure water system which turns raw water into ultra-pure water, mainly used in process tools for cleaning chemical residue on wafer surfaces. To reduce total water usage, TSMC’s effluent water from ultra-pure water systems and process tools are graded by purity. The cleanest is reused in the manufacturing process; the second grade taken from the recycling treatment is employed in secondary uses such as cooling-tower water.

Wastewater that cannot be recycled is discharged to treatment facilities for final wastewater treatment. TSMC adopts a strict front-end wastewater categorization strategy to improve treatment efficiency. Wafer fabs’ wastewater can be divided into fluoride, copper, ammonia, Tetramethyl Ammonium Hydroxide, general acid, and various polishing wastewater categories, and all types of wastewater are strictly categorized at process tools, and collected to wastewater treatment facilities through separated piping. In order to manage these drains strictly, there are more than 20 categories of drainage types, carefully operated and maintained by professional teams to comply with the standards of the Science Park Administration (SPA). The water is then discharged to the SPA wastewater treatment plant for further treatment after professional teams ensure the discharge complies with SPA standards. The treated wastewater is discharged to rivers from the SPA’s wastewater treatment plants in compliance with river discharge standards. The SPA also conducts random measurement of the discharges of each company in Science Park.

Measures for Wastewater Treatment Emergency Response

TSMC operates only after ensuring that the environment will not be polluted. Each fab is equipped with effective wastewater treatment systems, including complete backup systems such as emergency power supplies, to reduce the likelihood of abnormal discharge. Operating status of all TSMC wastewater treatment systems are monitored 24 hours a day by shift personnel. If operating conditions diverge from the preset limits, a warning signal is sent and wastewater discharge is halted. Data gathered for monitoring system effectiveness have been designated an important tracking item to ensure effluent quality.
TSMC reviewed water pollution control hardware and management systems of each fab to identify high risks which might cause a similar incident. The risks include the facility compliance status compared to permits, storm water ditch pollution prevention measures and emergency response procedures. All TSMC fabs took immediate actions to enhance hardware facilities and management systems, and also conducted audits to continue improvement and reduce the risk of pollution and legal violation.

### TSMC Water Use, Wastewater Treatment and Discharge Diagram

#### Note: Overseas fabs

1. TSMC (China): On-site treated water discharges to Industrial District Wastewater Treatment Plant (IDWWPT). Discharge destination of IDWWPT treated water is Youdun Harbor.
2. US WaferTech: On-site treated water discharges to the City of Camas Publically Owned Treatment Works (POTW). Discharged destination of POTW treated water is Columbia River.

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### Developing New Technologies in Response to New Regulations

In addition to complying with SPA standards, TSMC continually works with industries and universities to improve discharge quality in areas such as COD (Chemical Oxygen Demand), TMAH (Tetra-methyl ammonium hydroxide) and NH3-N (ammonia nitrogen) to reduce hazards to water bodies. Since 2013, TSMC set up TMAH and NH3-N wastewater recycling and treatment systems to reduce hazardous substances in effluents and recycle resources in wastewater by controlling the flow of recycled materials from cradle to cradle to keep from secondary pollution.

Since 2014, the Science Park Administration added NH3-N and TMAH standards for influent. Due to long-term monitoring and treatment technology preparation, TSMC has completed sources reduction or treatment systems installation according to each fab's characteristics to ensure wastewater effluents comply with new standards.

In addition, TSMC continues to explore new wastewater treatment and chemical recycling technologies. For example, TSMC led the industry in performing a series of experiments to obtain the optimal processing technology for phosphorus acid wastewater recycled by external contractors and high-concentration Hydrogen Peroxide on-site reuse, which attests to our dedication to protect the environment.

### Major Wastewater Pollution Control Measures in 2014

Please refer to “Major Water Saving Measures in 2014” section in this report for TSMC’s water saving measures; our major wastewater quality improvement measures are as follows:

- Installed TMAH wastewater recycling system in advanced fabs and partial mature fabs to recycle TMAH to be used by other industries which also reduce NH4-N in effluents.
- Installed NH3-N wastewater treatment system in advanced fabs to reduce NH3-N in wastewater. The by-product ammonia sulfate is recycled by recycling contractors.
- Reduced ammonia use in mature fabs to reduce NH3-N in wastewater.
- Reduced COD (Chemical Oxygen Demand) in wastewater by using...
Reverse Osmosis. The condensed liquid is treated by qualified waste treatment contractors.
• Reuse high concentration acid and alkaline from ion-exchanger or Reverse Osmosis as wastewater neutralization chemicals so as to reduce conductivity of wastewater.
• Treat Chemical Mechanical Polishing process wastewater by using Ultra-filter to recycle solids and reduce its quantity in wastewater.

