A Practitioner of Green Power

TSMC aims to set the standard for in environmental protection by seamlessly integrating green practices into daily operations. The Company uses innovative technologies to address climate and energy, water stewardship, circular resource management, and air pollution control. TSMC champions comprehensive sustainable actions to strengthen environmental protection, driven by its commitment to coexist and thrive with the Earth's ecosystem.

Climate and Energy | Water Stewardship | Circular Resources | Air Pollution Control

Reclaimed Water

Successfully integrated into 5nm and 3nm manufacturing processes

Zero Waste Manufacturing Center

Launched and projected to reduce annual outsourcing of waste processing by 130,000 metric tons

0

Abnormal occurrence: No incidents reported in air pollution control equipment

Climate and Energy

Strategies	2030 Goals	2025 Targets	2024 Achievements
Strengthen Climate Resilience Develop climate change response and measure to reduce the impact of climate risks	0 days of production interruption due to climate disasters	0 days of production interruption due to climate disasters	**0 days of production interruption due to climate disasters** ✓ Target: 0 days
Drive Low-carbon Manufacturing Continue to use best available technology to reduce emissions of greenhouse gases (GHG) and become an industry leader in low-carbon manufacturing	Reduce unit GHG[Note 1] emissions by 30% compared to the base year (metric ton of carbon dioxide equivalent ($MTCO_2e$)/12-inch equivalent wafer mask layer) by 30%, and restore GHG emissions to the 2020 level (Base year: 2020)	Reduce unit GHG emissions (metric ton of carbon dioxide equivalent ($MTCO_2e$)/12-inch equivalent wafer mask layer) by 10% (Base year: 2020)	**Increased unit GHG emissions (metric ton of carbon dioxide equivalent ($MTCO_2e$)/12-inch equivalent wafer mask layer) by 19%** —[Note 2] Target: 10% (Base year: 2020)
Use Renewable Energy Continue to purchase renewable energy and install solar-energy power systems to achieve target of 100% renewable energy use	60% of the electricity consumption at all company operational sites comes from renewable energy	20% of the company's total electricity consumption comes from renewable energy, while overseas subsidiaries use 100% renewable energy	**TSMC overseas sites used 100% renewable energy[Note 3]; accounting for 14.1% of TSMC's power consumption** ↑ Target: TSMC overseas sites used 100% renewable energy; accounting for 13% of TSMC's power consumption
Increase Energy Efficiency Plan and implement new energy-saving measures each year to increase energy efficiency	Cumulative energy-saving rate reaches 18% between 2016 and 2030 through new energy-saving measures	15.5% cumulative energy-saving rate	**Cumulative energy-saving rate reached 15%** ✓ Target: 15%
	Double energy efficiency after five years of volume production for each process technology[Note 4]	Energy efficiency of 3nm process technology increases by 0.2 times in the 2nd year of volume production	**Energy efficiency of 5nm process technology was 0.6 times higher in the 5th year of volume production** —[Note 2] Target: Energy efficiency of 5nm process technology doubles in the 5th year of volume production

Applicable to all TSMC fabs around the world | Applicable to TSMC fabs in Taiwan and other specific fabs | Only applicable to TSMC fabs in Taiwan | Applicable to TSMC overseas fabs | ↑ Exceeded | ✓ Achieved | — Missed target

Note 1: The statistical data covers the Scope 1 and Scope 2 GHG emissions. The categories of GHGs include CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, and NF_3.

Note 2: For the reason for the failure, please refer to "Drive Low-carbon Manufacturing."

Note 3: Definition of renewable energy use: Self-generated renewable energy, purchased renewable energy, renewable energy certificates, and carbon credits produced by renewable energy

Note 4: Energy efficiency is the product equivalent per kWh of power. (12-inch equivalent wafer mask layer/kWh)

To reach the target of net zero emissions by 2050, TSMC promised to accelerate the progress of RE100, procure high-quality carbon credits, and implement various energy conservation and carbon reduction measures. In 2024, the Company promoted the "roof-mounted PV procurement project" and "maximal renewable energy installation project for existing fabs" to expand the areas for PV installation, and the renewable energy consumption throughout the year increased to 3,610GWh. The same year, the Company also joined the EC jointly initiated by the SEMI and SCC to promote development of sustainable energy. Furthermore, TSMC plans to mark 2025 as reference year to achieve the absolute reduction requirements set in the Paris Agreement by proposing plans that comply with the SBTi in 2026.

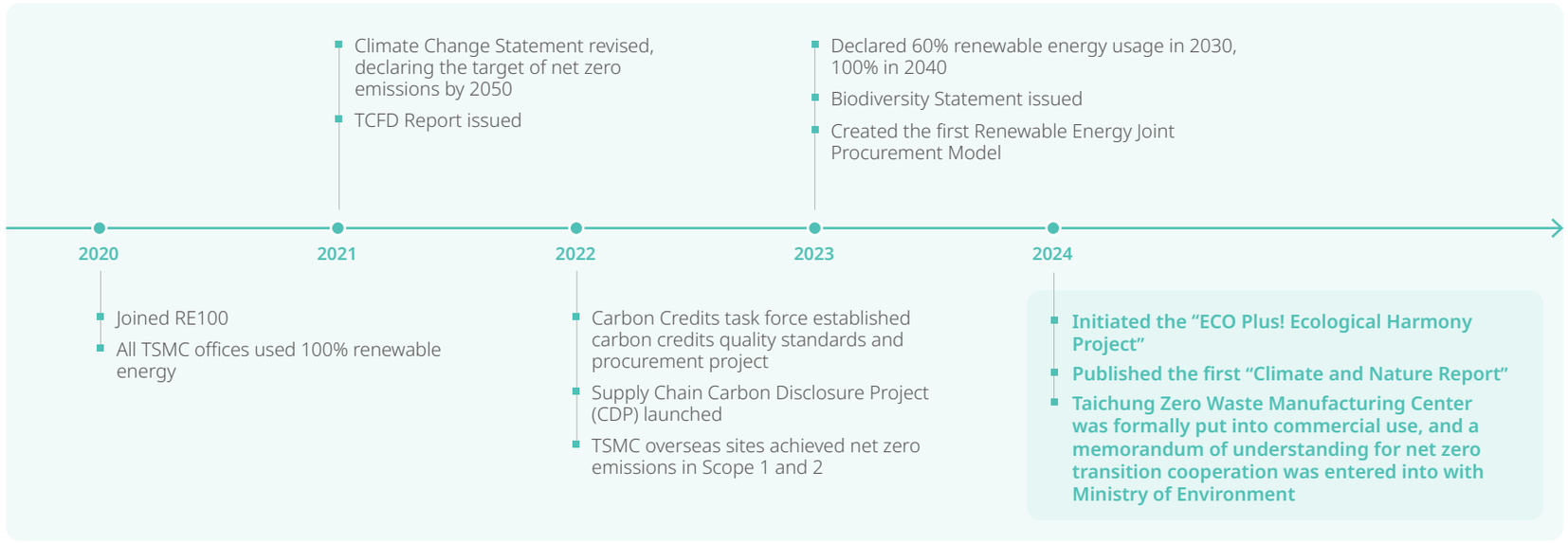
Facing impacts on the eco-environments caused by climate change, TSMC also initiated the "Eco Plus! Ecological Harmony Program" in 2024 and published the first "Climate and Nature Report " to strengthen biodiversity conservation actions. For supply chain management, TSMC formulated the "TSMC Supply Chain Carbon Reduction Action Strategy " and required major emission contributors to sign the GHG emissions reduction agreement, driving the green transition of the overall industry chain and working together to achieve net zero sustainable development.

Strengthen Climate Resilience

In light of intensifying global weather conditions, resilience in disaster response is the key to sustainable business operations. According to the "Global Risk Report " published by the WEF in 2025, environmental-related risks account for 50% of the top ten global risks over the next decade, making them the highest proportion. These include the top four risks: Extreme Weather Events, Biodiversity Loss and Ecosystem Collapse, Critical Changes to Earth Systems, Natural Resource Shortages, and the tenth-ranked, Pollution."

Through regular and systematic risk assessments, TSMC identifies potential impacts and opportunities, actively implementing the "climate risk adaptation standards," to mitigate the potential effects of climate-related disasters. In 2024, TSMC successfully achieved its goal of zero production interruptions. To improve the organization's climate resilience, TSMC will include Water Positive in its core strategy to respond to climate change. In 2024, the Company continued to increase reclaimed water consumption and planned to establish a reclaimed water plant in TSMC Arizona. Meanwhile, TSMC reinforced the technology of recycling and reuse of waste resources through the Taichung Zero Waste Manufacturing Center and developed electronic-grade chemicals in cooperation with suppliers to be reused by TSMC and strived to implement a business model that facilitates environmental sustainability.

Summary of Response Measures for Climate Change



Identify Climate/Natural Risks and Opportunities

TSMC convenes representatives from internal departments and external experts every two years to identify and update climate-related risks and opportunities based on the framework of the Recommendations of the TCFD. During the workshop held in 2024, in addition to recognizing the physical climate risks associated with typhoons, TSMC introduced ten nature-related risks and four nature-related opportunities to assess and reduce the Company's dependency on and impact to the natural environment. This was done to conduct materiality identification effectively.

Opportunities and Response Strategies for Climate/Nature Risks – Transition Risks

Transition Risks

Risk / Opportunity	Crucial Countermeasures
Total GHG emissions and carbon taxes/carbon levy Renewable Energy Regulations and Procurement Taiwan is estimated to charge additional recycling facilitation fees in response to amendments of regulations NEW Participate in renewable energy programs / Participate in carbon trading markets	Set aggressive carbon reduction targets: commit to net zero emissions from global operations by 2050 Establish a renewable energy task force to collaborate with related associations and government agencies to accelerate the development of renewable energy and realize green energy diversification strategy Work with associations to propose suggestions to the government about building a carbon credit market
Net zero emissions Turn to technologies/business directions with low impacts on nature NEW Obtain rewards and cooperation from the public sector Develop low-carbon products and services; increase energy efficiency in customer products	Map out the Company's net zero emissions roadmap, formulate net zero emissions strategies, and enforce related measures Continue carrying out GHG reduction actions and participate in government carbon offset programs for carbon reduction to earn carbon credits Establish carbon credit purchase strategy and implement net zero measures for overseas fabs Continue investing in R&D resources to develop energy-saving products
EIA commitments Reputational risk at the EIA stage due to negative impacts on nature NEW Promote water efficiency and diversification Transition to the operation of recycling and reuse to reduce the dependence and impacts on nature NEW	Diversify water sources and increase using reclaimed water Strengthen water resource management and continue to expand for AWS certified fabs
Uncertainties in new energy-saving/carbon reduction technologies Improve plant energy efficiency Transition to high-efficiency production for the reduction of dependence and impact on nature NEW	Continue to promote energy-saving and carbon reduction actions and track facility outcomes every quarter through the Energy Saving and Carbon Reduction Committee Build green factories, obtain green building certificates, and share experiences with external parties
Impact on corporate reputation Reputational risk from failing to meet nature-related commitments NEW Reputational risk due to suppliers' negative impacts on nature NEW Enhance corporate reputation	Stick to green manufacturing and green innovation, and enhance the Company's green image through transparent disclosure
Increase in the attention paid to nature issues by customers/investors NEW Nature-positive actions that support ecological restoration and boost brand value NEW Recover/protect/conserve ecosystems or habitat NEW	Establish a biodiversity team to carry out relevant evaluations of biodiversity and initiate the "Eco Plus! Ecological Harmony Program" to promote seven biodiversity protection and promotion actions by adopting habitat, species, and knowledge as the three major aspects Publish the "Climate and Nature Report" to disclose biodiversity conservation strategies and actions

The identification results indicate that the top three risks related to climate issues are: "Net zero emissions, environmental impact assessment commitments, and the uncertainties of the development of new energy-saving and carbon-reduction technologies." The top three opportunities are: "Promoting low-carbon green production, developing low-carbon products and services/improving customer product energy efficiency, and enhancing resilience against natural disasters." For nature-related issues, the top three risks are: "Shifting towards technologies/operations with low environmental impact, reputational damage caused by negative impacts on nature (direct operations — environmental impact assessments for expansion), and reputational damage caused by negative impacts on nature (direct operations — corporate commitment goals)." The top three opportunities are: "Transforming into highly efficient production to reduce dependency on and impact on nature, restoring/protecting/conserving ecosystems or habitats, and enhancing corporate reputation through actions that promote positive growth for nature (ecosystem restoration)."For detailed measures addressing each risk and opportunity, please refer to the "TSMC Climate and Nature Report ."

Opportunities and Response Strategies for Climate/Nature Risks – Physical Risks

Physical Risks

Risk / Opportunity	Crucial Countermeasures
Floods (TSMC operations) Floods (supply chain) Droughts (TSMC operations) Droughts (supply chain) Typhoons (TSMC operations) NEW Typhoons (supply chain) NEW Shortage in water resource supply NEW Increase resilience against natural disasters	Assess flood and drought risks at fabs, formulate and carry out risk mitigation measures Request suppliers to evaluate the flood and drought risks of their operational facilities and implement risk reduction actions Establish comprehensive water monitoring system and emergency response processes and hold regular drills Establish and implement fab typhoon monitoring system, pre-typhoon inspection measures, and emergency response procedures Require suppliers to establish typhoon monitoring system, pre-typhoon inspection measures, and emergency response procedures Promote industrial reclaimed water, civil reclaimed water, and diverse water resource development to reduce regional water consumption pressure
Rising temperature Drive low-carbon green manufacturing	Establish the Energy Saving and Carbon Reduction Committee, led by senior executives, to reduce greenhouse gas emissions
Impact of air composition in external environments of new fabs NEW	Confirm the equipment procurement specifications of new fabs in advance through data collection and analysis to avoid equipment performance risks during the operating stage
Shortage of renewable energy supply NEW Damage to environments caused by the supply of renewable energy NEW	Evaluate diverse renewable energy sources Include the development conditions for renewable energy sites into the scope of ecological check and evaluation Examine whether the site has any potential impact when purchasing renewable energy; if yes, require the energy supplier to adopt corresponding protective measures

Identification of new nature-related risks and opportunities by TSMC in 2024.

TSMC Climate and Nature Management Framework

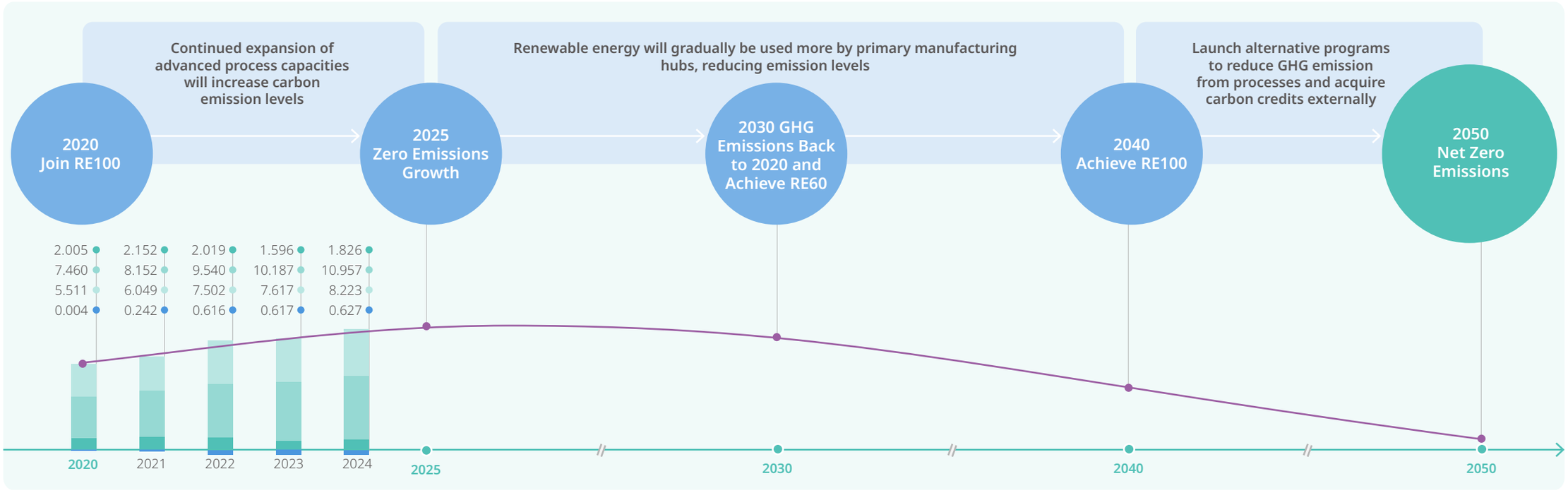
	Corporate Management Strategies and Actions	2024 Execution Summary
Governance	• The Board will regularly review risks and opportunities related to climate change	✓ Review the implementation progress at each stage for increasing the renewable energy usage ratio ✓ ESG Steering Committee confirmed the application for SBT and provided instructions to departments to formulate the implementation plan and financial project NEW ✓ Energy Saving and Carbon Reduction Committee defined the five major energy conservation teams and adopted the achievement rate of annual energy conservation targets and the level of innovation for energy conservation ideas as the indicators to encourage the inspiration and implementation of energy conservation measures ✓ The chairperson of Risk Management Steering Council reported to Audit and Risk Committee regarding the net zero transition, water resources, power supply risks, natural disasters, regulations, and other issues of the Company related to climate change
Strategies	• Organize interdepartmental discussions and identify short-, mid-, and long-term climate risks and opportunities	✓ Planned and carried out 1,177 energy-saving measures across eight major categories, saving additional 810 GWh. See "Increase Energy Efficiency" for more information ✓ Promoted "Green Energy for Charity Project" to install photovoltaic (PV) systems for charity organizations and schools in remote townships. See "Renewable Energy Systems" for more information
	• Assess the potential financial and operational impact on TSMC from major climate risks and opportunities	✓ Completed financial impact qualitative assessment of major climate risks and opportunities and implemented financial impact quantitative assessment of financial impact of major climate risks. See "TSMC Climate and Nature Report" for more information
	• Conduct scenario analysis and assess SBT and net zero emission reduction blueprint and actions	✓ See "TSMC Climate and Nature Report" for more information
	• Assist suppliers in enhancing awareness and adaptability to climate risks, develop and implement specific carbon reduction actions	✓ Required major emission contributors to execute GHG emission reduction agreement and commit to the reduction targets NEW ✓ Implemented "TSMC Supply Chain Carbon Reduction Action Strategy" to assist suppliers in achieving the carbon reduction targets NEW
Risk Management	• Use TCFD and TNFD frameworks to develop a process for identifying climate/nature risks NEW	✓ Evaluated the qualitative and quantitative financial impact of major climate/nature risks/opportunities discussed in the climate/nature risk/opportunity workshop
	• Set up and implement response measures based on climate risk identification and prioritized result	✓ Reported assessment results of the climate risks/opportunities and response plans to the ESG Committee Chairperson
	• Integrate climate risk identification and assessment in the ERM process	✓ See "6.2 Risk Management" in the annual report for more information
Metrics and Targets	• Set management indicators related to climate change	✓ See "Climate and Energy Strategies, Goals, and Outcomes" for more information
	• Through ISO 14064 annual inventory and disclosure of GHG emissions, review the impact on the Company's operations and assess the risks of Scope 1, Scope 2, and Scope 3 and related mitigation strategies	✓ Continued to implement carbon reduction measures based on various inventory and evaluation results. See "Drive Low-carbon Manufacturing" for more information
	• Set climate change management targets and review progress and performance	✓ Set climate and energy targets for 2030 to have implementation performance regularly reviewed by senior executives. See "Climate and Energy Strategies, Goals, and Outcomes" and "GHG Reduction Standard Practices" for more information

Drive Low-carbon Manufacturing

TSMC reviews its overall carbon reduction efforts through the GHG inventory results certified by a third party annually. In 2024, the Company's total GHG emission was 21,006,442 tCO_2e. Direct emissions from Scope 1 processes, such as F-GHGs and nitrous oxide processes, accounted for 9%; indirect GHG emissions in Scope 2 from electricity use, which was the major emission source, accounted for 52%; indirect GHG emissions from the value chain in Scope 3 accounted for 39%, mainly from upstream activities related to raw materials production, energy, and transportation. In response to the increase in the production capacity in advanced processes, GHG emissions increased by 8% from the preceding year, and emissions per unit product increased by 19% from the preceding year, which failed to achieve the annual target. TSMC will continue to enhance the introduction of various energy conservation and carbon reduction measures and increase the consumption of renewable energy .

TSMC continues to implement GHG reduction standard practices. In 2024, the Company replaced and newly installed 3,436 local scrubbers on the manufacturing end, used carbon-neutral natural gases to reduce direct emissions of 390,000 tCO_2e, added nine new green factories with green building certificates, with a cumulative of 51 factories obtaining the LEED Gold Certification or above in 2024. As for reduction actions for scope 3, TSMC established "TSMC Supply Chain Carbon Reduction Action Strategy " that comprises "performance tracking, support provision, motivation improvement, and innovative cooperation" in the hope of realizing decarbonization and creating a green semiconductor industry chain.

Roadmap to Net Zero Emissions



GHG Reduction Standard Practices

Scope 1
Direct GHG Emissions

Processes that use F-GHGs and nitrous oxide

- Optimize gas quantity used in production
- Low Global Warming Potential Gas Substitution Project
- Install Point-of-Use abatement equipment for F-GHG and nitrous oxide
- Use carbon-neutral natural gas

3,436 Units	Fully installed equipment with reduction technology for the newly established F-GHGs and nitrous oxide processes
96%	Installed/replaced 44 units of equipment with reduction technology for the existing F-GHG processes, and the reduction rate of F-GHGs reached 96%
390,000 Metric tons	Fabs in Taiwan recorded 0 emissions from the consumption of natural gases and reduced carbon by 390,000 metric tons

Scope 2
Indirect GHG Emissions (From Purchased Energy)

Energy usage

- Build green buildings
- Enhance energy usage efficiency
- Use renewable energy
- Incorporate energy-saving and low-carbon emission designs into next-generation process equipment

1	The green building verified area won the No. one in global semiconductor industry; together with the newly added certification of nine buildings, achieved the accumulated total of 51 LEED buildings and 31 EEWH buildings certifications, respectively
1,177 Items	The energy efficiency of advanced technology processes was more favorable than peers with similar technologies [Note 1]. TSMC implemented 1,177 items of energy saving measure and effectively conserved 810 GWh of power, equivalent to a carbon reduction of nearly 400,000 metric tons
1	The Company introduced the unique Next Generation Semiconductor Manufacturing Tool Energy Conservation Project worldwide, completed a total of 236 energy saving projects, and conserved a total of 1,000 GWh of power
3,610 GWh	TSMC consumed approximately 3,610 GWh of renewable energy worldwide, accounting for 14.1%

Scope 3
Indirect GHG Emissions (Value Chain)

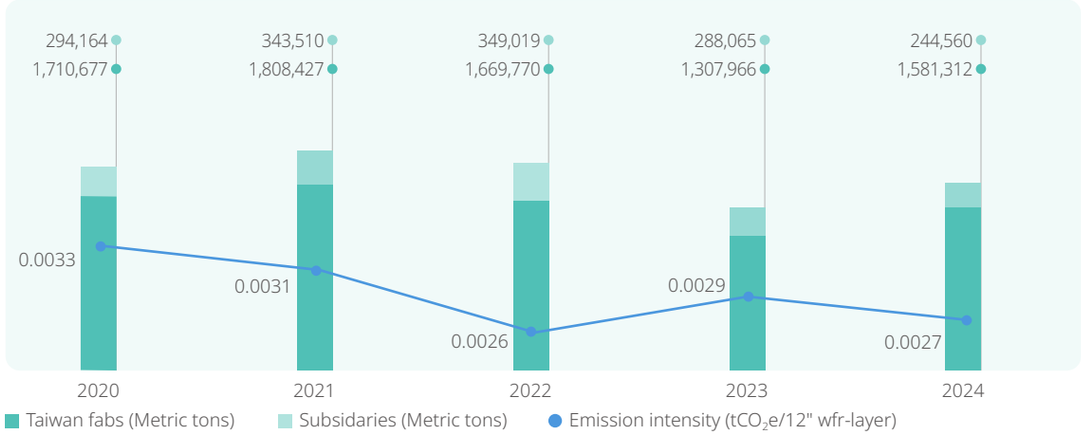
Raw material production, energy-related activities upstream, and transportation

- Require suppliers to pass the external verification
- Raw material carbon footprint reduction
- Participate in the CDP supply chain project
- Optimize transportation scheduling
- Carbon reduction subsidy project

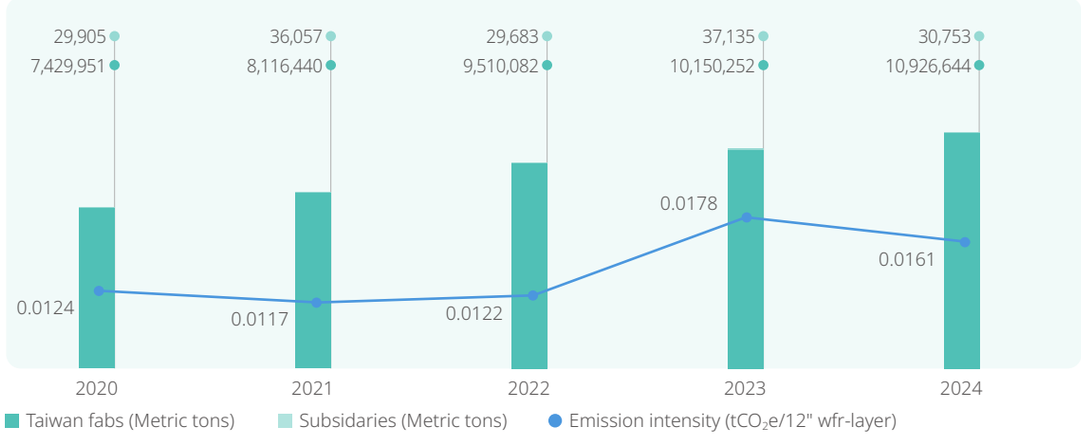
90%	High energy consumption suppliers [Note 2] shall pass GHG inventory and third-party verification, and the verification rate reached 91%
107,000 Metric tons	Guided suppliers to set energy saving targets and take actions; achieved an additional annual energy conservation of 217 GWh, equivalent to a carbon reduction of 107,000 metric tons
100%	Invited critical material and equipment suppliers [Note 3] to disclose carbon reduction targets and progress with a response rate of 100%
14,000 Metric tons	Improved the delivery schedule for processing tools and replaced air freight with ocean freight, reducing GHG emissions by 14,000 metric tons
450,000 Metric tons	Provided a subsidy of NT$84 million to support suppliers in replacing or purchasing new equipment. A total of 26 suppliers passed the evaluation and brought an overall carbon reduction investment amount of NT$5.5 billion and a carbon reduction of 450,000 metric tons

Note 1: Figures from the Joint Steering Committee (JSTC) report of the World Semiconductor Council
Note 2: High Energy Consumption Suppliers: Suppliers that use power more than 5GWh/year in a single factory
Note 3: Definition of critical material and equipment suppliers: Suppliers accounting for the top 85% of material and equipment purchasing expenses

Scope 1 GHG Emissions

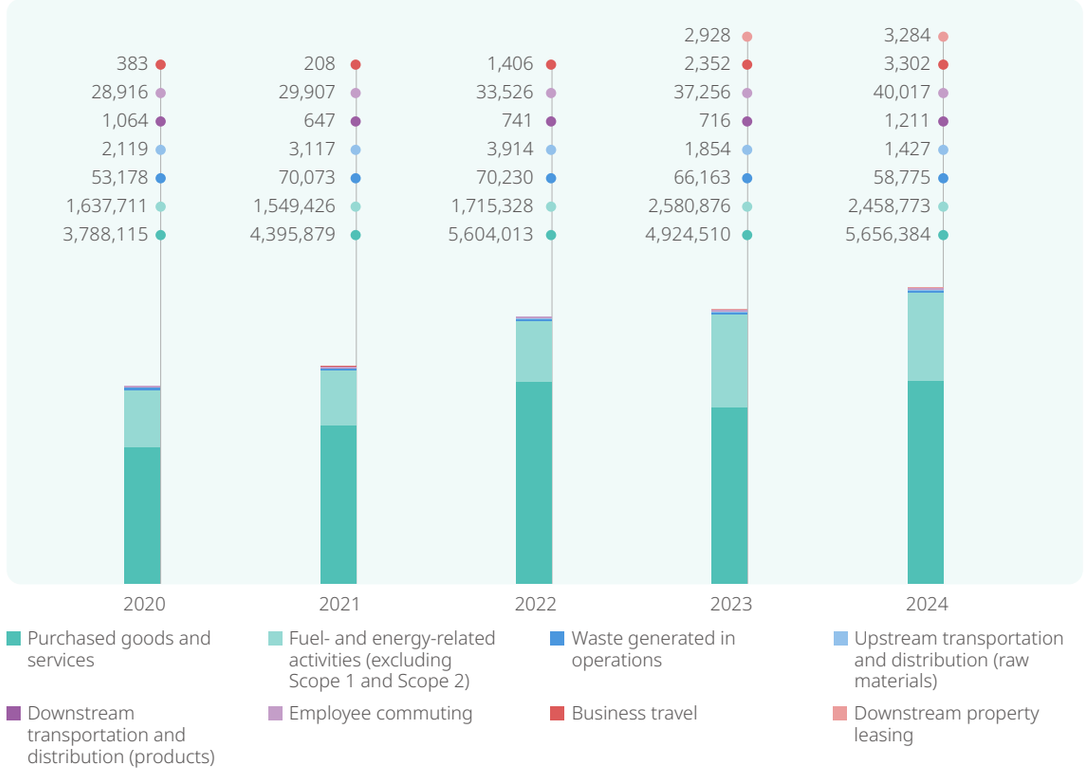


Scope 2 GHG Emissions



Scope 3 GHG Emissions

Unit: Metric tons



Note 1: The GHG emissions data for Scope 1 and Scope 2 include the parent company and all subsidiaries of TSMC.

Note 2: Scope 1 inventory data adopted business control approach as the inventory basis; 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories IPCC Fifth Assessment Report (GWP 100) were applied from 2020 to 2024.

Note 3: GHG emissions data for Scope 3 covered TSMC fabs in Taiwan (including the R&D Center and Zero Waste Manufacturing Center), TSMC (China), TSMC (Nanjing), TSMC Washington, LLC, JASM, TSMC Japan 3DIC R&D Center, and VisEra.

Note 4: In term of electricity emission factor, TSMC fabs in Taiwan (including the R&D Center) and VisEra adopted 0.494 kg CO_2e/kWh as announced by Ministry of Economic Affairs in 2023; TSMC (China) adopted average emission factor of power grids in Shanghai City of 0.5849 kg CO_2e/kWh in 2022; TSMC (Nangjing) adopted national electricity average emission factor of 0.5366 kg CO_2e/kWh; TSMC Washington, LLC adopted average emission factor of 0.288 kg CO_2e/kWh based on the electricity grids in the western and northwestern regions of the United States; JASM and TSMC's 3DIC R&D Center in Japan adopted Tokyo electric power's emission factor of 0.408 kg CO_2e/kWh.

Product Carbon Footprint

TSMC conducts carbon footprint and water footprint assessments every three years and has passed ISO 14067 and ISO 14046 verifications. According to the results of the carbon footprint assessment in 2024, the wafer manufacturing stage had the greatest environmental impact, accounting for 84%, while the raw material stage accounted for 16%. The carbon footprint of products across various technology nodes in mature process fabs (7nm and above) increased compared to 2020, primarily due to global economic downturn in 2023, which led to lower-than-expected capacity utilization rates, and the expansion of the raw material inventory scope. The carbon footprint of the advanced 5nm process decreased compared to the previous assessment, primarily owing to the increased demand for advanced processes and the successful implementation of energy saving and carbon reduction measures. Regarding the unit wafer water footprint, both mature and advanced process fabs showed reductions compared to 2020. For further analysis of water consumption and water quality indicators, please refer to "Product Water Footprint ".

In 2024, TSMC adopted the "Carbon Handprint" conceptual methodology proposed by Finland's VTT Technical Research Centre and Lappeenranta University, supported by the CLC. Unlike the carbon footprint, which primarily evaluates the carbon emissions generated during an organization's operational processes, the carbon handprint is used to measure an organization's positive contributions to reducing carbon emissions. According to estimates from Taiwan's ISTI, referencing studies from the ACEEE and Oxford Economics, TSMC's reduction of 400,000 metric tons of carbon emissions during its production processes, combined with the energy-saving effects enabled by ICT products utilizing TSMC chips in six major smart applications , contributed to saving 141 billion kilowatt-hours globally in 2024. This is equivalent to reducing 59.62 million metric tons of carbon emissions, representing the positive impact of TSMC's carbon handprint.

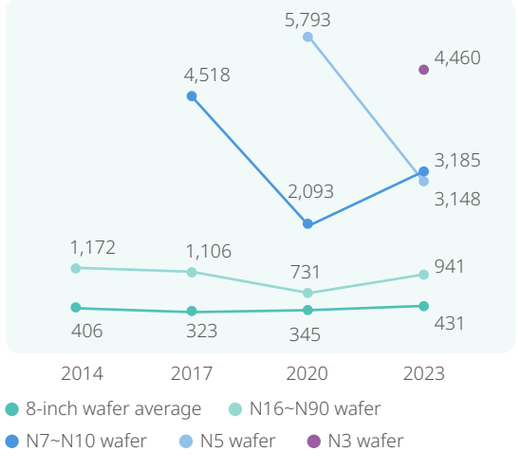
Sources of Carbon Handprint

- Improving energy and resource efficiency during product manufacturing to provide customers with lower-carbon products
- Utilizing innovative solutions to reduce environmental impact

Through positive thinking, businesses are encouraged to move beyond simply "reducing their own carbon footprint" to actively "reaching out to assist customers and upstream and downstream supply chains in reducing their carbon footprint," thereby creating a greater impact on carbon reduction

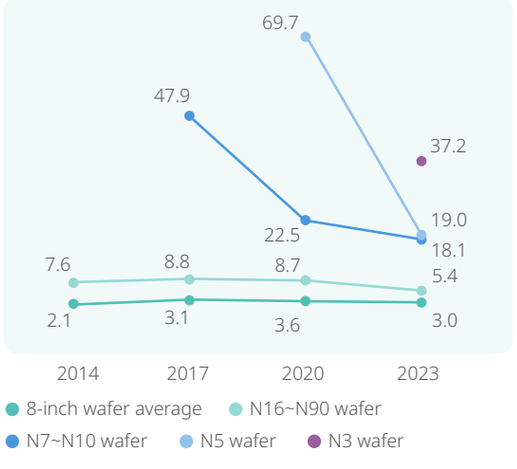
TSMC Product Carbon Footprint

Unit: Kg CO^2e / Wafer



TSMC Product Water Footprint

Unit: m^3/unit-wafer



TSMC is committed to enhancing energy and resource utilization efficiency in its production processes.

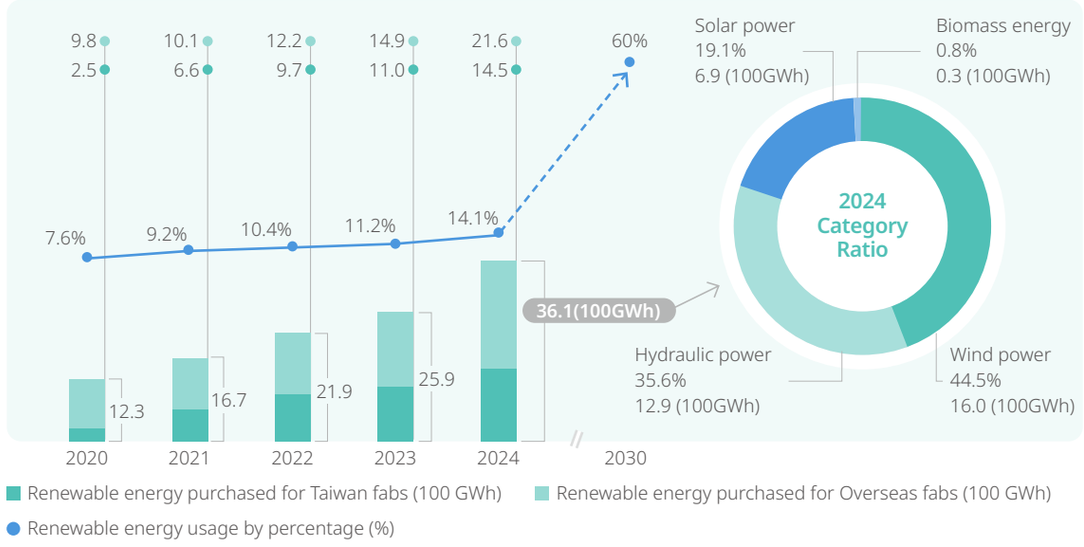
Use Renewable Energy

In 2024, TSMC's Taiwan fabs increased renewable energy consumption to 1,450 Gwh. At the same time, the Company maintained 100% renewable energy usage in its global offices and offset 100% of CO_2 emissions generated from overseas sites. TSMC has achieved zero electricity-related carbon emissions for its overseas subsidiaries for seven consecutive years. In 2024, TSMC continued to promote the diversification of renewable energy development by launching the "Rooftop Solar Power Procurement Project." Through this initiative, the Company actively purchased photovoltaic systems installed on building rooftops, aggregating small-scale green energy resources. This effort also encouraged community investments in constructing solar power systems, fostering a green economy.

As of 2024, TSMC has cumulatively signed contracts for 4.4 GW of renewable energy procurement, which is estimated to reduce carbon emissions by approximately 5.23 million metric tons annually. Starting in 2025, TSMC is expected to receive electricity from offshore wind power, marking the first case in Taiwan of offshore wind energy being supplied to private enterprises. Additionally, TSMC continues to participate in the Ministry of Economic Affairs and Taiwan Power Company's "Green Energy Allocation Sandbox Program." This program treats all fabs of a single corporate entity as a unified user group, allowing the purchased renewable energy to be flexibly allocated based on the actual usage needs of each fab. This approach removes the limitations of the original renewable energy transfer mechanism, which required specifying the fixed installed capacity of renewable energy to be transferred to each plant in its supply contract, thereby enhancing the efficiency of renewable energy utilization.

In 2024, TSMC joined the Energy Collaborative, an initiative launched by SEMI and the Global SCC. This organization brings together industry forces to collaboratively explore low-carbon energy regulations in the Asia-Pacific region and eliminate supply barriers. The goal is to reduce carbon emissions in the semiconductor industry and promote environmental sustainability.

Renewable Energy Consumption and Ratio



Renewable Energy Development Timeline

2020
- Completed one of the first renewable energy wheeling transactions in Taiwan, purchasing 1,230 GWh of renewable energy
- First semiconductor company to join the RE100
- Signed the world's largest PPA (920 MW)

2021
- Committed to achieving 40% of the Company's electricity consumption as renewable energy by 2030

2022
- Established diverse supply of renewable energy by including a small-scale hydroelectric station and start supply in December

2023
- Brought forward the 2050 target of 100% renewable energy coverage in the Company to 2040
- Promised 60% renewable energy coverage in 2030
- Pioneered supply chain renewable energy joint procurement model
- Participated in the green power allocation sandbox project

2024
- **Joined the "Energy Collaborative" jointly initiated by SEMI and SCC**
- **Initiated the "roof-mounted PV procurement project" and "maximal renewable energy installation project for existing fabs"**

Renewable Energy Systems

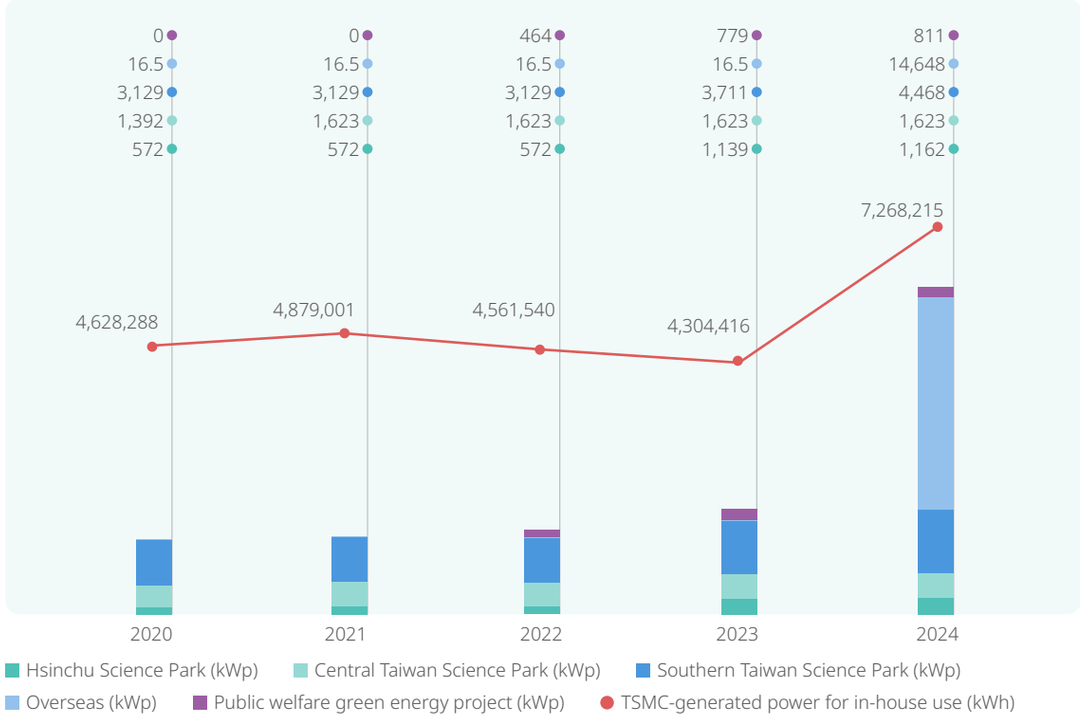
While purchasing renewable energy externally, TSMC also installs solar photovoltaic systems to generate zero-carbon renewable energy for internal use. In 2024, TSMC launched a three-year "Existing Facility Renewable Energy Maximization Project," which involves installing solar photovoltaic systems on rooftops of office buildings, parking towers, and ground parking lots at existing facilities. This project is expected to add over 2,600 kilowatts of peak power capacity. In 2024, TSMC's total installed solar panel capacity reached 15,912 kilowatts of peak power, generating approximately 7.27 million kilowatt-hours of renewable energy and reducing carbon emissions by 3,591 metric tons. Additionally, to enhance the recycling value of decommissioned solar photovoltaic modules, Phase 4 office building rooftops and Phase 8 parking shelters at Fab 18 adopted the "new detachable circular solar photovoltaic modules" developed by Taiwan's ITRI for the first time. These modules enable the complete extraction of high-purity silver, silicon wafers, and glass panels, increasing resource recovery efficiency and promoting environmental friendliness.

TSMC has also expanded its scope of shared benefits by continuing to promote the "Public Welfare Green Energy Program" in 2024. Through the TSMC Charity Foundation, the company facilitates collaboration between its facilities management teams, partner vendors, government agencies, and universities to provide free assistance in installing solar power systems for social welfare organizations and rural schools. All proceeds from the sale of generated electricity are fully returned to these organizations and schools. In 2024, the program added eight new sites, with an installed capacity of approximately 811 kilowatts of peak power and a generation of about 925,000 kilowatt-hours. The proceeds amounted to approximately NT$3,999,000, which were given back to the benefiting institutions and schools.