Wastewater Discharge Quantity
TSMC’s wastewater quantity per 8-inch wafer equivalent per mask layer in 2014 decreased by 14.5% compared to 2013 from 35.5 liters to 30.4 liters.

<table>
<thead>
<tr>
<th>Year</th>
<th>TSMC Wastewater Discharge (Taiwan)</th>
<th>TSMC Wastewater Discharge (Overseas)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>2.14</td>
<td>14.40</td>
</tr>
<tr>
<td>2011</td>
<td>2.88</td>
<td>15.10</td>
</tr>
<tr>
<td>2012</td>
<td>2.69</td>
<td>2.88</td>
</tr>
<tr>
<td>2013</td>
<td>2.70</td>
<td>15.10</td>
</tr>
<tr>
<td>2014</td>
<td>3.04</td>
<td>19.10</td>
</tr>
</tbody>
</table>

Wastewater Effluent Measurement Results
All TSMC fabs are equipped with continuous monitoring equipment to monitor and record changes in water quantity and quality, such as acidity, suspended solids, copper ion and fluoride ion concentration for the fabs with copper process, in order to take appropriate responses when abnormal situations occur. We also conduct offsite sampling and analyze wastewater effluent quality at least four times a year, which provides a calibration reference for online analyzers, ensuring that TSMC complies with water quality standards.

In 2014, TSMC wastewater effluent quality was close to 2011 levels, indicating good stability in all fabs. The wastewater effluent quality data includes: pH was maintained between six to nine (SPA standard is five to nine), suspended solids were controlled from 5.18 to 9.34 mg/L (SPA standard is below 30), COD was controlled from 3.3 to 341 mg/L (SPA standard is below 500), Fluoride ion was controlled within 13 mg/L (SPA standard is below 15), and Copper ion was controlled within 2.7 mg/L (SPA standard is below 3).

In 2015, the Hsinchu Science Park Administration changed the limit for copper ion to 1 mg/L, which is equal to the Drinking Water Standard in Taiwan. TSMC’s fabs in Hsinchu have enhanced equipment and treatment processes to comply with the new standard. In addition, the Taiwan Environmental Protection Agency approved the Environmental Impact Assessment (EIA) application for the Central Taiwan Science Park extension project. The EIA committed standard for copper ion in wastewater effluent is 0.8 mg/L, which surpasses the Drinking Water Standard in Taiwan. TSMC fabs constructed in this Park will also comply with this standard.

TSMC Wastewater treatment system
5.4.3 Air Pollution Control

Effective Treatment Based on Waste Air Specification

TSMC’s air pollution control strategy is to optimize process to reduce pollutants in air exhaust, and then to abate pollutants in air exhaust through high-efficiency equipment to comply with or surpass legal requirements. Air pollutant concentrations in TSMC’s exhaust are far below the standards required by Taiwan’s EPA, according to actual measurements performed over the years.

Wafer fabs emit three major types of exhaust: acid exhaust, base exhaust, and volatile organic compounds. Heat exhaust emitted by process equipment does not cause air pollution. Air pollution control systems depend on various categories and characteristics of pollutants. TSMC installs local scrubbers behind process tools in order to treat toxic, flammable, and PFC gases. First, high temperatures or other physical and chemical measures are used to significantly reduce the concentration of pollutants in tool exhaust. The gas is then inducted to central waste gas treatment equipment for endpoint treatment. Endpoint treatment includes zeolite-rotary-wheel absorbing equipment for volatile organic compounds (VOC) treatment and wet scrubber equipment for acid or base gases.

Stable Operation, Continuous Monitoring

The performance of all TSMC fabs, including overseas facilities, is fully compliant or exceeds the air pollutant emissions standards in the areas where they operate. TSMC has deployed high-performance air pollution control equipment with at least N+1 backup systems so that all pollution control equipment can continue waste gas control 24 hours a day, 365 days a year in case of equipment breakdown. Operational status of all TSMC air pollution control systems is monitored 24 hours a day by shift personnel. Data collected by system efficiency monitoring have been classified as an important tracking item in order to ensure air exhaust quality. In 2009, we added an electronic quarterly air pollution report system that can automatically confirm the accuracy of declarations.