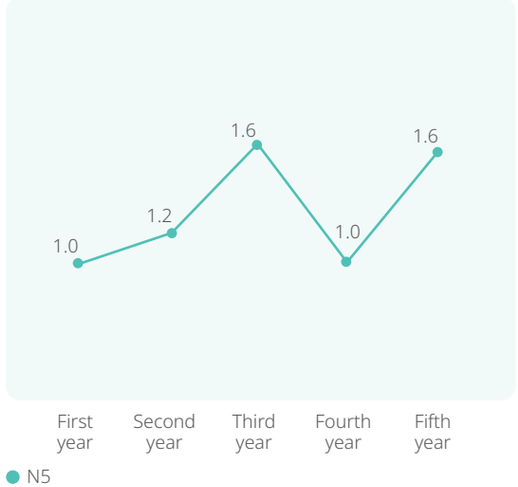
Increase Energy Efficiency

TSMC comprehensively promotes green manufacturing. Apart from the existing Net Zero Center, Zero Waste Center, and Water Resource Center, the Company added the Sustainable R&D Center and Environmental Monitoring Center in 2024 to focus on the R&D and application of emerging technologies that promote sustainable development and reinforce the control technologies and quality testing capabilities in the hope of accelerating the transition progress. To create energy conservation opportunities, TSMC defined its five major energy conservation teams and commended fabs with excellent achievements and innovative energy conservation actions through the Energy Saving Annual Award. For the first time, the 2024 trophies were made with environmental considerations in mind, incorporating recycled waste glass as a key material. The design features a sapling motif to symbolize the concept of green sustainability.

TSMC Renewable Energy Installed Capacity and Power Generation for In-house Use



Energy Efficiency of Process



Note 1: The standardized baseline for energy efficiency is the values taken from the first year of volume production.
Note 2: The datas cover fabs in Taiwan. (excluded the R&D Center)

In addition, to improve employees' awareness of energy management, TSMC organized three sessions of energy conservation and carbon reduction workshops in Hsinchu, Taichung, and Tainan fabs in 2024. Themes included energy conservation and carbon reduction technologies, international carbon fee issues, carbon reduction pathway, and other policies. The sessions attracted 837 participants. TSMC also created 18 promotional posters on energy transition and net-zero emissions to help employees understand the Company's efforts and actions in energy conservation and carbon reduction, demonstrating its commitment to environmental sustainability.

Five Major Green Manufacturing Centers

Sustainable R&D Center
Set up green manufacturing directions and targets and cooperate with the government and the academic sector to carry out R&D and verification of sustainable technologies, establish relevant methodologies and promote the applications

Net Zero Center
Cooperate with suppliers to develop and introduce innovative energy conservation technologies and promote energy conservation and carbon reduction measures

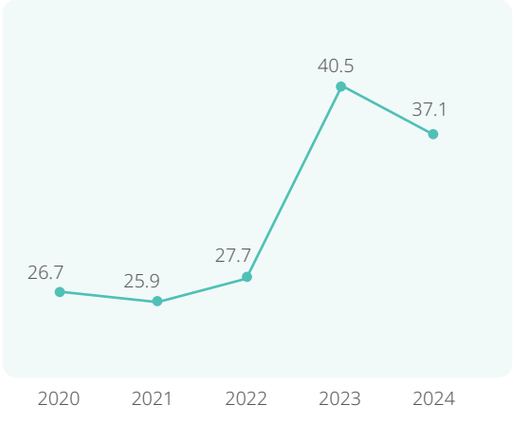
Zero Waste Center
Recycle waste and make it into electronic-grade raw materials and industry-grade products, realizing zero waste through resource circulation

Water Resource Center
Formulate the Water Positive strategies, develop diverse water resources, introduce new water management technologies, and promote environmental education courses

Environmental Monitoring Center
Execute the self-inspection of recycled air discharge, water management, GHG and waste to build a comprehensive protection system

Unit Product Energy Consumption

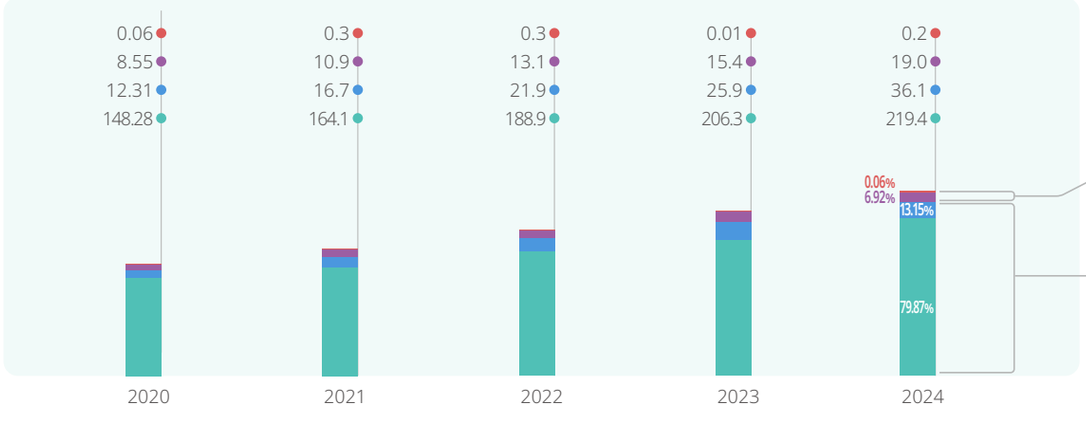
Unit: kWh/12-inch equivalent wafer mask layer



Note 1: The datas cover fabs in Taiwan (including the R&D Center), TSMC (CHINA), TSMC (Nanjing), TSMC Washington, LLC, JASM, and VisEra.
Note 2: Diesel and natural gas are not used for production and are excluded from the calculation.

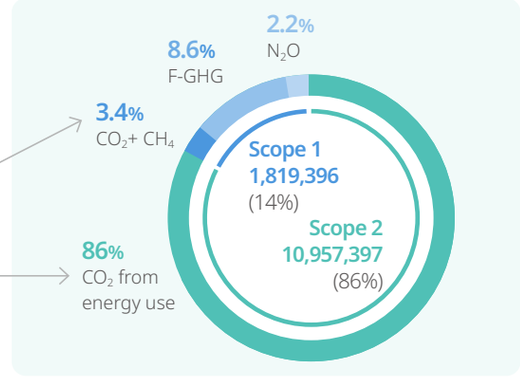
Total Energy Consumption

Unit: 100 GWh



Note 1: (Import) LNG = 9,000 kcal/m³; vehicle diesel = 8,642 kcal/L; 1 kcal = 4,186.8 J; 1 kWh = 860 kcal ≒ 3,600 kJ
Note 2: GHG emissions from fabrication processes include only direct emissions (scope 1) and indirect emissions from electricity use (scope 2); GHG emissions datas for Scope 1 and Scope 2 cover TSMC fabs in Taiwan (including the R&D Center and Zero Waste Manufacturing Center), TSMC (China), TSMC (Nanjing), TSMC Washington, LLC, JASM, TSMC Japan 3DIC R&D Center, subsidiaries or offices in the U.S./Europe/Canada/Japan and South Korea, and VisEra.
Note 3: The Scope 1 inventory datas adopted business control approach as the inventory basis; the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse GaseInventories (GWP) was adopted from 2020 to 2024.
Note 4: Renewable energy includes solar power, wind power, biomass energy, and hydroelectric energy.

GHG Emissions from Manufacturing Processes



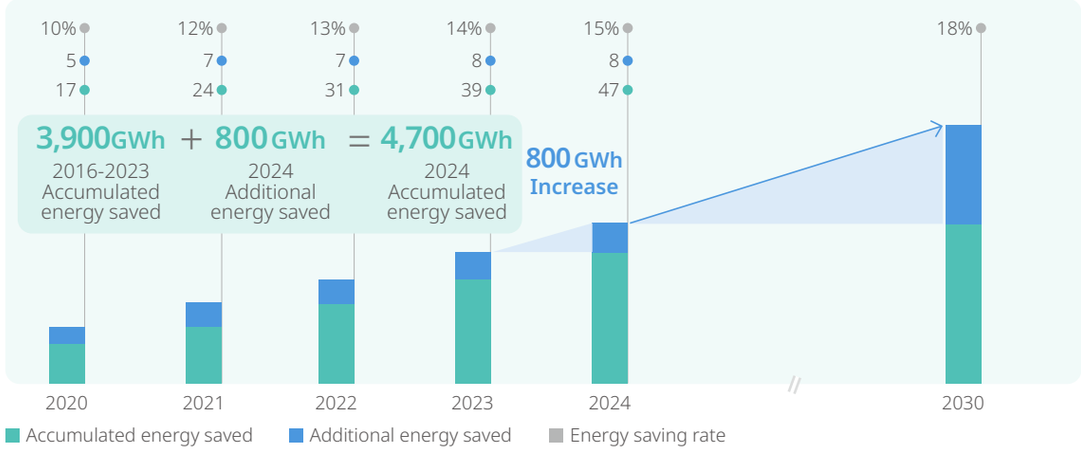
Expand Energy-saving Measures

In 2024, TSMC's total energy consumption was 27,456 GWh, with purchased electricity, natural gases, and diesel accounting for approximately 93.0%, 6.9%, and 0.1%, respectively. TSMC continues to invest resources in improving energy efficiency. In 2024, TSMC implemented 1,177 energy conservation measures across eight categories, achieving a 15% energy-saving rate and conserving 810 GWh in electricity. Energy conserved in 2024 was the equivalent of reducing 400,000 metric tons of carbon emissions and saving NT$3.04 billion in energy costs. As of 2024, the "Energy Conservation Action Project for Next Generation Fab Tools" launched in 2018, has validated and applied 236 energy-conservation programs to over 100 advanced process equipment types. Combined with cross-site energy-saving measures, the initiative has collectively saved one billion kilowatt-hours of electricity.

In addition to its Taiwan facilities, TSMC (China), TSMC (Nanjing), TSMC Washington, LLC, and JASM also implemented energy-saving projects in 2024, collectively saving 35 million kilowatt-hours of electricity. TSMC Arizona is expected to join the energy-saving efforts in 2025, further expanding the green benefits.

Total Energy Consumption

Unit: 100 GWh



Note: 1 kWh = 3,600 kJ

Five Major Energy Conservation Teams with Continuous Innovation

	Advanced Processes R&D Team	12-inch Wafer Fab Team	Advanced Backend and 8-inch Wafer Fab Team	EUV Team	Facility Team
Targets (Including Existing and Future Tools)	Next Generation 3nm/2nm	12-inch wafer fabs (including overseas fabs)	Backend fabs and 8-inch wafer fabs (including overseas fabs)	EUV tools	Shared facilities not used for production
Missions	• Develop energy-efficient components • Optimize programs • Compile tool specifications	• Replace and upgrade equipment with low energy efficiency • Optimize programs	• Replace and upgrade equipment with low energy efficiency • Compile specifications for new tools in backend fabs	• Optimize programs • Develop energy-efficient components	• Upgrade equipment with low energy efficiency • Develop smart energy conservation systems • Compile specifications for new tools
Achievements from Key Programs in 2024	✓ Adopted high-performance equipment for new tools; the use ratio of energy-saving pumps was approximately 99%, and the use ratio of chillers was approximately 98% ✓ Continued to implement the "low global warming potential gas substitution project"; it is estimated that the consumption of HFCs will be reduced by approximately 16% in 2024	✓ Continued to promote the "hot water recycling system for wafer cleaning tools 2.0" with a term of eight years, which saved 13.64 kWh of electricity and reduced 6,700 metric tons of carbon	✓ Implemented the "high-performance pump/chiller" replacement plan, and the energy conservation rate was approximately 30% to 50%	✓ Introduced the optimal designs for the operating scheduling for EUV tools, and the power consumption per wafer was reduced by approximately 30%	✓ Introduced Next Generation FFU to improve operating efficiency, and the average energy conservation rate was approximately 6.1% NEW ✓ Introduced low energy consumption and high-efficiency local scrubbers, and the GHG reduction rate reached 95%

Energy Conservation Measures

A total of **1,177 Measures**

Facility Equipment

- Smart lighting in clean rooms
- Changed to yellow LED lighting+

40	39.87 GWh	19,696 Metric tons
Energy-saving measures	Conserved in electricity	Reduced of CO_2

Lighting Energy Savings
All Fabs

- AI powered chilled water energy saving system
- Replace cold water with PCW for cooling air compressors throughout first- and second-stage compression

14	108.55 GWh	53,623 Metric tons
Energy-saving measures	Conserved in electricity	Reduced of CO_2

A.C. Energy Savings
All Fabs

- High efficiency transformers

41	75.03 GWh	37,064 Metric tons
Energy-saving measures	Conserved in electricity	Reduced of CO_2

Increased Performance
All Fabs

- Energy-saving mode for uninterrupted power supply system
- Cooling fan for battery cabinet to conserve energy
- Use standby mode for local scrubbers

17	57.57 GWh	28,439 Metric tons
Energy-saving measures	Conserved in electricity	Reduced of CO_2

Standby Energy Savings
All Fabs

Manfacturing Tools

- Reduce PCW and exhaust emissions from manufacturing processes
- CDA flow smart control mechanism

211	76.98 GWh	38,028 Metric tons
Energy-saving measures	Conserved in electricity	Reduced of CO_2

Energy Usage Management
All Fabs

- Replace with new high-efficiency, energy-saving pumps and chillers

367	76.16 GWh	37,623 Metric tons
Energy-saving measures	Conserved in electricity	Reduced of CO_2

Unit Replacement
All Fabs

- Use high-efficiency, energy-saving auxiliary equipment and components for new equipment
- Optimize water usage and exhaust settings

359	336.05 GWh	166,009 Metric tons
Energy-saving measures	Conserved in electricity	Reduced of CO_2

New Units Specs
12-inch Fabs/ Advanced Backend Fabs

- Replace tool components with energy-saving components
- Hot DI water circulation system

128	40.96 GWh	20,234 Metric tons
Energy-saving measures	Conserved in electricity	Reduced of CO_2

Equipment Adjustments
All Fabs

Note: The carbon emission equivalent factor is 0.494 kg CO_2e per kWh; 1 kWh = 860 kcal = 3,600 kJ

Strengthen Nature and Biodiversity Protection

TSMC places great importance on environmental sustainability, guided by its Biodiversity Statement . The Company aligns with the TNFD framework and its recommended assessment methodology, following the four-step process of Locate, Evaluate, Assess, and Prepare (LEAP). This approach helps TSMC understand the interdependencies, reliance, and impacts between its global facilities, local suppliers in Taiwan, and surrounding ecosystems. It also facilitates the identification of areas with potential for biodiversity conservation. In 2024, TSMC collaborated with industry, government, academia, and research partners to launch the "Eco Plus! Ecological Harmony Program ." Centered on three key pillars — habitats, species, and knowledge — the initiative aims to promote biodiversity protection and awareness through concrete actions.

In 2024, under the "Habitat" pillar, TSMC completed assessments of potential ecological corridor areas and developed a strategy for eco-friendly farming on Dadushan. The Company also engaged with stakeholders to exchange management practices for OECM. Under the "Species" pillar, TSMC carried out resource demand evaluations for the conservation of Squalidus Banarescui and Ring-necked Pheasants, as well as improvement planning for the rehabilitation ponds at the Central Taiwan Science Park facilities. Under the "Knowledge" pillar, efforts included the completion of surveys covering 13.3% of priority sampling areas in Taiwan Bird Atlas, accumulating bird sound recognition data in Taiwan using the Merlin App, training 277 volunteer bird surveyors, and hosting information sessions for the "Biodiversity Scholarship and Proposal Grant" in northern, central, and southern Taiwan. Additionally, in collaboration with the Ministry of Education, TSMC organized 33 iNaturalist promotional events, attracting a total of 1,071 student participants.

In addition, TSMC continued to promote the Plant A Tree Program in 2024 and planted a total of 110,851 trees and 292,730 shrubs. For the first time, the program incorporated volunteer leave, inviting TSMC employees to participate in the “Good to Have You” tree planting and beach cleaning activities on World Earth Day, International Day for Biological Diversity, and World Environment Day. A total of 443 employees participated, planting over 1,760 saplings, and cleaning approximately 1,691 kg of marine debris. In terms of environmental education, TSMC enhanced awareness of conservation among employees and the public through specialized courses and guided tours at the "TSMC Central Taiwan Science Park Ecological Zone" and the "TSMC Southern Taiwan Science Park Reclaimed Water Facility Environmental Education Learning Zone." In 2024, a total of 1,930 participants took part in these activities. For more information on TSMC's extended efforts in nature and biodiversity conservation, please refer to the “Climate and Nature Report .”

Case Study

Introduce the FFU to Improve the Operating Efficiency from 55% to 60%

The cleanrooms within wafer fabs require extremely high air cleanliness levels. Fan filter units are utilized to effectively filter tiny particles in the air, creating a stable airflow field and ensuring the quality of the process environment. To enhance operational efficiency, TSMC collaborated with suppliers to optimize the fan structure while maintaining the original dimensions (120 cm × 120 cm) and operational specifications (airflow speed greater than 0.45 meters per second). This optimization involved increasing the fan blade diameter from 400 mm to 448 mm, combined with flow field simulations of the volute air duct to confirm a reduction in turbulence. Additionally, the rotation mode was changed from an inner rotor to an outer rotor, enhancing torque on the shaft and thereby increasing airflow. This improvement successfully raised operational efficiency from 55% to over 60%, with an estimated power consumption reduction of 0.018 kW per unit. In 2024, the optimized units were successfully implemented in Phase 1 of Fab 20 and Phase 1 of Fab 22, achieving electricity savings of 3.3 million kilowatt-hours.

TSMC improves the structure of fans for dust-free rooms to improve energy conservation benefits.

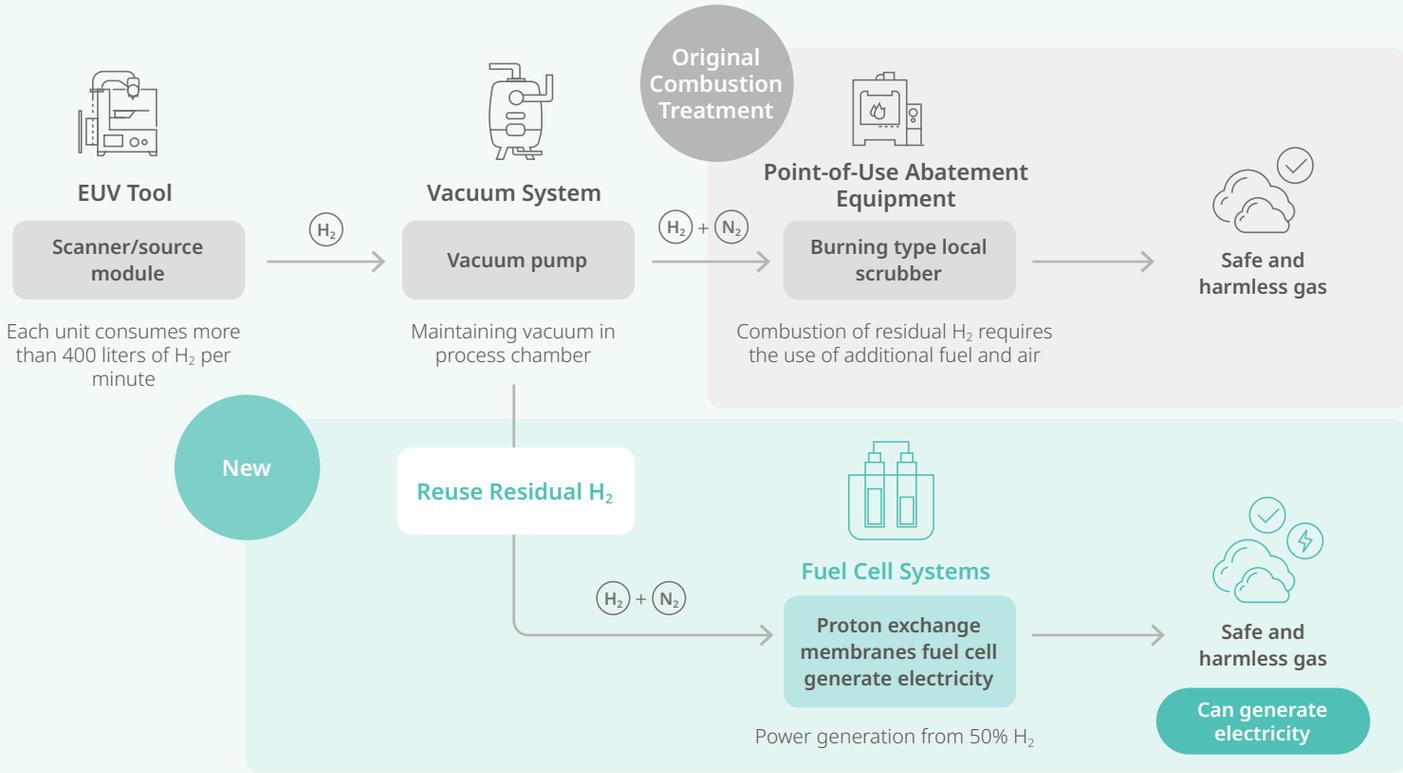
Case Study

Reuse of Waste Hydrogen from EUV for Green Energy Transition

The EUV process requires hydrogen to maintain the cleanliness and stability of the light source, with each machine consuming over 400 liters of hydrogen per minute. The current method for handling excess hydrogen involves adding fuel or air and using combustion-based on-site treatment equipment to process the residual hydrogen. To enhance the efficiency of hydrogen utilization, TSMC collaborated with the Green Energy and Environmental Research Laboratories at the ITRI to advance the "Preliminary Assessment Project for Resource Utilization of Excess Hydrogen in EUV Processes." Together, they developed a 10-kW Proton Exchange Membrane Fuel Cell, which converts the chemical energy in excess hydrogen into electrical energy. Testing under conditions of 50% hydrogen concentration and a flow rate of 240 liters per minute achieved a power generation efficiency of 45%.

In 2024, TSMC further developed a 30-kW fuel cell system, achieving a power generation efficiency of 52.3% under conditions of 50% hydrogen concentration and a flow rate of 320 liters per minute. The system also became the first in the industry to obtain the SEMI S2 certification for semiconductor manufacturing equipment safety, health, and environmental standards. Looking ahead to 2025, TSMC plans to design and conduct safety evaluations for a 150-kW fuel cell system. The goal is to fully convert excess hydrogen from the EUV process into electricity, enhancing energy utilization efficiency and promoting more environmentally sustainable process management.