To ensure normal equipment operations and reduce abnormal pollutant emissions, TSMC has installed backup systems, including power generation, to back up malfunctions of operation equipment. TSMC has also installed backup fuel supply systems for VOC pollution control equipment that will engage if the original fuel supply systems experience difficulties.

Air Emissions Record

In 2014, the average removal efficiency of VOC exhaust remained at a relatively high level of 95% in TSMC’s Taiwan fabs and 93.5% in overseas fabs, well above the standard for local regulations. TSMC’s VOC volume per 8-inch wafer equivalent per mask layer in 2014 decreased by 2.1% compared to 2013 from 0.153 g to 0.150 g. In addition, based on the Taiwan EPA’s formula for calculating SOx and NOx emissions, TSMC estimates that our NOx emission was 41.29 tons and SOx emission was 45.97 tons in 2014.

The issue of poor air quality caused by PM 2.5 (particulate matter of less than or equal to 2.5 um) has caused great concern in Taiwan recently. Although relatively little PM 2.5 is emitted or derived from the semiconductor manufacturing process, TSMC continues to pay attention and conduct self-assessments. Assessment results found that VOC incineration after absorption and concentration might emit very small quantities of PM 2.5, and is not a major source of air suspended particles compared to other industries. TSMC will continue monitoring PM 2.5 emission status and reduce its quantity as possible.
5.4.4 Waste Reduction and Resource Recycling

TSMC has transitioned from traditional waste cleaning and disposal to integrated resource management, and has a designated waste resources management unit to treat waste as valuable resources to be recycled as much as possible. In order to sustainably use our resources, the first priority of our waste management is reduction; the second is material recycling, followed by energy recovery, and finally disposal through incineration and landfill. TSMC carefully selects waste disposal and recycling contractors and performs annual audits of certification documents, and site operations. TSMC also adopts proactive actions to strengthen vendor auditing effectiveness. For example, all waste transportation contractors are requested to track their fleet through GPS in order to trace all cleanup transportation routes and abnormal stays. Approximately one third of contractors have complied as of the end of 2014. All contractors are expected to complete and join the system in 2015. In addition, all waste recycling and treatment vendors install CCTV in operation sites for review and auditing in tracing waste handling status. All these actions are to ensure legal and proper recycling and treatment of wastes.

TSMC has made great efforts in reducing raw materials usage with significant achievements in waste reduction and recycling over the past decade. Although the categories of waste are growing more complex, TSMC continues to develop new waste recycling technology with suppliers to raise its recycling rate and reduce waste disposed in landfills. TSMC's Taiwan sites continued to carry out reduction and recycling programs in 2014, and our waste recycling rate reached 93%, exceeding 90% for the sixth consecutive year, while our landfill rate was below 1% for the sixth consecutive year. Our overseas subsidiaries are also endeavoring to improve their waste recycling rates.

### Innovative 3R Waste Projects

In 2014, TSMC initiated several environmental programs which focused on raw chemical usage reduction, and reuse and recycling of used chemicals For example:

- **Sulfuric Acid and Peroxide Usage Reduction**: TSMC's process unit reduced usage of raw sulfuric acid and peroxide.

### TSMC VOC Emission

<table>
<thead>
<tr>
<th>Category</th>
<th>Scope</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Waste</td>
<td>Taiwan</td>
<td>24,688</td>
<td>25,523</td>
<td>33,158</td>
<td>42,180</td>
<td>61,026</td>
</tr>
<tr>
<td>Hazardous Waste</td>
<td>Taiwan</td>
<td>61,243</td>
<td>67,588</td>
<td>90,596</td>
<td>101,100</td>
<td>140,022</td>
</tr>
<tr>
<td>Waste Recycling Rate (%)</td>
<td>Taiwan</td>
<td>91.88</td>
<td>91.37</td>
<td>93.42</td>
<td>92.41</td>
<td>93.06</td>
</tr>
<tr>
<td>Waste Incineration Rate (%)</td>
<td>Taiwan</td>
<td>7.44</td>
<td>8.25</td>
<td>6.15</td>
<td>7.37</td>
<td>6.79</td>
</tr>
<tr>
<td>Waste Landfill Rate (%)</td>
<td>Taiwan</td>
<td>0.66</td>
<td>0.38</td>
<td>0.43</td>
<td>0.22</td>
<td>0.15</td>
</tr>
</tbody>
</table>

**Note:**
1. Hazardous wastes are defined by local governments.  
2. Overseas sites include TSMC China and WaferTech.
reduced waste produced at the same time. In 2014, a total of 5,760 tons of raw sulfuric acid and peroxide was saved, this also represents an equal weight or 5.9% reduction on waste sulfuric acid produced.

- Waste sulfuric acid on-site reuse: In TSMC, a waste sulfuric acid pretreatment system is being set up at all fabs to produce recycled sulfuric acid. This recycled acid is used on-site to react with ammonia waste to produce reusable ammonium sulfate. It is estimated that waste sulfuric acid will reduce 30,000 tons in 2015.

- Chemical Waste Recycling Technology Development: Work with supplier to recycle used developer chemical which can be re-used in other industrial processes to conserve natural resources and reduce ammonia waste. A total of 16,200 tons of developer chemical was recycled in 2014.

Computer Reuse and Recycling Campaign
TSMC fully supported ASUSTek Computer Inc.'s "Computer Reuse and Recycling Campaign", which has also received support from the Ministry of Economic Affairs. TSMC donated more than 58,128 used personal computers, notebook computers, and LCD monitors since 2007, making up one-third of the total amount received in this project to become the largest donor.

Our purpose in participating in this campaign is to promote the concept of material recycling. Through this recycling campaign, refurbished computers are donated to students in rural elementary and junior high schools and to disadvantaged minorities to narrow the digital divide, caring for society and protecting the environment at the same time.

5.4.5 Environmental Accounting
The purpose of TSMC’s environmental accounting system is to identify and calculate environmental costs for internal management. At the same time, we can also evaluate the cost reduction or economic benefits

### 2014 Environmental Cost of TSMC Fabs in Taiwan

<table>
<thead>
<tr>
<th>Classification</th>
<th>Description</th>
<th>Investment</th>
<th>Expense</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Direct Cost for Reducing Environmental Impact</td>
<td>(1) Pollution Control Fees for air pollution control, water pollution control, and others</td>
<td>7,435,572</td>
<td>3,632,331</td>
</tr>
<tr>
<td></td>
<td>(2) Resource Conservation Costs for resource (e.g. water) conservation</td>
<td>1,993,937</td>
<td>103,816</td>
</tr>
<tr>
<td></td>
<td>(3) Waste Disposal and Recycling Costs for waste treatment (including recycling, incineration and landfill)</td>
<td>0</td>
<td>698,703</td>
</tr>
<tr>
<td>2. Indirect Cost for Reducing Environmental Impact (Managerial Cost)</td>
<td>(1) Cost of training</td>
<td>273,800</td>
<td>209,085</td>
</tr>
<tr>
<td></td>
<td>(2) Environmental management system and certification expenditures</td>
<td>273,800</td>
<td>209,085</td>
</tr>
<tr>
<td></td>
<td>(3) Environmental measurement and monitoring fees</td>
<td>273,800</td>
<td>209,085</td>
</tr>
<tr>
<td></td>
<td>(4) Environmental protection product costs</td>
<td>273,800</td>
<td>209,085</td>
</tr>
<tr>
<td></td>
<td>(5) Environmental protection organization fees</td>
<td>273,800</td>
<td>209,085</td>
</tr>
<tr>
<td>3. Other Environment-related Costs</td>
<td>(1) Costs for decontamination and remediation</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>(2) Environmental damage insurance and environmental taxes</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>(3) Costs related to environmental settlement, compensations, penalties and lawsuits</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>9,703,309</td>
<td>4,439,017</td>
</tr>
</tbody>
</table>

### 2014 Environmental Efficiency of TSMC Fabs in Taiwan

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Cost Saving of Environmental Protection Projects</td>
<td>Energy saving: completed 158 projects</td>
<td>375,660</td>
</tr>
<tr>
<td></td>
<td>Water saving: completed 26 projects</td>
<td>50,666</td>
</tr>
<tr>
<td></td>
<td>Waste reduction: completed 6 projects</td>
<td>75,200</td>
</tr>
<tr>
<td></td>
<td>Material reduction: completed 164 projects</td>
<td>351,082</td>
</tr>
<tr>
<td>2. Real Income of Industrial Waste Recycling</td>
<td>Recycling of used chemicals, wafers, targets, batteries, lamps, packaging materials, paper cardboard, metals, plastics, and other wastes</td>
<td>361,957</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1,214,565</td>
</tr>
</tbody>
</table>
of environmental protection programs to promote economically efficient programs. With environmental costs expected to continue growing, environmental accounting can help us manage more effectively. In practice, environmental accounting measures define the various environmental costs and set up independent environmental account codes, then provide these to all units for use in annual budgeting. This online system can output data for environmental cost statistics.