EUV Process Residual Hydrogen Reuse Procedure



Water Stewardship

Strategies	2030 Goals	2025 Targets	2024 Achievements	
Manage Water Resource Risks Enforce climate change mitigation policies; implement water conservation and water shortage adaptation measures	Reduce unit water consumption[Note 1] by 30% (L/12-inch equivalent wafer mask layer) (Base year: 2010)	Reduce unit water consumption by 2.7% (L/12-inch equivalent wafer mask layer) (Base year: 2010)	Increased unit water consumption by 14.3% (L/12-inch equivalent wafer mask layer) Target: Reduce unit water consumption by 2.7%	— Note 2
	>65% global Water Positive achievement rate NEW	>17% global Water Positive achievement rate NEW	-	-
Develop Diverse Water Resources Develop water reclamation technologies; continue to practice water conservation and use reclaimed water during manufacturing	>60% replacement of water resources with reclaimed water[Note 3]	15% replacement of water resources with reclaimed water	17% replacement of water resources with reclaimed water Target: 14%	↑
Innovative Water Pollution Prevention Technology Improve the efficiency of water pollution control and removal of water pollutants	Water pollution composite indicator reduction rate[Note 4] of >60%	Water pollution composite indicator reduction rate of 60%	Water pollution composite indicator reduction rate of 63% Target: 60%	↑

Applicable to all TSMC fabs around the world | Applicable to TSMC fabs in Taiwan and other specific fabs | Only applicable to TSMC fabs in Taiwan | Applicable to TSMC overseas fabs | ↑ Exceeded | ✓ Achieved | — Missed target

Note 1: Unit water consumption = Unit tap water consumption
Note 2: For the reason for the failure in achievement, please refer to "Strengthen In-house Water Reclamation and Water Use Efficiency."
Note 3: Replacement of water resources = consumption of reclaimed water/(consumption of reclaimed water + consumption of tap water)
Note 4: Nine key pollutants were identified, including Chemical Oxygen Demand (COD), fluoride, suspended solids (SS), ammonia nitrogen, nitrate nitrogen, arsenic (As), boron (B), copper (Cu), and cobalt (Co). These pollutants were used as indicators for assessing the reduction of overall pollution concentrations and the effectiveness of pollution prevention measures.

TSMC actively implements sustainable water resource management. The Company published its Water Statement and included Water Positive as one of the long-term goals for the water management of all TSMC fabs around the world. Through the use of reclaimed water and the development and restoration of diverse water resources, TSMC mitigated environmental impacts generated from operations. In 2024, the reclaimed water consumption verification for 5- and 3-nanometer process technologies was completed and has been fully implemented at the Tainan plant. The overseas JASM site has restored five million m^3 of groundwater and continues to expand its scope. In addition, TSMC has optimized its water pollution prevention performance to allow the average reduction rate of PFASs to reach 95% through the introduction of absorbent filter technology so as to facilitate environmental protection and sustainable development.

TSMC Water Consumption in Three Science Parks

Hsinchu Science Park

Daily Supply to Science Park: 610 thousand m^3/day

12.6%

Water Consumption: 77 thousand m^3/day

Central Taiwan Science Park

Daily Supply to Science Park: 1.55 million m^3/day

3.7%

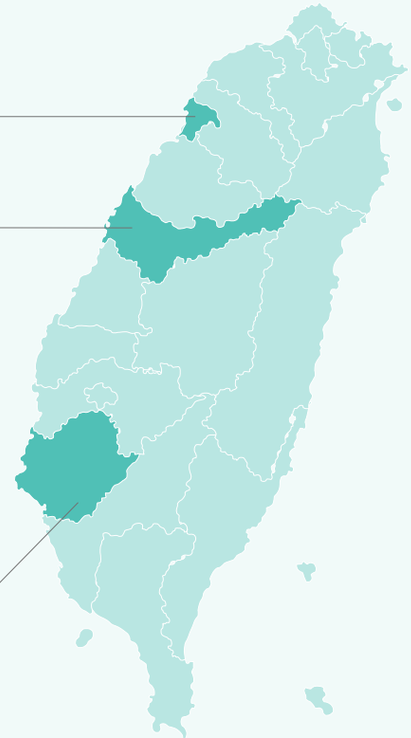
Water Consumption: 58 thousand m^3/day

Southern Taiwan Science Park

Daily Supply to Science Park: 972 thousand m^3/day

12.7%

Water Consumption: 124 thousand m^3/day



2024 Status

Water signal from the Water Resource Agency	Government response measures	TSMC response measures
Blue Normal water levels	Stable supply and demand	• Monitor WRA reservoirs supply for TSMC fabs • Host drills regularly
Green Fairly severe	Farmers encouraged to suspend Farming	• Drought emergency response team in operation • Check water resources and water truck capacity • Spontaneously save water by 5%
Yellow First stage	• Reduce water pressure at specific times • Suspended irrigation water in certain areas	• Reduce water consumption by 7% • Water truck drills
Orange Second stage	Reduce water supply to industrial users by 5-20%	• Activate water trucks • Reduce water consumption by 7-20%
Red Third stage	Water rationing by district	• Activate water trucks • Reduce water consumption by 7-20%

Resource: Water Resources Agency, Ministry of Economic Affairs

Manage Water Resource Risks

Each year, TSMC makes use of the WRI water risk assessment tool to identify the water risk levels of the regions where its facilities are located. Based on the 2024 assessment results, TSMC fabs in Taiwan, TSMC (Nanjing), JASM, and VisEra are rated as mid-to-low risk, and TSMC Washington, LLC is rated as low risk. TSMC (China), despite being in a region with abundant water resources, is rated as high risk as it faces challenges due to significant variations in raw water quality. Similarly, TSMC Arizona, located in a desert climate zone, is also categorized as a high-risk area.

In addition to strengthening TSMC (China)'s water treatment systems to improve water quality, TSMC began planning a reclaimed water plant project for TSMC Arizona in 2024 to address local water resource risks. This initiative leverages advanced reclaimed water testing and implementation verification conducted at TSMC's Taiwan sites as a demonstration for the Arizona plant. TSMC is also evaluating the promotion of local water resource restoration to reduce environmental and operational risks. Furthermore, during the construction phase of its facilities, TSMC raises site elevations and installs flood gates to mitigate potential water-related risks. The Company also incorporates existing measures, such as water recycling and reuse practices and wastewater treatment systems, into its planning and design. TSMC regularly reviews regional water usage ratios and water condition data to implement timely response measures when necessary.

Water Resource Management and Technological Development

TSMC's Water Resource Center oversees water usage within its fabs, develops diverse water resource initiatives, and manages related technologies. In 2024, the Taichung fabs (Fab 15A and Fab 15B) and Tainan fabs (Fab 6, Fab 14A Phase 7, and Fab 14B Phases 5 and 6) underwent annual audits in accordance with the AWS's sustainable water management standards, while the Hsinchu fabs (Fab 5, Fab 12A, Fab 12B, and Advanced Backend Fab 3) completed its three-year recertification process. All facilities maintained Platinum-level performance.

To achieve sustainable water resource management, TSMC has established close collaboration and communication with governmental agencies, academic institutions, and suppliers. In 2024, TSMC conducted feasibility assessments with the Water Resources Agency of the Ministry of Economic Affairs and local government water bureaus on various water resource initiatives, such as municipal reclaimed water, desalinated seawater, brackish water, and river restoration projects. Additionally, TSMC partnered with academic institutions to study regional water resource development potential and advance new technologies. In 2024, TSMC and National Chung Hsing University jointly executed three industry-academia collaboration projects: reducing biological sludge combined with

WRI Risk Identification

Overall WRI Risk Index		TSMC Assessment	TSMC Assessment Results		TSMC Response Measures	
Frequency	• Water risk • Decreasing underground water levels • Interannual variation • Seasonal variation • Drought • Flood risks • Tsunami risks	Flood risk	Low risk	1 Facility	Facility Design	• Elevate facility • Install flood gates
Quality control	• Coastal erosion • Untreated water bodies	Water risk	Mid-to-low risk	19 Facility	Water Management	• Establish emergency response procedures • Develop diverse water sources • Introduce reclaimed water into processes • Set water pollution composite indicator
Regulation and reputation	• Drinking water quality • Sanitary conditions • Sustainable investment index	Water quality risk	High risk	2 Facility		

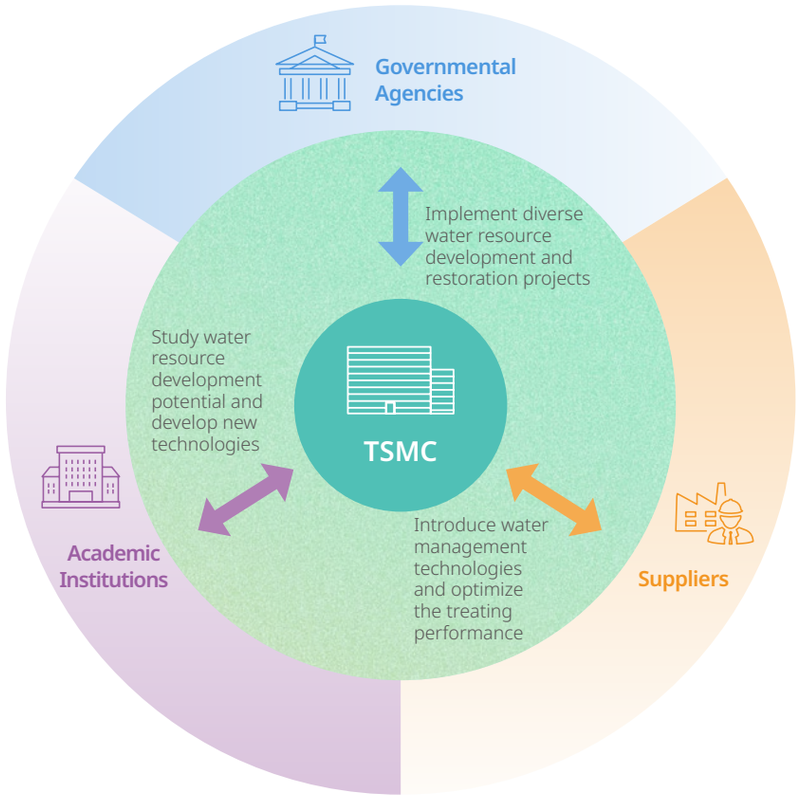
Note: In 2024, JASM was rated as being in a medium-to-low risk area, while TSMC Arizona was rated as being in a high-risk area

biogas recovery, recovering copper ions from wastewater, and electrochemical water quality analysis to enhance water treatment technology capabilities. Furthermore, through collaboration with suppliers, TSMC has developed innovative pollution prevention measures and optimized treatment efficiency to achieve optimal operational performance and promote environmental sustainability.

Water Positive

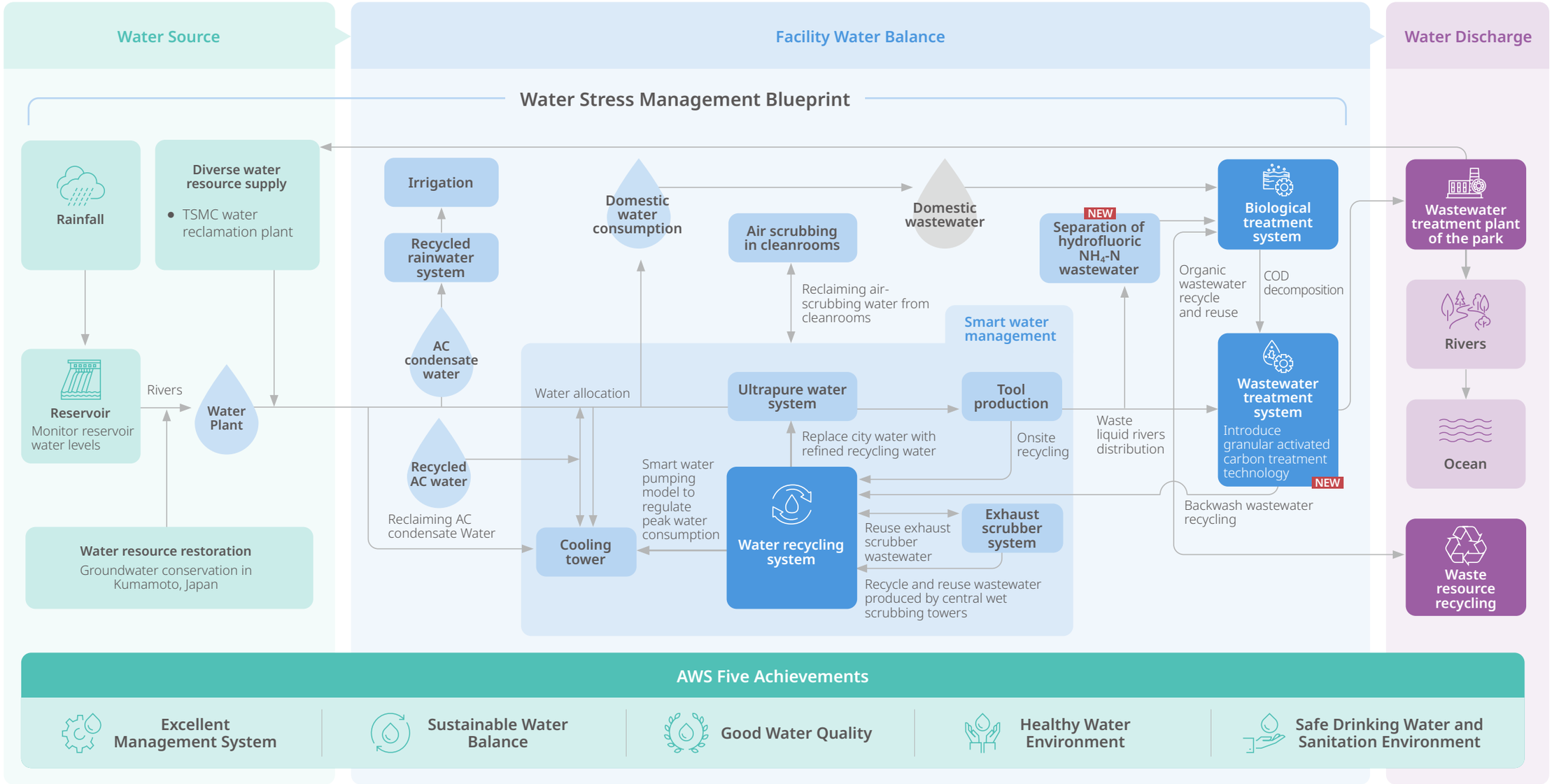
The concept of water positive refers to a scenario where the amount of water restored by a company exceeds the amount of water it consumes. In response to the growing severity of global climate change, TSMC has incorporated water positive into its core global water resource management strategies in 2024. In addition to expanding the use of reclaimed water, TSMC continues to participate in desalination plant projects promoted by the Water Resources Agency of the Ministry of Economic Affairs in Hsinchu and Tainan. In 2024, TSMC signed a purchase agreement for 45,000 cubic meters of water per day to alleviate regional water resource pressure and enhance supply resilience. For its overseas facilities, JASM, located in Kumamoto, Japan, benefits from abundant groundwater resources. TSMC actively promotes groundwater recharge projects in the region, restoring five million cubic meters of groundwater in 2024 — equivalent to three times JASM's water consumption — achieving water positive status for the area.

TSMC Water Management Cooperation Model



TSMC S.T.S.P. Reclaimed Water Plant

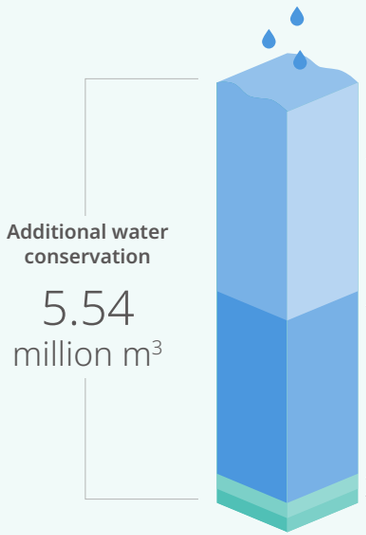
Water Balance and Supply Chain Environmental Relationship



Strengthen In-house Water Reclamation and Water Use Efficiency

TSMC utilizes a diversified water supply integration platform to manage water usage information across its fabs and implement four major water-saving measures: "Decreasing Water Discharge Loss from the System, Reducing Facility System Water Consumption, Increasing Wastewater Recycling by Facilities, and Improving Water Production Rate of the System." In 2024, TSMC achieved an additional water savings of 5.54 million cubic meters, with the total amount of recycled water from its recovery systems reaching 284.6 million cubic meters. In 2024, TSMC's water consumption per unit product was 161.0 liters per 12-inch wafer equivalent (measured by photomask count), which represents an 8.7% reduction compared to 2023. However, this figure remains higher than the baseline year (2010), which was 140.9 liters per 12-inch wafer equivalent. The increase is primarily due to the addition of several new facilities in 2024, including Phase 1 of Fab 20, Phase 1 of Fab 22, Phase 1 of TSMC Arizona, Phase 1 of JASM, and Advanced Backend Fab 6B. Although these facilities have not yet begun formal production, they still have fixed water consumption, contributing to the higher water usage per unit product. To address this, TSMC will continue to increase the use of reclaimed water and develop diverse water resource initiatives to further reduce reliance on tap water supplies.

Water-saving Measures and Achievements in 2024



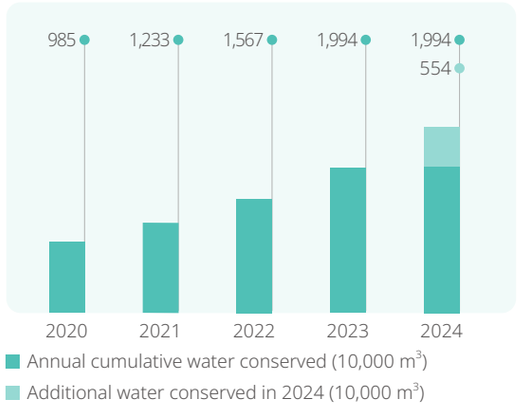
Increase Wastewater Recycling by Facilities
Recycled back-wash water 679,000 m³ (12.26%)
Recycled other wastewater 1,418,000 m³ (25.6%)
Recycled water refined into industrial water 458,000 m³ (8.26%)

Improve Water Production Rate of the System
Increase the water production rate of RO recycling systems 769,800 m³ (13.9%)
Improve usage efficiency of recycled water 1,466,300 m³ (26.5%)

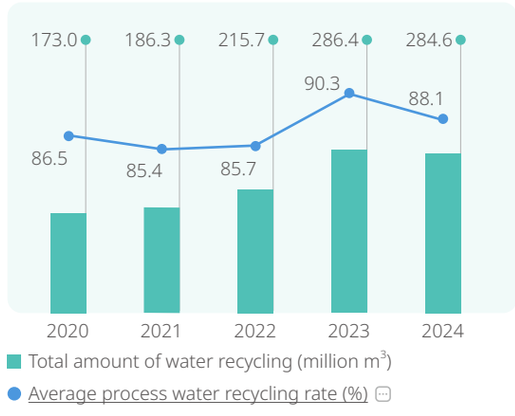
Reduce Facility System Water Consumption
Reduce backwashing water of cooling towers and sand filters by 2,000 m³ (0.04%)
Replace tap water used by MAUs with reclaimed water of 379,000 m³ (6.85%)

Decrease Water Discharge Loss from the System
Recycled from MAU drain 364,000 m³ (6.58%)

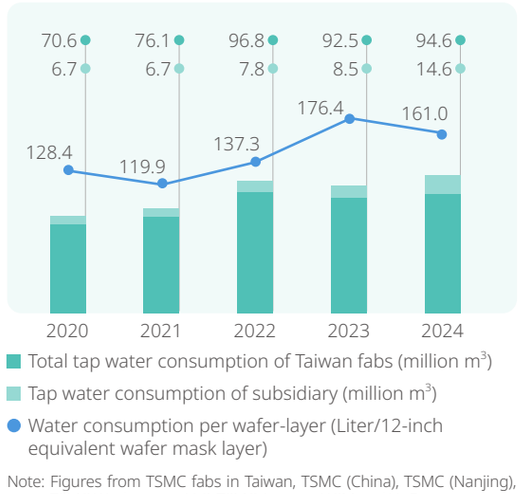
Annual Water Conservation



Water Recycling and Usage Efficiency

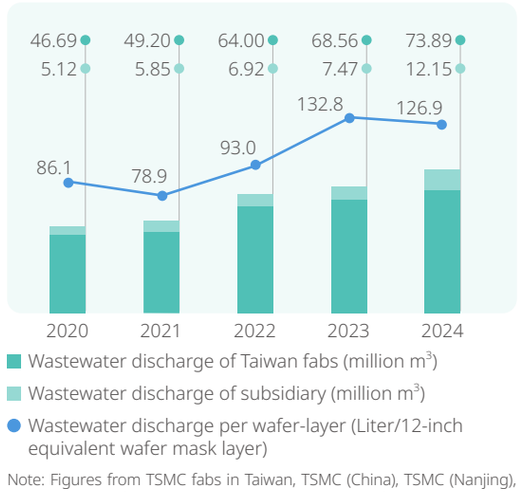


Tap Water Consumption and Water Consumption per Wafer-layer



Note: Figures from TSMC fabs in Taiwan, TSMC (China), TSMC (Nanjing), TSMC Washington, LLC, TSMC Arizona, JASM and VisEra