Our economic benefit evaluation calculates cost savings for reduction of energy, water or wastes as well as benefits from waste recycling according to our environmental protection programs.

The environmental benefits disclosed in this report include real income from projects such as waste recycling and savings from major environmental protection projects. In 2014, TSMC fabs completed 350 environmental protection projects, and these benefits, in addition to benefits from waste recycling, totaled more than NT$1,215 million.

5.4.6 Environmental Management in TSMC Subsidiaries
TSMC requires our manufacturing subsidiaries, including TSMC China, WaferTech and TSMC Solar to have the same environmental management measures as TSMC. Subsidiaries are required to be consistent with our environmental policy and work standards. Our manufacturing subsidiaries have actively set up environmental management systems, and they conform with our practice of requiring facilities to obtain ISO 14001 certification within 18 months of mass production.

TSMC assists its non-semiconductor subsidiary TSMC Solar to assess risk for their specific wastewater, air emissions, wastes, and chemicals to ensure legal compliance. TSMC and its subsidiaries register various environmental performance indices in TSMC’s e-platform TSM (Total ESH Management) regularly for monitoring and management to pursue continuous improvement.

5.5 Environmental Dimension Special Topics

5.5.1 Green Products
TSMC collaborates with its upstream material and equipment suppliers, design ecosystem partners and downstream assembly and testing service providers to reduce environmental impact. We reduce the resources and energy consumed for each unit of production and are able to provide more advanced, power efficient and ecologically sound products, such as lower-power-consumption chips for mobile devices, high efficiency LED driver for Flat Panel Display Backlighting and indoor/outdoor Solid State LED lighting, and “Energy Star” low standby AC-DC adaptors, etc. In addition to helping customers design low-power, high-performance products to reduce resource consumption over the product’s life cycle, TSMC implements clean manufacturing practices that provide additional “green value” to our customers and our other stakeholders.

TSMC-manufactured ICs are used in a broad variety of applications covering various segments of the computer, communications, consumer, industrial and other electronics markets. Through TSMC’s manufacturing technologies, customers’ designs are realized and incorporated into peoples’ lives. These chips make significant contributions to the progress of modern society. TSMC works hard to achieve profitable growth while providing products that add environmental and social value. We have listed below several examples of how TSMC-manufactured products significantly contribute to society and the environment.

Environmental Contribution by TSMC Foundry Services

1. Providing New Process Technology to Achieve Lower Power Consumption:

- The continuous development of TSMC’s advanced semiconductor process technologies follows Moore’s Law, which holds that process technology moves forward one generation every 24 months. In each new generation circuitry line widths shrink, making circuits smaller and lowering the energy and raw materials consumed per unit area. At the same time, the smaller IC die size consumes less power. TSMC’s 28nm technology, for example, can accommodate approximately four times the number of electronic components as the 55nm technology. ICs made with 28nm technology in active or standby mode consume roughly one third the power of 55nm products, according to TSMC’s internal test results. The Company continuously provides process simplification and new design methodology based upon its manufacturing excellence to help customers reduce design and process costs.

- TSMC leads the foundry segment in technology, having achieved volume production at the 28nm node. TSMC’s 28nm processes include 28nm High Performance (28HP), 28nm High Performance Low Power (28HPL), 28nm Low Power (28LP), 28nm High Performance Mobile Computing (28HPM), and 28nm High Performance Compact Mobile Computing (28HCP). Customer 28nm production tape-outs are more than double the number of 40nm customer tape-outs. The TSMC 28nm process also has surpassed the previous generation’s production ramp and product yield at the same point in time, due in part to closer and earlier collaboration with customers. TSMC will continue to encourage customer designs that result in the most advanced, energy-saving, and environmentally friendly products. TSMC quickly ramped its 28nm technology. The 28nm contribution to wafer revenue grew significantly from 1% in 2011 to 33% in 2014. This reflects the fact that TSMC’s advanced manufacturing process technology helps the Company achieve both profitable growth and energy savings.
TSMC delivers performance-per-watt scaling in its 20nm SoC (20SoC) and 16nm FinFET Plus (16FF+) process technologies. With energy-efficient transistors and interconnects, the 20nm SoC process can reduce total power consumption of the 28nm process by one third, and by migrating from planar to FinFET technology, the 16nm FinFET Plus process can further reduce total power consumption to about 30% of 28nm technology. 20SoC technology entered the production stage with smooth ramping and stable yield performance. By introducing the advanced patterning technique, this process provides better density and power value for both performance-driven products and mobile computing applications migration. In addition, wafer revenue of 20nm SoC accounted for 9% of 2014 total wafer revenue. The 16nm FinFET Plus process entered risk production in 2014 and nearly 60 customer designs are scheduled for tape-out by the end of 2015.