Wastewater Discharge per Unit

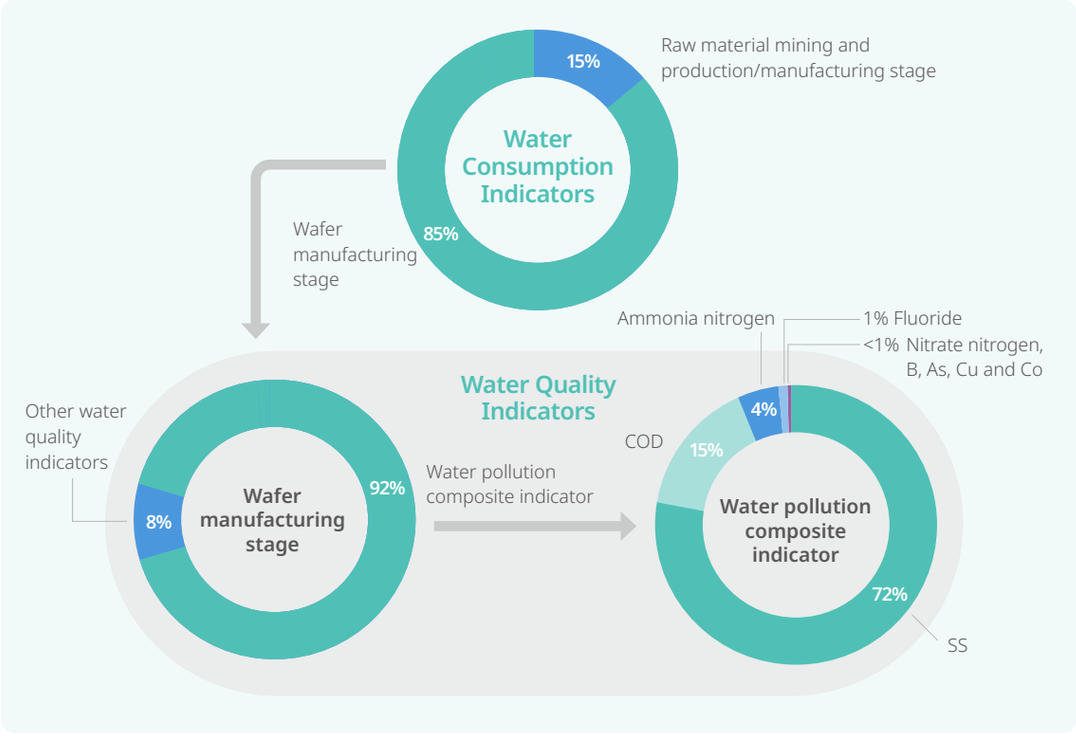


Note: Figures from TSMC fabs in Taiwan, TSMC (China), TSMC (Nanjing), TSMC Washington, LLC, TSMC Arizona, JASM and VisEra

Product Water Footprint

TSMC conducts a product water footprint survey every three years and obtains ISO 14046 third-party verification to refine its water resource management practices both internally and across its supply chain. The water footprint survey is divided into water consumption and water quality indicators. Based on the 2024 survey results, for the water consumption indicator, TSMC's fabs accounted for 85%, primarily due to direct water usage within the facilities. Suppliers of raw materials accounted for the remaining 15%, mainly including chemical suppliers, raw silicon wafer providers, and bulk gas suppliers. For the water quality indicator, the primary water pollutants during the wafer manufacturing phase were suspended solids (72%), chemical oxygen demand (15%), and ammonia nitrogen (4%). Compared to the 2021 survey results, the proportion of water consumption during the wafer manufacturing phase increased due to the expansion of fabs, which raised water demand. TSMC will continue to implement water-saving measures in manufacturing processes to reduce consumption. For the water quality indicator, TSMC regularly reviews overall pollutant concentration reductions and control measures through the Water Pollution Comprehensive Index Reduction Rate. Additionally, TSMC is developing new wastewater treatment technologies to enhance pollutant removal efficiency, thereby reducing the product water footprint.

Product Water Footprint Distribution Map



Environmental Education

TSMC upholds the spirit of coexistence between corporate operations and environmental ecosystems by promoting sustainable water resource utilization through environmental education. Currently, TSMC operates two environmental education facilities certified by the Ministry of the Environment: the "TSMC Central Taiwan Science Park Ecological Park" and the "TSMC Southern Taiwan Science Park Reclaimed Water Plant Environmental Education Learning Park." To deepen the promotion of water resource conservation, TSMC has designed water resource learning courses tailored for upper elementary school students, junior high school students, and adults. In 2024, TSMC held 63 sessions with 1,930 participants. Additionally, in 2024, TSMC organized in-person activities for employees, such as "Understanding Reclaimed Water Plant Tours," and developed an online course on "Water Resource Management," which is scheduled to launch in 2025. These initiatives aim to enhance employees' knowledge of water resources and empower them to take action to protect the environment.

TSMC is committed to promoting environmental education.

Develop Diverse Water Resources

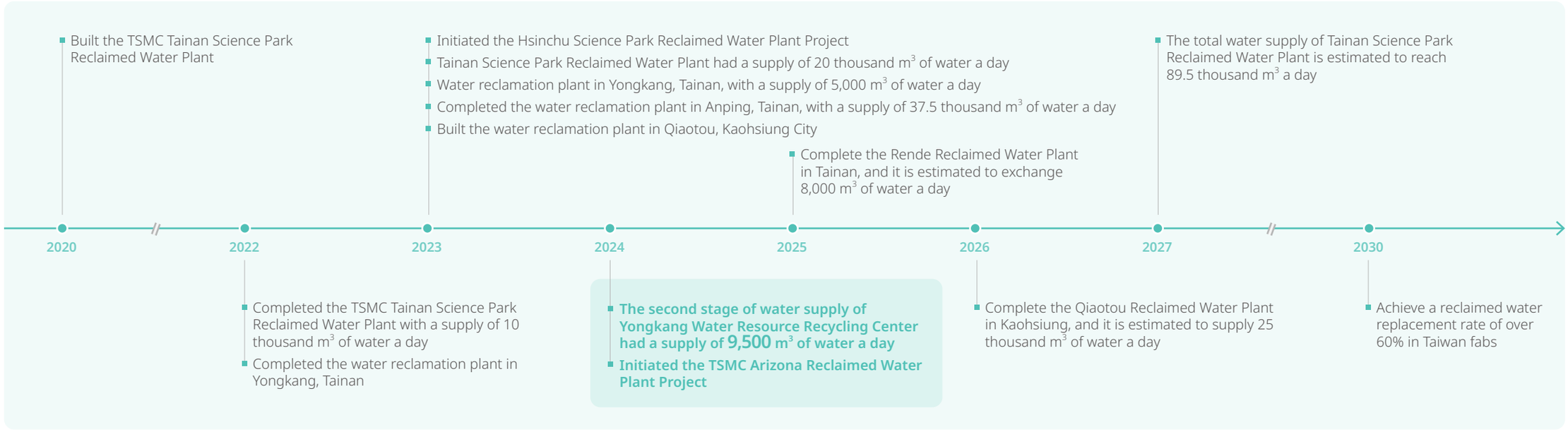
TSMC is committed to maximizing the efficient use of every drop of water. In addition to implementing water-saving measures in manufacturing processes, TSMC actively invests in the development of reclaimed water technologies. To ensure that water quality meets the specifications and cleanliness requirements of manufacturing processes, reclaimed water is initially used for secondary purposes. Gradually, through validation processes, reclaimed water is introduced into manufacturing, starting with mature processes and progressing to advanced processes.

After two years of effort, TSMC successfully achieved the use of reclaimed water for its 5-nanometer and 3-nanometer processes in 2024, enhancing the efficiency of water resource utilization.

In 2024, TSMC Tainan Science Park Reclaimed Water Plant, Yongkang Water Resource Recycling Center, and Anping Reclaimed Water Plant collectively supplied 67 thousand m^3 of recycled water daily. The Tainan fabs cumulatively consumed 19.65 million m^3 of reclaimed water, reducing tap water consumption by 31%. TSMC is committed to further increasing the use of reclaimed water, with municipal reclaimed water being a key component of this effort. However, due to geographical constraints, not all municipal wastewater treatment plants are able to produce reclaimed water for supply to TSMC fabs. To alleviate regional water supply pressure and support the government's diverse water resource development policies, TSMC has collaborated with the Tainan City Government on an innovative "Water Exchange" management model. Under this model, reclaimed water from the newly constructed Rende Reclaimed Water Plant will be allocated to water recipients arranged by the government, while TSMC will cover the premium costs. The Rende Reclaimed Water Plant is expected to be completed and operational in 2025. Through the joint efforts of all parties, this initiative aims to contribute to the sustainable development of regional water resources.

At the same time, TSMC is extending its experience in using reclaimed water from its Taiwan fabs to overseas operations. In 2024, TSMC launched the TSMC Arizona Reclaimed Water Plant project and began assessing near zero liquid discharge testing. By minimizing wastewater discharge, this approach aims to further enhance water recycling rates and strengthen the resilience of the fab in dry climates.

Reclaimed Water Development and Material Supply Schedule

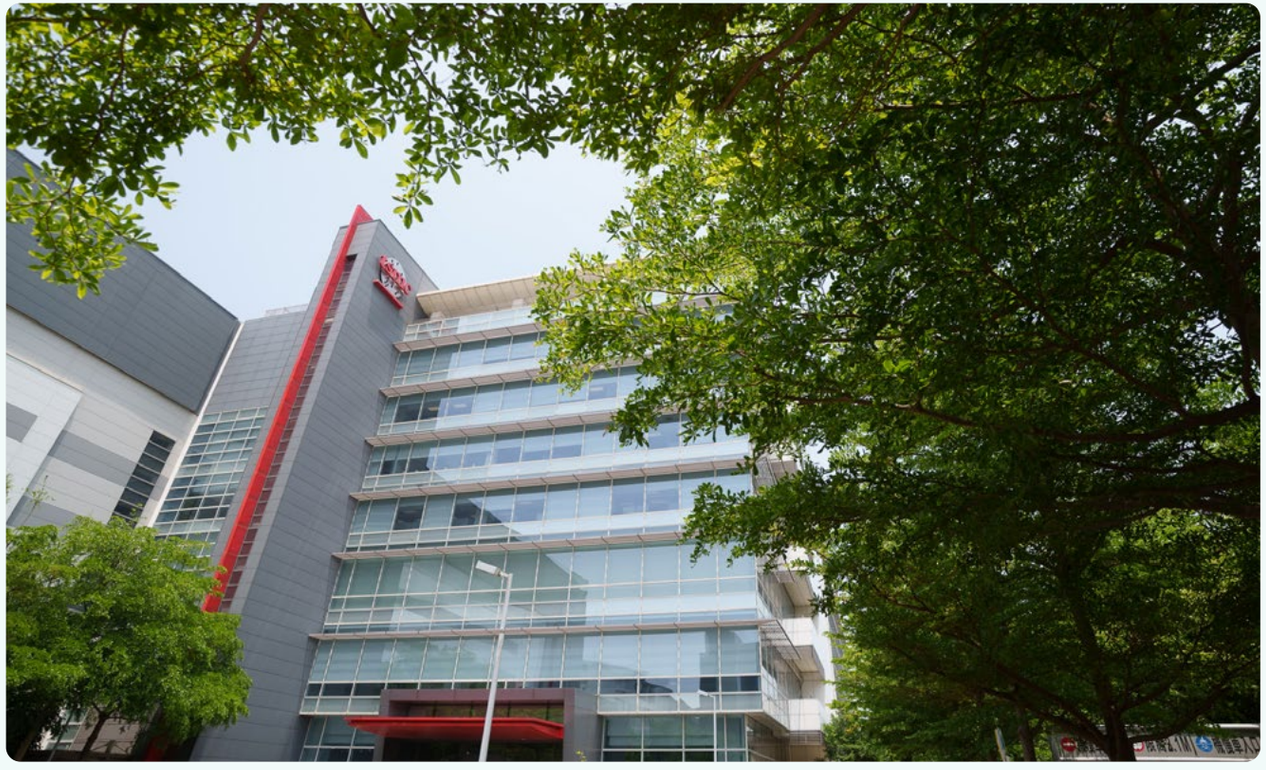


Case Study

Introduce Reclaimed Water into Advanced Processes

After the official commissioning of the TSMC Southern Taiwan Science Park Reclaimed Water Plant in 2022, TSMC began planning the use of reclaimed water for manufacturing processes. To ensure wafer quality, TSMC established a rigorous reclaimed water quality verification procedure. Initially, reclaimed water was used for secondary purposes to observe its water quality stability. A small-scale ultrapure water system was then used to simulate the ultrapure water produced from reclaimed water, ensuring it met semiconductor manufacturing standards. Once the water quality was verified to exceed required specifications, reclaimed water was introduced into the ultrapure water systems of mature manufacturing fabs to produce ultrapure water that meets wafer process requirements. This initiative was gradually expanded to advanced fabs utilizing 5-nanometer and 3-nanometer processes.

The operations and facility teams at TSMC's Tainan fabs conducted wafer trial production for all manufacturing processes, with each process requiring approximately three months of testing to ensure that the quality of wafers produced using reclaimed water was consistent with those made using traditional water sources. Only after passing the quality verification process could reclaimed water be approved for use. Following a two-year validation process, TSMC successfully introduced reclaimed water into the most advanced semiconductor manufacturing processes in 2024. This complex and time-consuming procedure demonstrates TSMC's commitment to quality and its responsibility to customers, ensuring that the use of reclaimed water does not compromise its exceptional product quality. Through these efforts, TSMC contributes to the sustainable development of the semiconductor industry.



TSMC introduces reclaimed water into fabs with advanced processes.

Innovative Water Pollution Prevention Technology

TSMC continues to advance wastewater resource management by establishing 38 wastewater diversion systems based on the composition and concentration of process wastewater for recycling and reuse. Additionally, TSMC has developed technologies such as biological membrane treatment systems, hypochlorous acid mixing systems, and high-gravity rotary beds to effectively treat wastewater that cannot be recycled before discharging it to the wastewater treatment plants in the industrial parks. In 2024, the overall wastewater pollution reduction index reached 63%, surpassing the annual target of 60%. To ensure the stable operation of pollution control equipment, the wastewater treatment system is equipped with backup and early warning mechanisms. In the event of system failures, backup equipment is immediately activated to ensure continuous operation and achieve the goal of zero failure in pollution prevention. In 2024, no abnormal wastewater discharge incidents occurred.

In response to Taiwan's regulatory requirement to include total phosphorus in effluent standards starting in 2027, TSMC plans to proactively incorporate total phosphorus into its wastewater management indicators by 2025. The Company will utilize wastewater diversion technology to recover phosphorus-containing wastewater, which will then be handed over to waste treatment contractors for concentration and purification into phosphoric acid solvents. This approach not only reduces the total phosphorus concentration in wastewater to meet industrial park regulatory standards but also promotes the development of a circular economy.

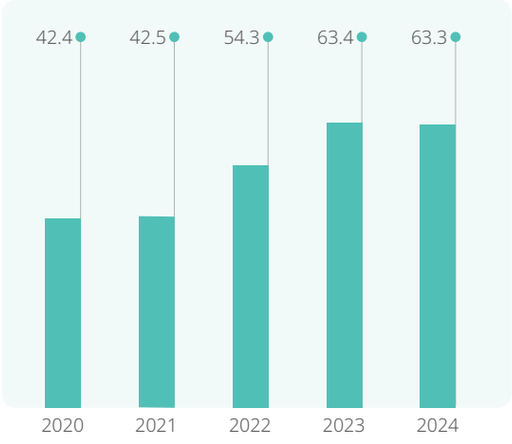
Develop New Wastewater Treatment Technology

TSMC continues to innovate in pollution prevention technologies to ensure its water resource management keeps pace with advancements. In 2024, TSMC collaborated with National Taiwan University, ITRI, and suppliers to introduce drinking-water-grade bituminous coal GAC adsorption filtration technology for treating PFASs process wastewater, achieving an average removal rate of up to 95%. The system installation for existing fabs is expected to be completed by 2025, and this technology will become the standard design for wastewater systems in new fabs.

Following the modification of the high-gravity rotating bed equipment to enhance the reduction rate of IPA in organic waste liquids, TSMC in 2024 further expanded the scope of this technology's application. By utilizing the high-speed centrifugal force generated by the ultragravity rotary bed to improve mass transfer efficiency, the technology was applied to ammonia nitrogen wastewater treatment at the Advanced Backend Fab 6. This process enabled ammonia nitrogen to more effectively combine with sulfuric acid to form ammonium sulfate, achieving a 95% ammonia nitrogen removal rate. Experimental results showed that the ammonium sulfate quality could be maintained without requiring a concentration process, effectively simplifying operational procedures. Simultaneously, TSMC optimized the diversion mechanism for ammonia nitrogen wastewater treatment. Low-concentration wastewater is treated using biological systems, while high-concentration wastewater utilizes MD technology. This approach eliminates the need for RO concentration, enhancing wastewater treatment efficiency, reducing chemical usage, and minimizing environmental impact.

Water Pollution Composite Indicator Reduction Rates

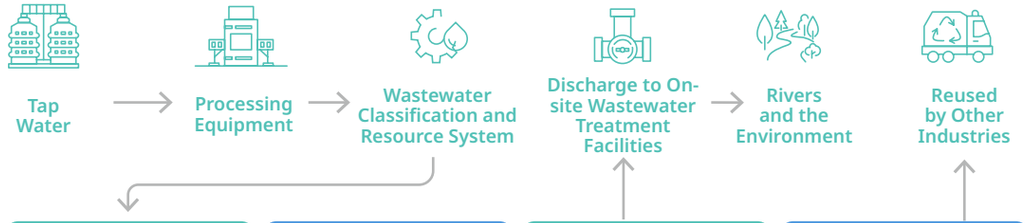
Unit: %



Note: Figures from TSMC fabs in Taiwan

TSMC extends the application of high-gravity rotating packed bed technology to ammonia nitrogen wastewater treatment.

Wastewater Classification and Resource System



	38 Different Types of Liquid Classified	9 Recycling Systems	13 Types of Wastewater Treatment	8 Products Recycled
Hydrofluoric (HF) Acid Wastewater	• HF acid wastewater (2 types) • Ozone-containing HF acid wastewater • Manufacturing process scrubbing water	• Hydrofluoric (HF) acid wastewater • Local scrubber wastewater recycling	• Chemical coagulation treatment of HF acid • HF (including ammonia) treatment • Biological treatment of HF acid wastewater	• Calcium fluoride • Fluorite Cryolit
Acidic, Caustic, and Organic Wastewater	• Deionized water • Ozone-containing deionized water • Acidic wastewater (2 types) • Ozone-containing acidic wastewater • Caustic wastewater • Ozone-containing Caustic wastewater • TMAH wastewater • Organic wastewater (2 types)	• Acidic wastewater recycling • Ozone-containing acidic wastewater recycling • Caustic wastewater recycling • Caustic wastewater upcycling • Organic wastewater recycling	• Acidic and Caustic wastewater treatment • NH_4-N wastewater treatment and recycling • TMAH liquid waste recycling • Biological treatment system for organic wastewater	• Ammonium sulfate • TMAH
CMP Wastewater	• Electroplating wastewater • CMP wastewater (2 types) • Copper-containing CMP wastewater • Cobalt-containing CMP wastewater	• Chemical coagulation recycling of CMP wastewater • Copper-containing CMP wastewater upcycling	• CMP wastewater treatment • Copper-containing CMP wastewater treatment • Cobalt-containing CMP wastewater treatment	• Silicon aluminum oxide
High concentration Liquid Waste	• Other wastewater (16 types) • Waste sulfuric acid • Waste copper sulfate • Cobalt-containing liquid		• Waste-H_2SO_4 reclamation • Copper-containing electroplating wastewater recycling • Cobalt-containing electroplating wastewater recycling	• Sulfuric acid • Copper bar • Cobalt bar

Case Study

Optimization of NH_4-N Wastewater Treatment to Reduce Electrical Conductivity by Approximately 40% in Estimation

TSMC actively addresses ammonia nitrogen wastewater by employing reverse osmosis technology to remove dissolved substances and increase the relative concentration of ammonia nitrogen, as well as utilizing membrane degassing treatment to enhance removal efficiency. However, since the reverse osmosis process requires additional chemical agents and equipment operation, TSMC has adopted a more environmentally friendly approach to reduce chemical usage by implementing diversion treatment for different concentrations of ammonia nitrogen wastewater. Through collaborative testing between production line and facility teams, TSMC successfully identified key concentration ranges: low-concentration wastewater is routed to biological systems, while high-concentration wastewater is treated using membrane degassing systems. This optimized process eliminates the need for reverse osmosis concentration, while simultaneously reducing chemical usage, waste generation, and energy consumption. According to 2024 trial results at Fab 20, the conductivity of ammonia nitrogen wastewater treated via the diversion process is estimated to decrease by approximately 40%, and chemical usage is expected to be reduced by about 30%, achieving the dual benefits of improved efficiency and environmental protection.

TSMC conducts NH_4-N wastewater separation based on the concentration to improve treatment efficiency.

Circular Resources

Strategies	2030 Goals	2025 Targets	2024 Achievements
Source Reduction Promote waste reduction by source separation and require vendors to provide low chemical consumption equipment	Outsourced waste[Note 1] amount per wafer production in Taiwan: ≦ 0.50 (kg/12-inch equivalent wafer mask layer)	Outsourced waste amount per wafer production in Taiwan: ≦ 1.11 (kg/12-inch equivalent wafer mask layer)	Outsourced waste amount per wafer production in Taiwan: 1.15 (kg/12-inch equivalent wafer mask layer) ↑ Target: ≦ 1.17
	Outsourced waste amount per wafer production in overseas subsidiaries: ≦ 1.10 (kg/12-inch equivalent wafer mask layer) NEW	Outsourced waste amount per wafer production in overseas subsidiaries: ≦ 1.36 (kg/12-inch equivalent wafer mask layer) NEW	Outsourced waste amount per wafer production in overseas subsidiaries: 1.38 (kg/12-inch equivalent wafer mask layer) NEW
Enhance Circular Economy Collaborate with vendors to develop new waste recycling technology to increase the amount of waste recycled and reused	70% In-house recycling rate	In-house recycling rate ≧ 33%	29%[Note 2] In-house recycling rate — Target: ≧ 33%
	Reduce the CO_2 emissions from waste treatment to the same as 2020 emission levels[Note 3] (53,178 metric tons)	Promote three projects to reuse instead of incinerate	Promote three projects to reuse instead of incinerate and reduce carbon emissions by 483 metric tons[Note 4] ✓ Target: three projects
	100% Waste recycle rate	Waste recycling rate 97%	Waste recycling rate 97% ↑ Target: 96%

Applicable to all TSMC fabs around the world | Applicable to TSMC fabs in Taiwan and other specific fabs | Only applicable to TSMC fabs in Taiwan | Applicable to TSMC overseas fabs | ↑ Exceeded | ✓ Achieved | — Missed target

Note 1: Outsourced waste refers to wastes disposed of or reused based on the application of a company with approval from the competent authority of the industry.