2. Manufacturing Power Management ICs with the Highest Efficiency:

- TSMC’s leading manufacturing technology helps its customers design and manufacture green products. Power management ICs are the most notably green IC products. Power management ICs are the key components that regulate and supply power to all IC components. TSMC’s analog power technology research and development team uses 6-inch, 8-inch and 12-inch wafer fabs to develop Bipolar-CMOS-DMOS (BCD) and Ultra-High Voltage (UHV) technology, producing industry-leading power management chips with more stable and efficient power supplies and lower energy consumption for broad-based applications in the consumer, communication, and computer markets. TSMC’s BCD is the best fit technology for high efficiency LED driver for the applications of Flat Panel Display Backlighting and indoor/outdoor Solid State LED lighting. In addition, TSMC’s UHV with 400V-800V options is the best fit technology for Green Product applications, such as “Energy Star” low standby AC-DC adapters, Solid State LED lighting, high efficiency DC Brushless motors.
- TSMC also provides analog and power-friendly design platforms. Customers use these platforms to develop energy-saving products.
- Power management ICs generates material revenue to TSMC’s industrial market segment. In 2014, TSMC’s HV/Power technologies collectively shipped more than 1.8 million customer wafers. In total, the Power management ICs manufactured by TSMC for our customers accounted for more than one-third of global computer, communication and consumer (3C) systems.

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3. Green Manufacturing that Lowers Energy Consumption:
   - TSMC develops manufacturing technologies that provide more advanced and efficient manufacturing services. Improvements reduce per-unit energy consumption, resource consumption and pollutant generation. They also lower energy consumption and reduce pollution during product use. To see the total energy savings benefits realized through TSMC’s green manufacturing, please refer to “Environmental Accounting”.

Social Contribution by TSMC Foundry Services

1. Providing Mobile and Wireless Chips that Enhance Mobility and Convenience:
   - The rapid growth of smartphones and tablets in recent years reflects strong demand for mobile devices. Mobile devices offer remarkable convenience, and TSMC contributes significant value to these devices. For example, new process technology helps chips provide faster computing speeds in a smaller die area, leading to smaller form factors for these electronic devices. In addition, SoC technology integrates more functions into one chip, reducing the total number of chips in electronic devices, which also leads to a smaller system form factor. Second, new process technology helps chips consume less energy. People can therefore use mobile devices for a longer period of time, increasing their convenience. And third, with more convenient wireless connectivity such as 3G/4G and WLAN/Bluetooth, people communicate more efficiently with each other, can “work anytime and anywhere,” significantly improving the mobility of modern society.

2. Enhancing Human Health and Safety with MEMS (Micro Electro-Mechanical Systems):
   - TSMC-manufactured ICs are widely used in medical treatment and health care applications. Through the Company’s advanced manufacturing technology, more and more IC products are providing major contributions to modern medicine. Customers’ MEMS products are used in a number of advanced medical treatments. MEMS are also widely used in preventative health care, such as early warning systems that limit the number of injuries to the elderly resulting from falls, systems that detect physiology changes, car safety systems and other applications that greatly enhance human health and safety.

Environmental Dimension

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 OC 080000, TSMC ensures that products comply with regulatory and customer requirements, including:

- The EU Restriction of Hazardous Substance (REACH): 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). The new RoHS 2.0, 2011/65/EU in 2011 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.

- **Perfluoroctane 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 encourage and assist suppliers to set up greenhouse gas (GHG) inventory procedures. We collaborated with 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 2011. In 2011 and 2012, TSMC’s 8-inch and 6-inch wafer passed PAS2050 carbon footprint certification respectively, and can fulfill customers’ requirements. We continue to promote product carbon footprint standards and expect to complete certifications for all fabs in 2015.

**Integrated Circuit Product Carbon Footprint Example - BGA Chip**

<table>
<thead>
<tr>
<th>Raw Material Suppliers</th>
<th>TSMC Fab</th>
<th>Testing/Assembly Sites</th>
<th>TSMC Customers</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.074</td>
<td>0.4596</td>
<td>0.4662</td>
<td></td>
</tr>
</tbody>
</table>

**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. 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. TSMC Fab 12 and Fab 3 collaborated with major suppliers and completed 12-inch and 8-inch wafer product water footprint and received external certification. The international standard for product water footprint ISO14046:2014 was published in 2014, and has been tracked by TSMC ever since its draft version. We will continue to establish product water footprint for all TSMC fabs and to receive ISO14046 verification in 2015.

**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 poly-vinylchloride (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 mostly made from reused sources. These measures have reduced both packing material consumption and waste generation.

5.5.2 Enhance Internal and External Environmental Education

TSMC continues to raise employees’ environmental awareness through educational programs, including new employee training, E-learning, family day, and the annual “Loving the Earth Begins with Me” program. “Loving the Earth Begins with Me” program, in addition to professional environmental education courses, makes use of designated environmental bulletin boards in each fab as well as promotional materials in elevators, restrooms, and employee publications to embed environmental concepts in employees’ everyday work and life. “Green Love Earth,” is intended to develop water, power and waste reduction into daily habits. These convey environmental ideas that are reflected in our employees’ actions, and lead many departments to seek opportunities to conserve energy, save water, and reduce waste.

External promotional activities not only include green supply chain management, but also active collaboration with academia, industries and local governments in our operation sites around the world. We aim to use our influence as a corporation to protect the environment and to meet our corporate social responsibilities. In order to give employees easy access to up-to-date environmental knowledge, we maintain an internal environmental protection website which files related information and maintains links to global environmental protection-related websites.

5.5.2.1 Enhance Internal Environmental Education Activities

Enhance Environmental Laws Awareness of Employees

TSMC provides a range of expert knowledge, from legal to environmental protection, environmental protection managers in all factories to conduct environmental educational programs. It includes practices about the recognition of laws for air, water, waste, toxics and others, and declaration procedures and skills for verification to implement the PDCA process in environmental protection.

Continuous Promotion of Internal ESH Competition

TSMC added an Environmental, Safety & Health (ESH) Award to its ongoing “Total Quality Excellence (TQE)” campaign to encourage employees to continuously improve ESH performance. The ESH award competition was also presented in the annual TQE Forum for sharing. There were a total of 557 ESH improvement cases selected in 2014, and 6 out of these 557 cases were selected for final competition in the Forum. The habits and methods of continuous ESH improvement are embedded in the daily tasks of employees in each facility through this ESH award competition and experience sharing.

5.5.2.2 Actively Participate in External Environmental Education Activities

“Eying the World” Program for Elementary Schools in Remote Areas of Hsinchu County

The “Endowing old things with new lives, eying the world” program by TSMC collected second-hand cameras from TSMC colleagues and
Environmental Dimension 86

Environmental Education, Low Carbon and LOHAS Summer Camp in Hsinchu County

TSMC assisted the Hsinchu County government to plan the 2014 Low Carbon and LOHAS Summer Camp, it consisted of four diversified educational programs for students to learn the knowledge about low carbon life and to practice it in daily life through playing, which includes the first day of green life for students, environmental protection DIY, interactive games about low carbon and outdoor teaching. The summer camp was divided into five stages with 1,000 children participating. This program complemented the "New Good Food Movement," to substitute for the 8,800 kilogram carbon dioxide produced by the summer camp to achieve the target of “Carbon-Neutral.”

Assistance for the Recognition of Environmental Education Facilities in Hsinchu County

TSMC continued to cooperate with the government of Hsinchu County with the application for EPA recognition of environmental education facilities in the “Zhudong Touqian River Ecological Park” from 2012 to 2013, which completed seven environmental education certifications and brought the communities, schools and public agencies in Hsinchu County the convenient and diversified teaching conditions of environmental education. By cooperating with the government of Hsinchu County the “Seeing Taiwan – Love at Touqian River – Teacher’s Training Camp” in 2014, through four teaching and training processes,
Conducting “A Journey of Graduation, Thanksgiving and Love Passing” of Jin Shan Elementary School in Remote Areas in Hsinchu County