Note 2: For the reason of missing target, please refer to "Enhance Circular Economy."

Note 3: Carbon emissions derived from waste incineration including removal and treatment. According to the carbon emission calculation results for 2024, emissions from incineration are the main source, accounting for approximately 87%. Therefore, the carbon emissions calculated here refer to those generated during the incineration process.

Note 4: The estimation is based on the emission factor for general business waste (incineration) at 0.737kg CO_2e/kg. The source of the emission factor: Open data platform of the government (Renewable Resource Center, Southern Taiwan Science Park)

Strategy	2030 Goals	2025 targets	2024 achievements
Strengthen inspection and Guidance Enhance contractor capabilities in self-management and implementing resource recycling through inspection, guidance, and tracking with applied technologies	All waste contractors shall acquire ISO 14001 or other international EHS Management certification[Note 5]	90% of waste contractors shall acquire ISO 14001 or other international EHS Management certifications	89% of waste contractors shall acquire ISO 14001 or other international EHS Management certifications ↑ Target: 88%
	All waste contractors shall finish building the System of Waste Intelligent Fast Track (S.W.I.F.T.)[Note 6]	48% of waste contractors shall finish building the System of Waste Intelligent Fast Track (S.W.I.F.T.)	44% of waste contractors shall finish building the System of Waste Intelligent Fast Track ↑ Target: 35%
	Increase the percentage of Excellent and Good waste contractor evaluation results to 90%[Note 7]	Increase the percentage of Excellent and Good waste contractor evaluation results to 90%	Increase the percentage of Excellent and Good waste contractor evaluation results to 88% ✓ Target: 88%

Applicable to all TSMC fabs around the world | Applicable to TSMC fabs in Taiwan and other specific fabs | Only applicable to TSMC fabs in Taiwan | Applicable to TSMC overseas fabs | ↑ Exceeded | ✓ Achieved | — Missed target

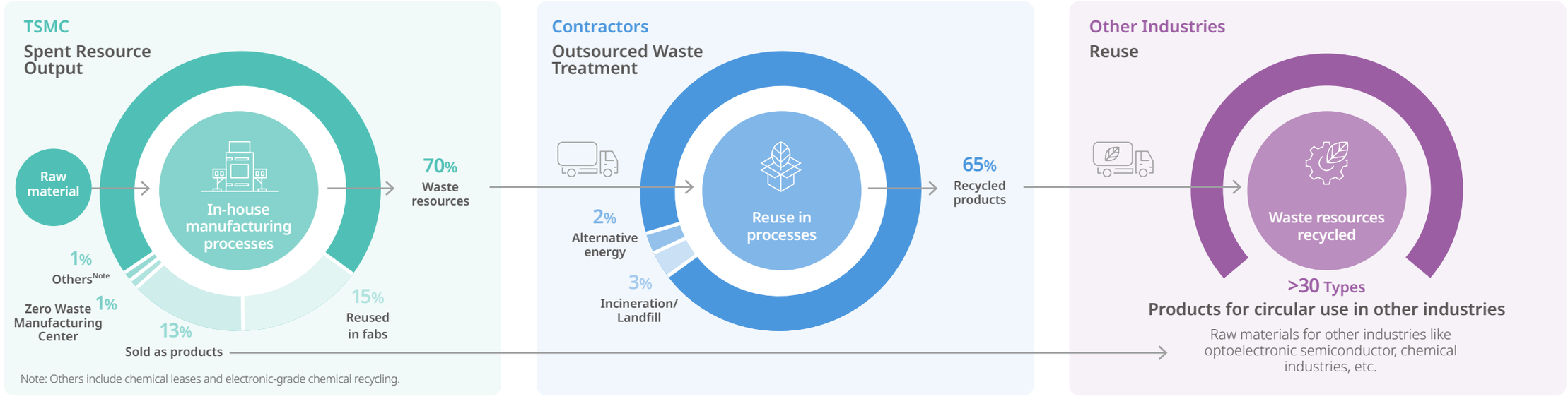
Note 5: TSMC requires waste treatment contractors to obtain at least ISO 14001 or ISO 45001 certifications three years after it becomes a qualified contractor as the basis for standardized management. Waste treatment contractors include waste treatment and recycling contractors. Government-owned enterprises, public-to-private enterprises, enterprises operating under the Act for Promotion of Private Participation in Infrastructure Projects, wholesale and retail industry, items exempted from on-line reporting, timber waste, lubricant waste, waste cooking oils, kitchen waste contractors not included in the aforementioned contractors.

Note 6: Only include TSMC-certified waste treatment contractors that have been working with TSMC for three years. Waste treatment contractors include waste treatment and recycling contractors. Government-owned enterprises, public-to-private enterprises, enterprises operating under the Act for Promotion of Private Participation in Infrastructure Projects, wholesale and retail industry, items exempted from on-line reporting, timber waste, lubricant waste, waste edible oils, food waste contractors not included in the aforementioned contractors.

Note 7: The evaluation does not include items exempt from itemized online reporting, nor does it include wholesale businesses, manufacturers stationed in the Zero-Waste Manufacturing Center, retail businesses, or contractors handling waste wood, waste lubricants, waste cooking oil, or kitchen waste.

By adopting the three major strategies of source reduction, circular economy, and inspection guidance, the Company proactively implements the targets of "minimizing waste, maximizing resource recycling, and optimizing contractor management." In 2024, the waste recycling rate (including overseas subsidiaries) reached 97%, while landfill rates for fabs in Taiwan remained below 1% for 15th consecutive year. This successfully extended the validity of the highest UL 2799 platinum certification for fabs in Taiwan and fulfilled the commitment in the "Environmental Policy." In 2024, TSMC further expanded its circular economic commitment and announced in November the official operation of the Taichung Zero Waste Manufacturing Center, the first integrated energy and resource circulation site in the semiconductor industry worldwide. TSMC cooperated with suppliers to recycle and produce electronic-grade TMAH and IPA and develop aluminum-plastic separation technology to allow the discarded packaging bags to be recycled and reused so as to continue innovating on the value-in-use of resources through diverse circular economic production models.

TSMC Waste Life Cycle Management Procedure



Note: Others include chemical leases and electronic-grade chemical recycling.

In-house waste management

- Source separation and collection procedure
- Waste output tracking and in-house reduction project
- Resource recycling equipment
- Zero Waste Manufacturing Center
- Chemical leasing
- Zero waste to landfill, UL 2799 certification
- New contractor selection procedure
- Annual evaluation standards
- Waste management practice forum

Waste clean-up

- TSMC GPS satellite fleet system
- Automated waste disposal declaration platform
- 2.0 Operations enhancement project
- Clearance safety forum NEW

Treatment and reuse operation

- Electronics-grade chemicals
- Industry cooperation to co-create resources project
- Annual inspection plan
- Quarterly inspection plan
- ISO 14001 certification plan
- System of Waste Intelligent Fast Track

Recycled product transport

- Cloud reporting platform

Recycled product flow

- Monthly tracking report
- Cloud reporting platform
- Track and compare with declared information

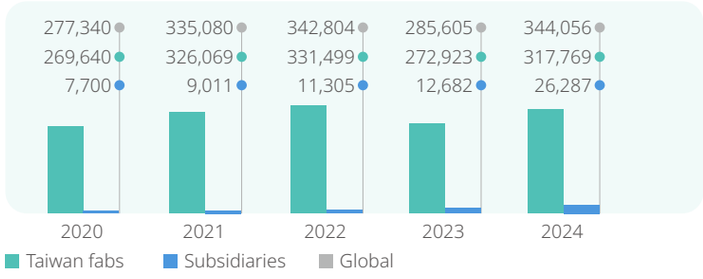
● Waste treatment contractor management project

2024 Total waste production 1,104,391 Metric tons

	General waste	Hazardous waste
97% Note 1 Recycled waste (1,067,782 Metric tons)		
Recycled materials (65%)	290,279 Metric tons	432,876 Metric tons
Reused in fabs (15%)	0 Metric tons	163,696 Metric tons
Converted to products and sold (12%)	90,423 Metric tons	42,327 Metric tons
Zero Waste Manufacturing Center (1%)	9,101 Metric tons	373 Metric tons
Energy recovery (fuel blending) (3%)	23,102 Metric tons	6,342 Metric tons
Others Note 2 (1%)	636 Metric tons	8,627 Metric tons
3% Non-recyclable waste (36,609 Metric tons)		
Incineration (3%)	28,915 Metric tons	4,402 Metric tons
Landfill(<0.5%)	1,760 Metric tons	1,532 Metric tons

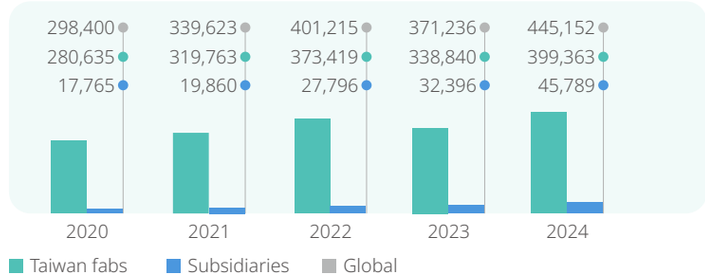
Outsourced General Waste

Unit: Metric tons/year



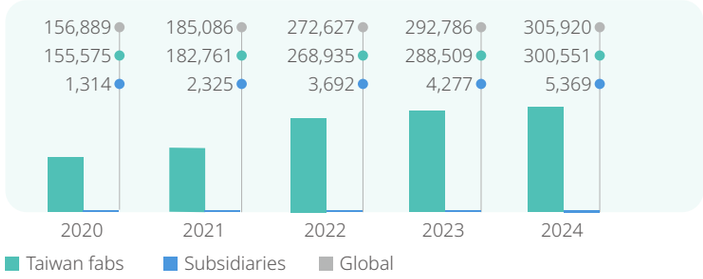
Outsourced Hazardous Waste

Unit: Metric tons/year



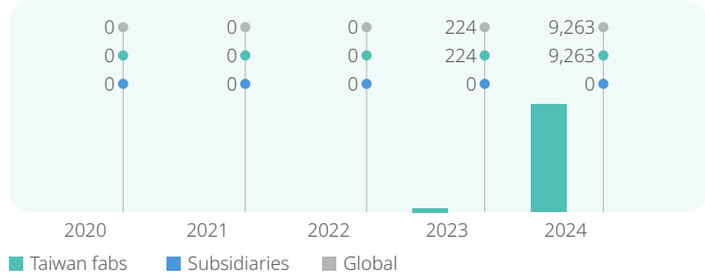
In-house Recycled Resources Note 3

Unit: Metric tons/year



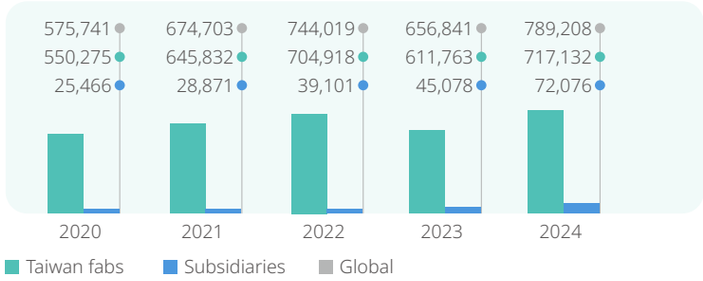
Other Measures Note 4

Unit: Metric tons/year



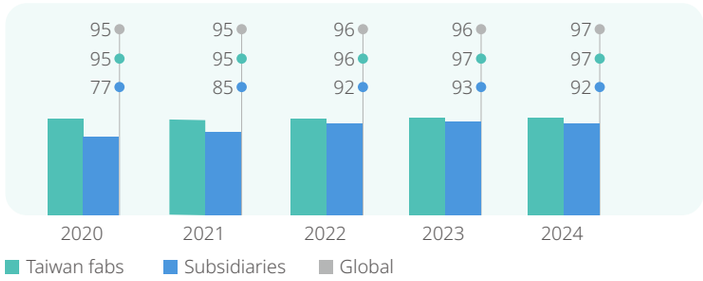
Outsourced Waste

Unit: Metric tons/year



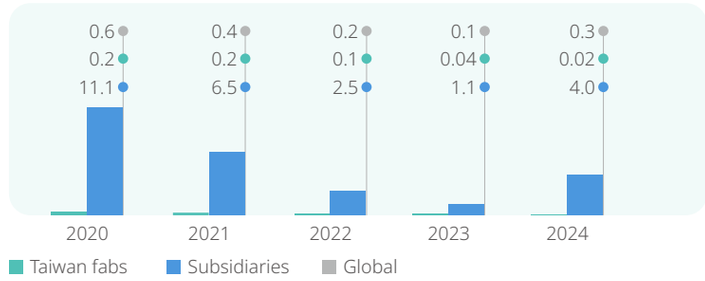
Waste Recycling Rate

Unit: %



Percentage of Waste Sent to Landfills

Unit: %



Note 1: The data include TSMC fabs in Taiwan, TSMC (China), TSMC (Nanjing), TSMC Arizona, TSMC Washington, LLC, JASM, and VisEra.
Note 2: Includes 571 metric tons chemical leasing, 8,692 metric tons electronic-grade chemicals
Note 3: In-house recycled resources include reused in fabs, converted to products and sold, and Zero Waste Manufacturing Center.
Note 4: Includes chemical leasing, electronic-grade chemicals recycling

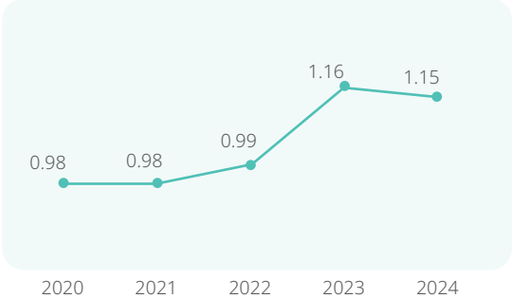
Source Reduction

"Source reduction" is one of TSMC's key strategy to minimize waste output. The "Waste Management Task Force" integrates cross-organizational collaboration between Facility, Process, and Resource recycling management departments, focusing on the PDCA management cycle model. At the beginning of each year, reduction targets and improvement plans are set, including adjustments to production parameters, optimization of process technologies to reduce raw material usage and in-house recycling and reusing as the prioritized to extend their lifecycle. TSMC also utilizes a unit waste generation management system to monitor waste generation and reduction progress. TSMC holds regular meetings to track the implementation status and effectiveness of these initiatives. In 2024, TSMC executed a total of 235 waste reduction projects for production equipment, reducing over 17,000 metric tons of waste.

Sulfuric acid is widely used in wafer cleaning processes within semiconductor manufacturing, making it a primary source of process waste liquid. Building on the waste reduction experience of adjusting the acid discharge mode for wet etching equipment in 2023, TSMC further expanded this approach horizontally to high-temperature wet etching equipment in 2024. By inspecting the equipment pipelines' resistance of high-temperature and corrosion and continuously monitoring the temperature changes and pH levels of waste liquid collection tanks, TSMC successfully reduced approximately 3,400 metric tons of sulfuric acid waste without compromising the quality of the original processes.

Outsourced Unit Waste Disposal per Wafer Trend

Unit: Kg/12-inch equivalent wafer mask layer



Note: The data include TSMC fabs in Taiwan and VisEra.

TSMC Waste Reduction Management Mechanism

Data Inspection and Planning
Based on the variations in waste generation across different fabs, develop reduction projects and set annual targets

Experiments and Operation
Conduct experiments and trials on reduction plans

Continuous Improvement
Review the gap between performance and target to improve deficiencies and solve anomalies

Control and Measurement
Control raw material usage, waste generation and concentration

Waste Reduction Measures and Results in 2024

Manufacturing Equipment Waste Reduction
>17,000 Metric tons

Chemical use time/flow reduction	132
Process simplification solution	35
Life cycle extension of chemicals	51
Chemical alternatives	1
Others	16

+

In-house recycling
>300,000 Metric tons

Copper/cobalt containing liquid electrolysis	2
Ammonium sulfate crystallization	1
Silicon-containing liquid dehydration by filter press	1
Sulfuric acid reclamation	1
Hydrofluoric acid reclaim	1
Fluoride sludge recovery	1
Silica sludge recovery	1
Isopropanol waste liquid recovery	1
Solvent waste liquid recovery	1

=

310,000
Metric tons
Reduced waste

245
Introduced waste reduction measures

Enhance Circular Economy

TSMC is dedicated to creating a green circular system by developing and adopting resource recycling technologies through its "Turning Waste into High Value Products" action plan. This initiative converts waste materials such as sulfuric acid, copper sulfate, cobalt sulfate, ammonium sulfate, hydrofluoric acid, and silicon-containing waste liquids into regenerated products for reuse within its facilities or sale to related industries. In 2024, the total amount of resources recycled at TSMC's Taiwan facilities reached approximately 291,000 metric tons, generating benefits of about NT$1.95 billion. Additionally, in 2024, TSMC conducted equipment upgrades and process optimization tests for resource recycling, which resulted in the in-house resource recycling rate falling short of the original target. For sulfuric acid waste treatment, TSMC adopted a nitric acid temperature control method, which uses temperature control to reduce reagent consumption, accelerate the reaction, and minimize residual byproducts. This approach shortened reaction time by 50%, thereby improving operational efficiency and producing high-quality industrial-grade sulfuric acid. TSMC continues to enhance reuse technologies and product quality.

Regarding the "Electronic-Grade Chemical Recycling Program," in 2024 , TSMC collaborated with suppliers to successfully convert TMAH waste into electronic-grade products for reusing within its facilities. In December, the development of electronic-grade IPA was also completed. The demonstration project for leasing regenerated activated carbon has been concluded, with a total of 770 metric tons of regenerated activated carbon leased, resulting in a carbon emission reduction of 5,100 metric tons . In 2025, TSMC plans to integrate the achievements of electronic-grade chemical reuse and collaborate with the Ministry of Environment to draft management methods for leasing liquid chemicals. Additionally, in November 2024, TSMC's Taichung Zero Waste Manufacturing Center officially commenced operations. Beside TSMC's organic solvent thermal recovery facility, the center partnered with suppliers to establish four processing facilities for calcium fluoride sludge, silicon oxide sludge, and isopropanol recycling. These facilities are estimated to reduce 130,000 metric tons of waste outsourcing annually. The Southern Taiwan Science Park Zero Waste Manufacturing Center is expected to be completed in 2027, further enhancing resource recycling capabilities.

Regarding the "Outsourced Waste Resource Recycling" plan, in 2024, TSMC implemented three incineration-to-reuse projects, including: converting organic sludge through thermal treatment into CLSM ; purifying waste aluminum etching liquid to regenerate industrial-grade phosphoric acid; and separating waste aluminum-plastic packaging bags to produce aluminum materials and plastic pellets, which are used in the manufacturing of bicycles and plastic products. Through green innovation, TSMC is giving new value to waste resources.

In addition to implementing circular economy practices during the production phase, TSMC also enhances employees' knowledge of resource recycling through training courses. These courses cover topics such as waste classification principles, waste-related regulations, and ISO 14000 environmental management standards. In 2024, a total of 44 sessions were held, with approximately 24,000 participants. TSMC also launched its first "TSMC Eco-Partner" trilogy campaign, which included lending of reusable cups, promoting the use of personal eco-friendly utensils, and supporting delivery services with eco-certifications. The initiative encouraged employees to reduce the use of single-use tableware and participate in eco-friendly delivery actions, with around 260,000 participants. Following the success of using discarded wafer carrier boxes as raw materials to create business card holders in 2023, TSMC developed 100% recycled ID card holders in 2024. These were showcased and gifted during the 5th TSMC ESG AWARD event, integrating the concept of resource regeneration into employees' daily lives.

Case Study

Refining Purification and Electrolysis Technology for Recycled Electronic-Grade TMAH

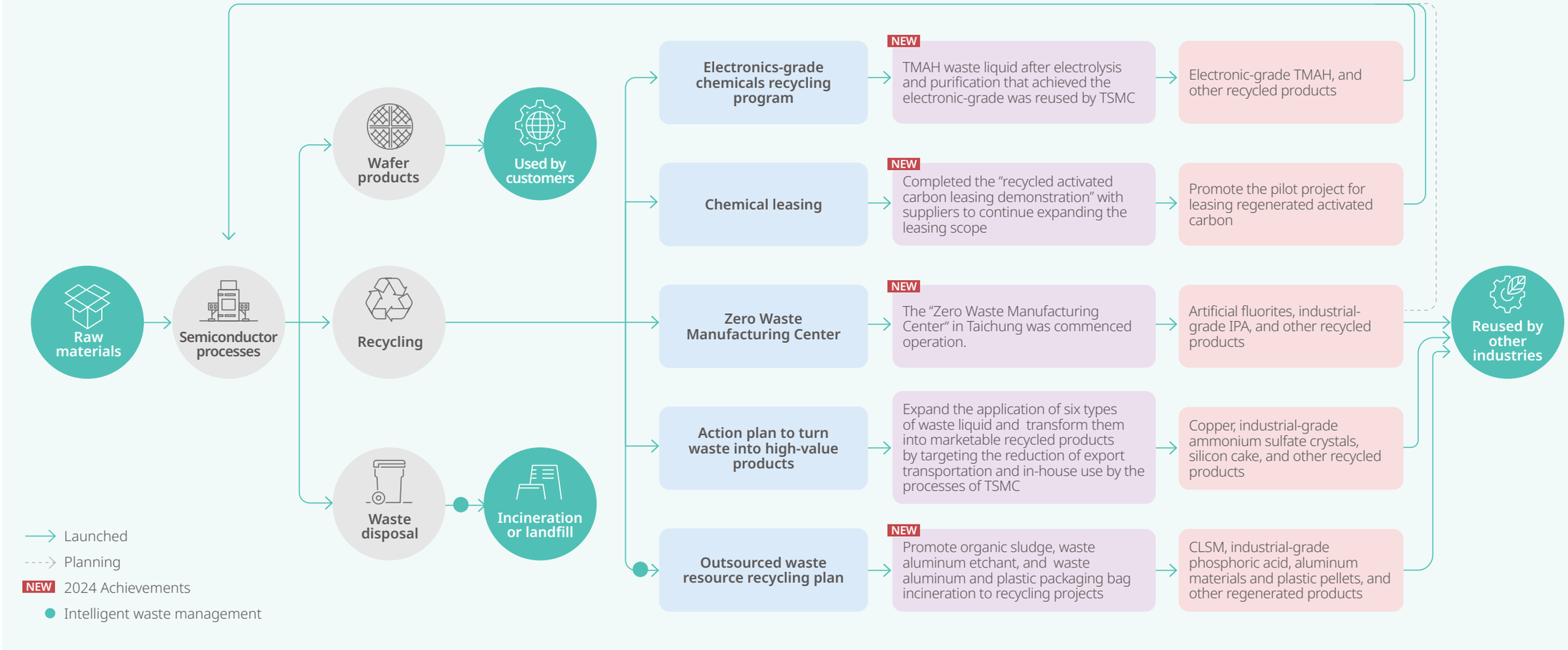
In response to the rapid development of advanced processes and the increasing demand for TMAH chemicals, TSMC collaborated with suppliers to conduct research on recycling TMAH waste liquid to enhance recycling rates. This effort included developing purification technologies capable of effectively removing impurities from waste liquid and improving electrolysis and filtration processes. In 2024, TSMC successfully regenerated electronic-grade TMAH that meets the quality standards for internal manufacturing processes . The recycled TMAH was introduced into Fab 12A, Fab 14A, Fab 14B, and Fab 15A, reducing the procurement of new liquid by approximately 1,100 metric tons and cutting carbon emissions by 6,600 kilograms . Additionally, TSMC developed electronic-grade IPA and continues to research new technologies for purifying waste liquids such as diluents, phosphoric acid, and hydrofluoric acid into electronic-grade materials, further advancing sustainable resource initiatives.

TSMC collaborates with suppliers to develop electronic-grade TMAH.

Practices for Circular Economy

1,680.77 Million
Savings from reducing waste in 2024 (NT$)

1,072.66 Million
Benefits from recycling waste in 2024 (NT$)



Case Study

Upgrade Aluminum-Plastic Separation Technology Revitalize Discarded Packaging Bags

To maximize the benefits of resource recycling, TSMC launched the Rebirth Initiative – an outsourced waste resource recycling program – in collaboration with suppliers. This initiative focused on research for recycling and reusing waste aluminum-plastic packaging bags and successfully developed a technology that completely separates the aluminum foil layer from the plastic layer . In December 2024, TSMC obtained approval for reuse from the Southern Taiwan Science Park Administration, with plans to implement the technology across all Taiwan fabs in 2025. This effort is estimated to reduce incineration volumes by 1,350 metric tons annually. Additionally, TSMC repurposed the separated plastic pellets to produce notebook covers and backs made from 100% recycled materials. These notebooks were created using eco-friendly paper certified by the FSC and were given as gifts during the 2025 Global Technology Symposium. This initiative imbues recycled resources with commemorative value.

TSMC recycles discarded aluminum-plastic packaging bags (left) and reproduced them into plastic pellets (middle) and aluminum materials (right).

Case Study

TSMC Eco-Eat Delivery Certification

To encourage employees to participate in eco-friendly initiatives, TSMC launched "eco-eat delivery certification" activities. The activities cover six key criteria: "using biodegradable straws, delivering with insulated boxes/bags, obtaining government eco-certifications, offering pre-order drink services with personal cups, providing reusable cup services, and offering bulk beverage services." A total of 64 businesses participated in the effort. During the activities, employees who purchased items from certified eco-friendly delivery businesses could accumulate points and earn chances to win prizes. This initiative aimed to reduce plastic usage and foster a green lifestyle.

TSMC encourages employees to bring their own cups to support environmental protection initiatives.

Case Study

The Inaugural Circular Economy Demonstration Center Turns Waste into Gold

Adhering to a "zero waste through resource recycling" philosophy, TSMC has established the Taichung Zero Waste Manufacturing Center , which includes four major recycling and processing facilities. These facilities convert waste generated from manufacturing processes into industrial-grade raw materials and evaluate the development of recycled electronic-grade chemicals for reuse in semiconductor manufacturing. The initiative is expected to reduce outsourced waste processing volumes by 130,000 metric tons annually. In 2024, the center processed 9,400 metric tons of waste, generating NT$80 million in benefits. Additionally, TSMC has collaborated with Taiwan's Ministry of Environment to develop "Thin-Film Carbon Capture Technology," using the Taichung Zero Waste Manufacturing Center as the country's first demonstration site. This technology will be applied to general waste thermal treatment (incineration) facilities in the future, further expanding green impact through innovative technology.

Four Major Recycling and Processing Mechanisms of Taichung Zero Waste Manufacturing Center

Solvent Thermal Recovery Plant
Generate "steam" after pyrolysis and heat recovery to serve as the auxiliary energy of the Taichung Zero Waste Manufacturing Center

Fluoride Recycling Plant
Generate "artificial fluorite" after drying, mixing, granulation and shaping to serve as the fluxing agent for the iron and steel industry

Taichung Zero Waste Manufacturing Center

Silica Recycling Plant
Generate "mineral powder" after drying, roasting, soaking, and surface modification to serve as raw materials for ceramic industries and construction material

Isopropanol Recovery Plant
Generate "industrial-grade/ electronic-grade IPA" after distillation and purification to serve as the raw materials for other industries or the semiconductor industry

Strengthen Audit Guidance

To ensure proper waste transportation and fulfill source management responsibilities, TSMC requires transportation contractors to comply with the guidelines outlined in the Supplier Transportation Management White Paper . Additionally, TSMC uses a dedicated GPS satellite fleet tracking system to monitor the waste transportation process, implementing transparent management practices. To enhance operational safety, TSMC further strengthened its "Waste Transportation Operations Improvement Project 2.0" in 2024. The Company hosted its first transportation safety seminar for liquid tanker contractors, covering topics such as personal protective equipment usage, transportation operation precautions, emergency response procedures, and common operational deficiencies. Furthermore, a quarterly training system was established to help transportation personnel familiarize themselves with operational processes and improve safety awareness. Personnel are required to complete training and pass tests before being allowed to operate within the facilities. In 2024, TSMC conducted annual on-site audits for 46 transportation contractors, achieving a 100% audit rate for liquid tankers, sludge vehicles, and hazardous waste transport vehicles. A total of 38 deficiencies were identified and corrected, including three related to company operational management, 12 related to transportation personnel training management, ten related to vehicle safety, and 13 related to transportation operation procedures.

Regarding waste treatment contractors, TSMC implemented the Waste Treatment Contractor Sustainability Enhancement Project through cross-organizational collaboration. The process began with a written review and on-site inspections across six key dimensions to carefully select partner contractors. For qualified contractors that pass the selection process, annual audits and guidance are conducted based on 156 audit criteria across eight dimensions. Finally, contractor operations are evaluated annually through three key dimensions, which serve as the basis for replacement assessments. In 2024, TSMC conducted on-site audits for 69 waste treatment contractors , achieving a 100% audit rate, and completed improvements for 98 deficiencies . The proportion of contractors rated as "Excellent" or above increased from 86% in 2023 to 88% in 2024, with 32% rated as "Outstanding." Additionally, 89% of contractors have obtained international certifications such as ISO 14001 for environmental, safety, and health standards. Furthermore, TSMC continues to assist contractors in establishing intelligent waste tracking systems. By 2024, 44% of waste treatment contractors had completed system implementation, leveraging digital transformation to enhance management efficiency.

Waste Clean-up Improvement Project 2.0 for the Improvement in Contractor's Operational Safety

Before Clean-up Contractor Selection

- Establish a standardized selection procedures to examine the qualification of contractors
- Establish personnel and vehicle certification systems to ensure the familiarity of personnel with the operations and the vehicle specifications

During Clean-up Operation Observation

- Examine the compliance of the on-site tank truck operations based on document data, vehicle specifications, and operating procedures
- Require the contractor's supervisor to follow the vehicle for self-audits to reinforce the management during the clean-up processes

After Clean-up Annual Audit

- Fully examine the management and operations of contractors through annual audits
- Combine the annual education and training plans of personnel with the annual inspection plans of tank trucks and strengthen accident case promotion and self-inspections of tank trucks
- Conduct clearance safety forum for waste transportation to strengthen awareness of safety culture NEW
- Quarterly training sessions and online tests to help familiarize employees with operational procedures NEW

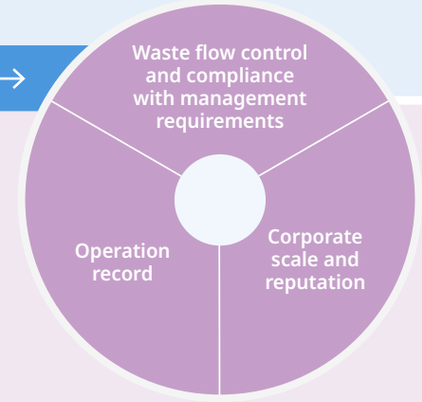
Waste Treatment Contractor Sustainability Enhancement Project

Contractor Selection six Main Aspects

- Environmental safety&health department
- Purchasing department
- Waste management section

Contractor Inspection eight Main Aspects

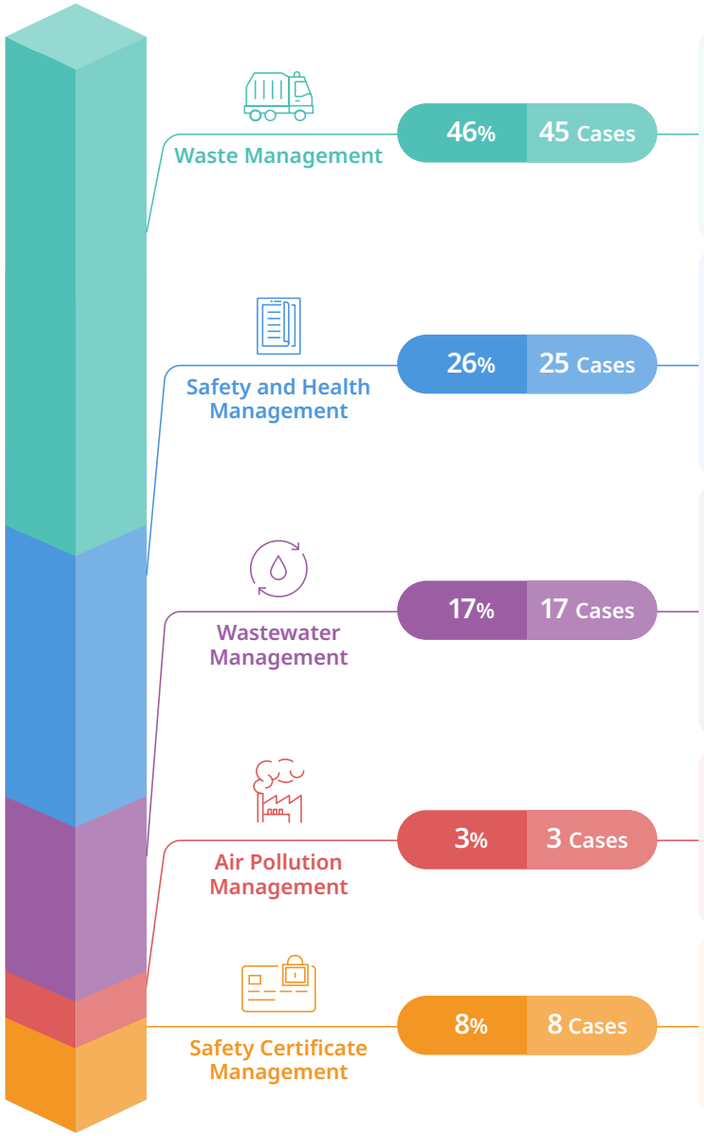
- Industrial safety and environmental protection
- Waste management section



Annual Evaluation three Main Aspects

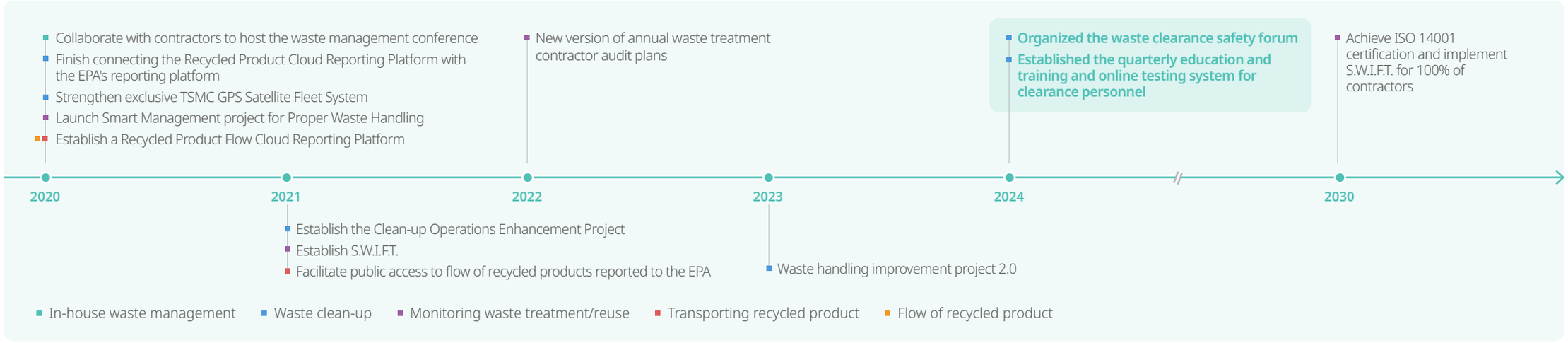
- Environmental safety&health department
- Waste management section
- Purchasing department
- Legal department

Waste Treatment Contractor Audit and Guidance Results in 2024

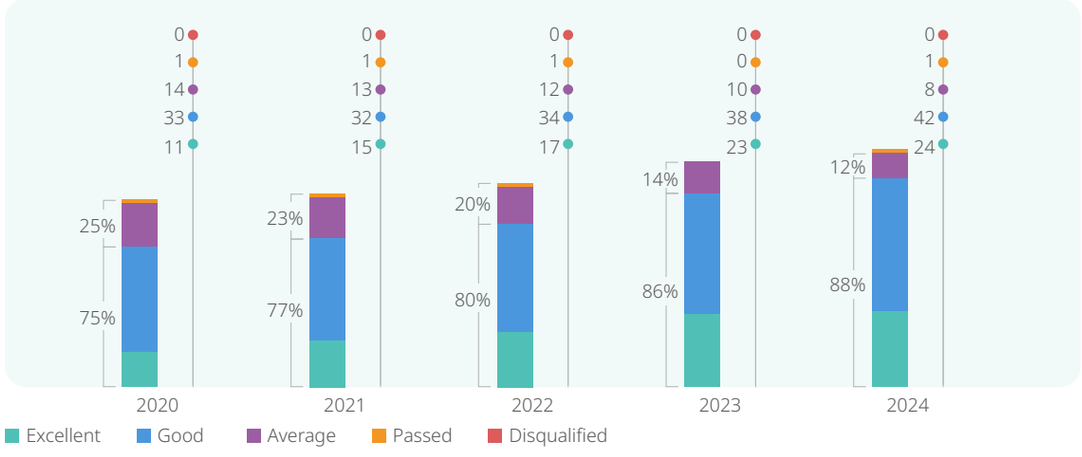


		Legal Compliance	On-site Environment/ Operational Improvement	Establishing Regulations and Procedures
Waste Management	46% 45 Cases	Add due diligence requirements Correct false declarations Amend waste disposal contracts Add recycled product sales contracts	Correct erroneous labels in waste storage areas Extend the storage period of the monitoring system Improve waste storage environment	
Safety and Health Management	26% 25 Cases	Formulate workplace environmental monitoring items and frequency based on the hazards and level of risk exposure and arrange special health check	Enhance compliance of on-site chemical labeling with the safety data sheet content Optimize safety protection equipment Reinforce the education and implementation of wearing personal protective equipment Implement hazardous machinery and equipment check	Improve the environmental safety and health management audit plan and implement the PDCA principles Execute the training for personnel in charge of hazardous chemicals
Wastewater Management	17% 17 Cases	Adjust the scope of the water pollution prevention and control plan to comply with on-site practices Conducting wastewater testing items according to water pollution prevention and control plan Correct false declarations Implement the patrol inspection system of dedicated personnel and systemize the records	Enforce wastewater meter records Improve the signs of discharge point and wastewater pipeline Implement equipment maintenance based on the water pollution prevention and control plan Regularly calibrate detection instruments according to the requirements	
Air Pollution Management	3% 3 Cases		Correct the air pollution pipeline signs to comply with the requirements of the license Conduct the pollution source regular record-taking Regularly calibrate detection instruments according to the requirements	
Safety Certificate Management	8% 8 Cases	Increase the certificates employee with first-aid/ occupational safety supervisors to comply with regulations Ensure the training compliance of operating personnel of machinery and equipment		

TSMC Waste Treatment Contractor Management Milestones

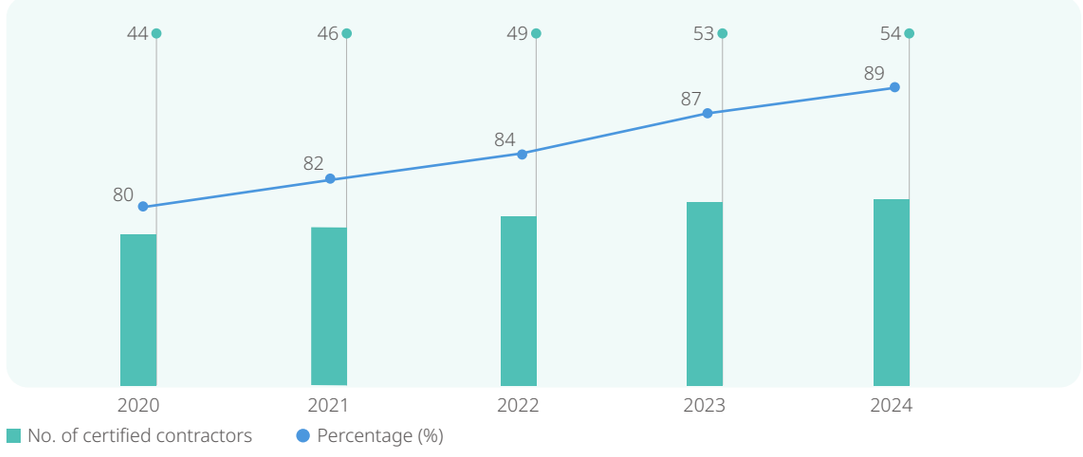


2024 Waste Treatment Contractor Evaluation Results



Note: The total score is 100 points: greater than 90 points are Excellent; 80-89 points are Good; 70-79 points are Average; 60-69 points are Passed; less than 60 points are Disqualified.

ISO-certified Waste Treatment Contractors



Air Pollution Control

Strategies	2030 Goals	2025 Targets	2024 Achievements
Adopt Best Available Technology Adopt the Best Available Technology to control the pollutants emitted from TSMC operations and minimize environmental impact	Reduce the unit air pollutant emissions[Note 1] by 65% (Base year: 2015)	Reduce the unit air pollutant emissions by 58%	Reduced the unit air pollutant emissions by 47%[Note 2] — Target: 58%
	Reduction rate of volatile organic gases: >99%	Reduction rate of volatile organic gases: >98.6%	Reduction rate of volatile organic gases: 99% — Target: >98.6%
Strengthen Monitoring for Air Pollution Control Equipment Leverage backup systems and dual-track management, along with pollutant monitors, to ensure that the equipment works as intended and to prevent abnormal occurrences	Report <1 abnormal occurrence in air pollution control equipment	Report <1 abnormal occurrence in air pollution control equipment	Reported 0 abnormal occurrences in air pollution control equipment — Target: <1

Applicable to all TSMC fabs around the world | Applicable to TSMC fabs in Taiwan and other specific fabs | Only applicable to TSMC fabs in Taiwan | Applicable to TSMC overseas fabs | Exceeded | Achieved | Missed target

Note 1: Air pollutant emissions include the total emissions of eight gases: VOCs, H_2SO_4, HCl, HNO_3, HF, H_3PO_4, Cl_2, and NH_3.