TSMC continued to cooperate with Jin Shan Elementary School in Remote Areas in Guanxi Township in Hsinchu County. In 2013, we hosted an “A Journey of Graduation, Thanksgiving and Love Passing” with concepts of environmental sustainability for 27 graduates. From school, Roman Highway, to Mawudu Forest, the distance was about 8 km, we offered activities like the lessons on local ecology, caring the elderly who lived alone in the community, and inviting children to get closer to their local native land. Enthusiastic parents prepared food, which allowed children to learn the niceties of being a good guest as well. Finally, we prepared the local food in season in Mawudu Forest to build a new feast of green happiness. We continued conducting “A journey of Graduation, Thanksgiving and Love Passing” for 19 graduates in 2014, which added a journey of music appreciation to expose children to new and different music.

Deepening Environmental Education for Saving Water

TSMC and South Region Water Resource Office, WRA, MOEA cooperated to examine the facilities for water and energy saving of Ceng Lin Elementary School to respond the “South Philosophy of Water” idea in practice. It allowed students to be acquainted with the ample and diversified environment and ecology of Zengwen Dam and to understand more about the dam which was responsible for water provision and flood protection. Children also became pioneers of environmental education for Zengwen Dam; they not only experienced the dam’s importance as a water reservoir, but also their close connection with the water environment, which could build a sustainable environment for humans and all kinds of ecology.

Environmental Education about Green Architectures for Junior High School and Elementary School

TSMC assisted four elementary schools in remote areas in Hsinchu County, Jin-Shan, Shi-Guang, Fu-Guangan and Jian-Shi, and 26 principals or teachers to conduct environmental education about green architectures. Its courses consisted of introduction to green ecological park and a guided tour of the ecological educational park. For teachers, it gradually promotes and develops the environmental sustained idea “Low Carbon, LOHAS and Green Earth,” from top to bottom. Teachers also led children to complete the TSMC green ecological education course.

The National Competition for Environmental Protection Volunteers

TSMC assisted the Hsinchu County government to hold the sport competition of environmental protection volunteers. By combining competition and carnival, it helped environmental protection volunteers and people to learn about environmental protection and put it into effect. The games were held in Hsinchu County Stadium. Among the 22 teams and 2000 environmental protection volunteers in “The National Competition for Environmental Protection Volunteers,” TSMC helped the Hsinchu County government to win third prize nationwide.

Love Sharing, Environmental Education for Pollution Control and Disaster Prevention

TSMC shared with public agencies and schools the culture of environmental protection, safety and hygiene of TSMC. TSMC took the lead to offer professional assistance and consultation by its practical experience of management. Through pollution protection, experience sharing for basic measurements in emergency and commanding for disaster relief, visiting and observation on site, practice planning and tutorship on site, it helped SMCs in the park to construct their self-management of environmental protection, safety and hygiene, reinforced disaster relieving measures and allowed students to understand and learn more about how firms implement public nuisance protection and disaster relief. It also helped to accomplished sharing for ISHA and other four companies, 19 people in total, two company tutors on site, annual practice for measurements in an emergency, 30 person-time observations and 43 person-time observations from the Institute of Occupational Medicine and Industrial Hygiene, National Taiwan University, and the Department of Safety Health and Environment Engineering, National United University.
5.5.2.3 Environmental Protection Promotion Activities in TSMC Subsidiaries

TSMC subsidiaries TSMC China Ltd. and WaferTech also continue to raise employees’ environmental awareness, and maintain good relationships with local communities through environmental protection promotion activities, as described in the following.

At the beginning of the New Year in 2014, TSMC China together with a local volunteer association in Songjiang District, collected second-hand clothes for renovation or recycling. The total collected over three days was 1,450 pieces of clothing. The activity not only showed love to the less-fortunate people in designated communities but also recycled used clothes for environmental protection.

On September 2014, over 10 volunteers of TSMC China went to Songjiang Old City Area to promote the Car Free Day for two consecutive years, which seeks to raise citizen’s environmental awareness. Nearly 300 citizens participated for more than 2 hours, and the participants were aware that riding bikes or taking buses were environmentally friendly for short trip.

TSMC’s U.S. subsidiary WaferTech actively recycles, conserves energy and reduces waste. In 2014, WaferTech held its thirteenth annual Earthweek event, which seeks to raise employee’s environmental awareness through recycling activities, displays and promoting alternative transportation. WaferTech employees recycled over 6,000 pounds of electronics during the Earthweek event.