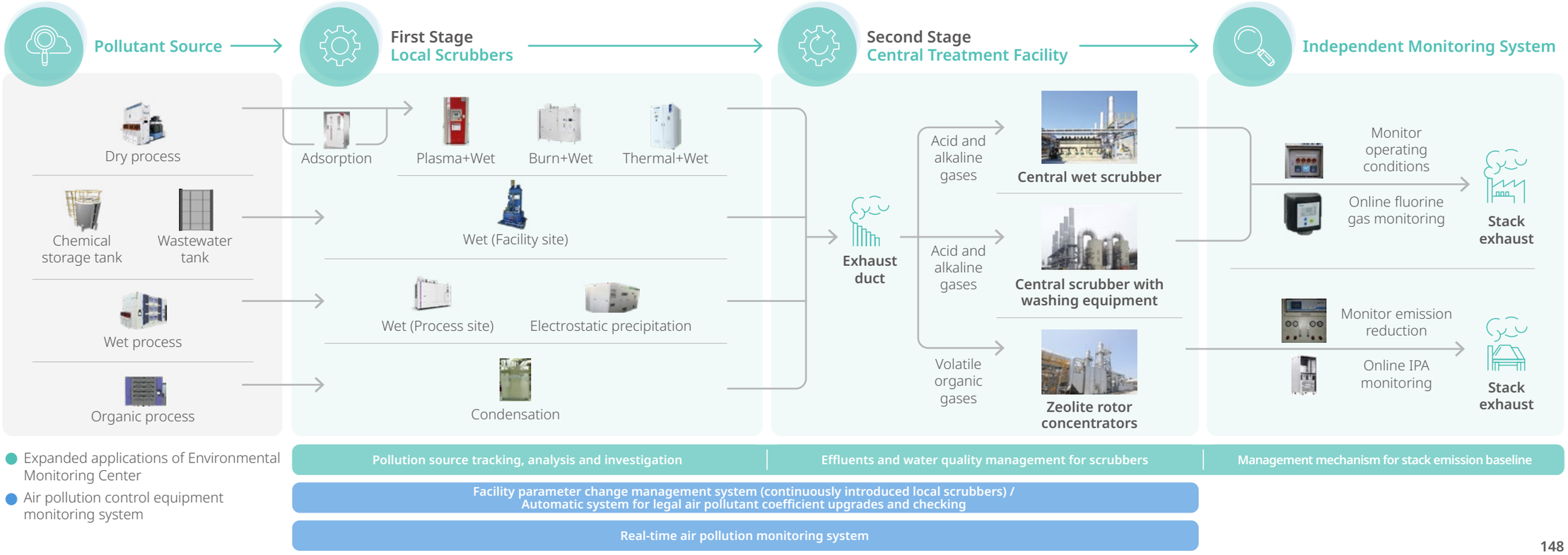
Note 2: TSMC failed to achieve the annual goal for wafer unit consumption primarily due to the fixed air pollution emission of Fab 20 Phase 1, Fab 22 Phase 1, TSMC Arizona Phase 1, JASM Phase 1, and Advanced Backend Fab 6B even if they have not been formally put into production (mass production) in 2024. TSMC will continue to invest in resources to mitigate the environmental impacts with the optimal and feasible technology.

TSMC is committed to achieving the goal of minimal air pollutant emissions by implementing source separation and multi-stage treatment technologies while actively strengthening the treatment performance of control equipment. In 2024, TSMC cooperated with suppliers to renovate electric-heating local scrubbers and successfully increased the reduction rate of N_2O to 90% and reduced the discharge of NO_x by 40%. In addition, it expanded the sampling test application of the Environmental Monitoring Center, added waste recycling testing technologies, and organized the first "self-sampling training workshop" to cultivate the self-sampling capabilities of on-site personnel. The number of traceability and improvement verification cases increased by 27% from 2023, showing the continuous advances in the control effects of equipment and environmental quality.

Adopt Best Available Technology

Air pollutants generated from the manufacturing of semiconductors are mainly acid, alkaline, and volatile organic gases. To effectively control air pollution emissions and improve treatment efficiency, TSMC adopted classification and reduction of emission from sources and strengthened treatment of terminal control equipment to achieve BAT with the multi-phase system. Exhaust gases are separated based on their properties - toxic, corrosive, flammable, acid and alkaline gases with high concentration, and perfluorocarbon GHGs at the first stage. The gases are introduced to high-efficiency local scrubbers for processing. The gases with low acid/alkaline concentrations will then be sent to central scrubbers for rinsing and neutralization in the second stage. Depending on their boiling points, volatile organic gases may be sent to condensation-type scrubbers first and then to zeolite rotor concentrators for adsorption to further reduce their discharge.

Air Pollution Control Procedures



Different Types of Local Scrubbers

Process	Semiconductor Fabrication	Target Pollutant	Control Technologies	Equipment	Reduction Rate	Real-time Parameter Monitoring
Dry process	Epitaxial dry etching	Corrosive gases	Burn-wet		>99%	• Natural gas flow • Oxygen flow • Circulating water flow • Inlet pressure
		Perfluorocarbons	Burn-wet (Large-capacity)			
	Dry etching	Corrosive gases	Plasma-wet		>95%	• Current amperage • Circulating water flow • Inlet pressure
		Perfluorocarbons				
		Flammable gases				
	Thin film	Corrosive gases	Thermal-wet with chemical dosing		>95%	• Reactor temperature • Circulating water flow • pH value • Inlet pressure
	Diffusion	Perfluorocarbons				
	Sputtering	Perfluorocarbons				
		Hydrochloric acids	Thermal-wet with chemical dosing (Add high-efficiency spray device)		Hydrochloric acids >87% Particulate matters >86%	
		Particulate matters				
	Ion implantation sputtering epitaxy	Toxic gases	Adsorption		>95%	• Pressure difference of local scrubber • Inlet pressure
	Thin film	Nitrous oxide (N_2O)	High-temperature thermal+wet		>90%	• Reactor temperature • Circulating water flow • Inlet pressure
Wet process	Wet etching	Corrosive gases	Wet + chemical dosage		>95%	• Differential pressure of local scrubber • Circulating water flow • Inlet pressure • pH value
		Organic gases				
		Alkaline gases $PM_{2.5}$	Wet electrostatic precipitation		>90%	• Inlet pressure • Corona voltage • Corona current
Organic process	PR stripping	High boiling point organics	Condensation		Specific high boiling point organics >95%	• Differential pressure of local scrubber • Condensation temperature
Storage tanks	Chemical Storage tank	Corrosive gases	Wet + chemical dosage (Facility site)		>95%	• Differential pressure of local scrubber • pH value • Circulating water flow • Inlet pressure
	Wastewater tanks	Acid and alkaline gases				

Source Reduction and Management - High Efficiency Local Scrubbers

In response to the development of advanced process technology, raw materials and chemicals used by wafer processes have been increasing. To prevent by-products derived from new processes from causing air pollution risks, TSMC performs secondary reviews through its New Tool and New Chemical Review Committee. In 2024, a carried out a total of 351 reviews, including the review of 170 new tools and 181 new chemicals. The first review focuses on the evaluation of risks related to new chemicals and the establishment of the control system, while the second review tests and confirms the impacts of the discharge on the environment to select appropriate discharge separation methods and local scrubbers, including electrical heating, burning, plasma, wash with agents, absorption, condensation, washing, and other equipment for treatment in advance, implementing the reduction in air pollution emissions.

At the same time, TSMC continued to cooperate with suppliers to study the NO_x reduction technologies of different local scrubbers. TSMC has further upgraded thermal type, burner type and plasma type local scrubbers, using the redox reaction method, uniform combustion temperature control method, and the multi-stage heating method to reduce 60% of the NOx discharge for a single fab as a whole. In 2024, the methods have been introduced into Fab 12B, Fab 14A, Fab 15A, and Fab 18B, and have been included in the standard design for new fabs. In addition, to improving air emission quality, TSMC further promoted the "N_2O reduction project" to adopt CH_4 as

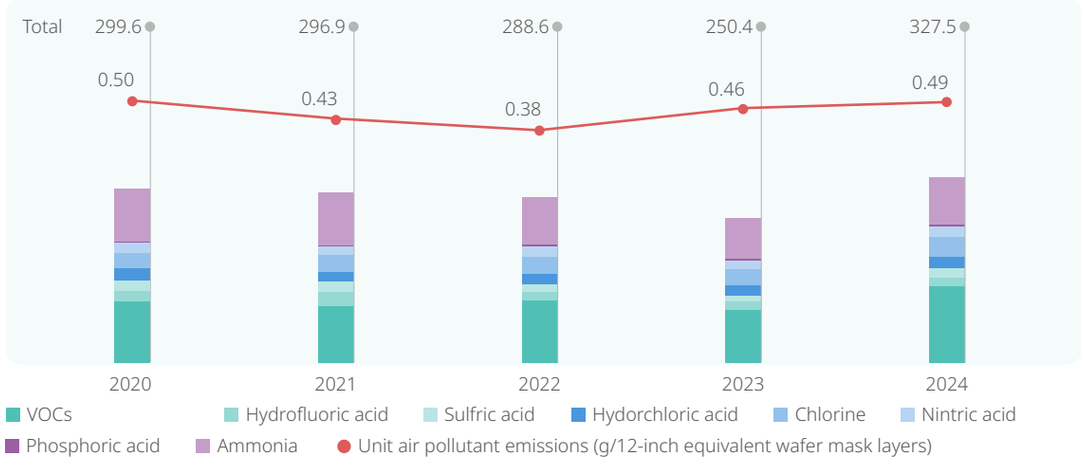
the reducing agent to generate hydroxyl radical, which can react with N_2O and facilitate its decomposition, under pyrolysis through the reformation of the electric-heating local scrubbers. According to the test, the reduction rate of N_2O increased from 42% to 90%, and the emissions of NO_x also reduced further by 40%, which passed the feasibility review of the New Tool and New Chemical Review Committee and improved eco-friendliness.

Strengthen Management of Terminal Prevention Facilities - Central Scrubbers

After the first-stage treatment, acid/alkaline gases are channeled to central treatment facilities for scrubbing and acid/alkali neutralization to remove pollutants in the second stage. Exhaust gases from wet processes that emit large amounts of acid/alkaline gases are sent to a central scrubber connecting washing tower to improve pollutant removal through two-stage washing. New fabs promote "dual zeolite rotor concentrator." However, when concentrated gases adsorbed by rotors enter thermal oxidizers, pyrolysis can remove volatile organic gas pollutants but may also produce NO_x pollutants. In 2024, new Fab 20, Fab 22 Phase 2, and Advanced Backend Fab 5B introduced the low-NO_x burner, which was included as a standard design, to reduce the NO_x discharge through the low oxygen combustion and flow control technologies. In 2024, the reduction rate of volatile organic gases reached 99%, continuously improving the performance of air pollution control.

Historical Emissions and Emissions Per Unit of Production

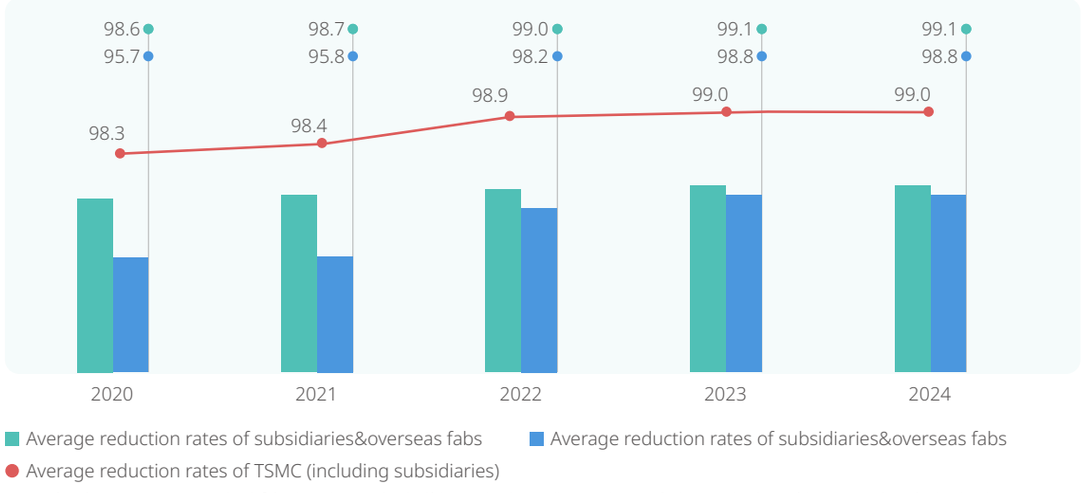
Unit: Tons/year



Note: TSMC air pollutant emissions are reported in accordance with local laws and regulations

Historical Volatile Organic Gas Reduction Rates

Unit: %



Note: The data scope covers TSMC fabs in Taiwan, TSMC (China), TSMC (Nanjing), JASM, and VisEra. TSMC Washington, LLC and TSMC Arizona are not required toinclude reduction information in accordance with local regulations.

TSMC continues to optimize the effectiveness of air pollution control equipment.

Timeline of Air Pollution Prevention Systems

Local scrubber · Central scrubbers · Zeolite rotor concentrators

2020
- Add chemical dosing system to scrubbers to wastewater tank scrubbers
- Introduce wet electrostatic precipators
- Introduce Smart Control Parameters for Single Zeolite Rotor Concentrators to existing facilities
- Introduce the Improvement Program for Inefficient Thermal Oxidizer of Zeolite Rotor Concentrators

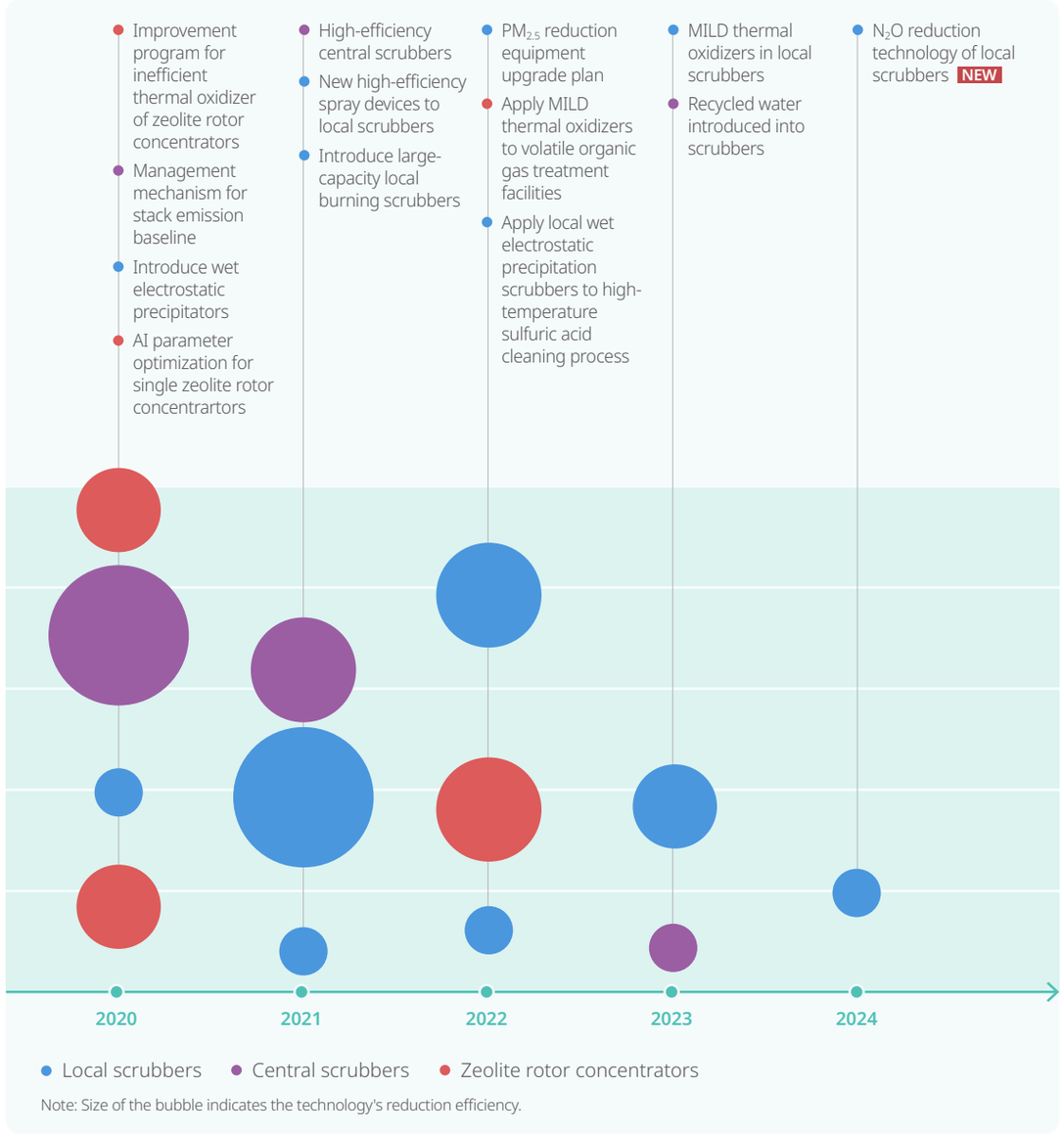
2021
- Add high-efficiency spray equipment to thermal wet scrubbers
- Introduce High-Efficiency Central Scrubbers to new facilities
- Introduce the Improvement Program for Inefficient Thermal Oxidizer of Zeolite Rotor Concentrators

2022
- $PM_{2.5}$ Reduction Equipment Upgrade Plan
- Introduce large-capacity burning equipment
- Apply MILD thermal oxiders to volatile organic gas treatment facilities

2023
- Apply local wet electrostatic precipitation scrubbers to high-temperature sulfuric acid cleaning process
- Develop real-time air pollution monitoring system
- Improve burning local scrubbers to reduce NO_x emissions

2024
- Introduce recycled water into scrubbers
- **Develop the N_2O reduction technology with a reduction rate reaching 90%**

Prevention Technology Feasibility and Reduction Effectiveness Evaluation



Note: Size of the bubble indicates the technology's reduction efficiency.

Expand the Application of the Environmental Monitoring Center and Initially Adopt Self-sampling Education

TSMC's Environmental Monitoring Center monitors and controls the three major application aspects, including air emissions, effluents, and surrounding areas, and improves equipment control and treatment performance. In response to the official operation of the Taichung Zero Waste Manufacturing Center in 2024, to accurately grasp the components/ingredients of waste, the Environmental Testing Center added the application aspect of "waste recycling." The sludge testing technology was initially developed to analyze waste liquids from various chemicals. Over time, it expanded its testing methods to improve the quality of recycled products and facilitate the development of the circular economy. In 2024, it continued to expand the testing scope, established the $PM_{2.5}$ testing method for stacks, added total phosphorus and NO_3-N testing for effluents, and added organic photochemical precursor testing for surrounding areas to comprehensively grasp the discharge and environmental quality of fabs.

In addition to developing diverse testing technologies, the Environmental Monitoring Center also provides verification for pollution emissions and improvements to control equipment across various fabs. To enhance the efficiency of air pollution mitigation and shorten the confirmation time, TSMC organized the first "self-sampling training workshop" in 2024 to cultivate the self-sampling capabilities of employees from the Facility Division and Industrial Safety and Environmental Protection Department regarding exhaust pollutants that contain inorganic acids (including sulfuric acid, nitric acid, hydrochloric acid, phosphoric acid, and hydrofluoric acid) and ammonia through the source of pollutants, sampling purpose and method described by lecturers, together with practical training and on-site exercises. A total of 14 sessions were organized, training 74 participants. The number of traceability and improvement verifications increased by 27% from 2023, further strengthening overall pollution control effectiveness.

Four Major Application Aspects of the Environmental Monitoring Center

Air Emissions

- Emission stack management system
- Traceability investigation
- Air pollution data digitalization and anomaly tracking
- $PM_{2.5}$ testing NEW
- Self-sampling training NEW

Surrounding Area

- Monitor surrounding areas with air quality vehicles
- Set up fixed testing stations at Zhunan, CTSP, and Tainan Science Park
- Organic photochemical precursor testing NEW

Effluents

- Effluent and scrubber water quality management system
- Water pollution data digitalization and anomaly tracking
- Total phosphorus and NO_3-N testing NEW

Waste Recycling

- Sludge testing NEW

Strengthen Monitoring of Air Pollution Prevention Equipment

TSMC is dedicated to maintaining the efficiency of air pollution control equipment and has installed additional measures, such as total hydrocarbon monitors and online monitoring instruments for isopropanol and fluorine gas, at various emission outlets to rigorously oversee monitoring values and actual emissions. Additionally, TSMC utilizes systems like the "Automated Verification System for Air Pollution Reporting Legal Coefficients," the "Facility Parameter Change Management System," and the "Facility Monitoring and Data Collection System" to track operational parameters of control equipment. By leveraging automated comparison and verification functions, TSMC ensures the accuracy of reporting information, preventing data loss or errors caused by human oversight. In response to process advancements and fab expansion needs, TSMC continued its updates to the Facility Parameter Change Management System initiated in 2023. In 2024, key control parameters of onsite treatment equipment at Fab 20 and Phase 2 of Fab 22 were incorporated into change management processes, ensuring operational stability of the equipment.

To maintain air pollution control equipment at its optimal operating status, at least one backup system is installed for all equipment to operate by adopting the “N+1” model. Meanwhile, the monitoring system and anomaly alert system are also established for the Facility Division and Industrial Safety and Environmental Protection Division to immediately carry out emergency repair or turn on the backup equipment, together with the assistance of the UPS, to minimize the risks of losses and achieve the target of zero failure in control equipment. In 2024, there was no air pollution control equipment anomaly, or punishment or expenses due to the violation of the Air Pollution Act.

Case Study

Optimize Control Equipment Treatment System to Achieve 90% Reduction Rate of N_2O

Different tail gases are generated from wafer manufacturing, and appropriate local scrubbers are adopted for burning and reduction based on their characteristics. With the burning temperature of the existing electric-heating local scrubbers being insufficient, the reduction rate of N_2O was worse than expected. Therefore, TSMC cooperated with suppliers to initiate the “N_2O reduction project” to introduce methane into electric-heating local scrubbers by adopting the reduction-oxidation reaction to serve as the reducing agent. Methane generates hydroxyl radicals under high temperatures and can react with N_2O to facilitate its decomposition and, in turn, improve the reduction efficiency. Meanwhile, methane can reduce NO_x to N_2 to reduce the discharge of NO_x and achieve double benefits.

In 2024, ITRI, a third-party verification department, carried out the test at TSMC. The N_2O reduction rate of electric-heating local scrubbers increased from 42% to 90%, and the NOx discharge can be further reduced by 40%. It also passed the SEMI S2 and the feasibility review of the New Tool and New Chemical Review Committee of TSMC. As of December, it has been introduced into Fab 12A, Fab 12B, Fab 14A, Fab 14B, and Fab 15A and included in the standard design for new fabs to improve the air pollution processing ability.

TSMC works closely with suppliers to renovate electric-heating local scrubbers to improve the reduction rate of N_2O.