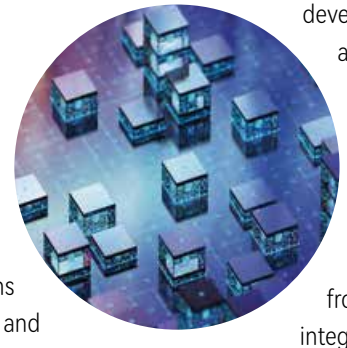
4.1 R&D and Innovation

Technology and innovation are the lifeline of our company. We have continued to invest heavily in advanced semiconductor packaging technology research and development and developing a strong engineering team, to produce high performance and cost-effective products that meet customers' needs. We have systematically mapped out a 10-year strategic blueprint that identifies key areas of technology focus by projecting industry and technology trends for the future. This will enable us to optimize our R&D resources and technology capabilities to seize important business opportunities and strengthen patent portfolios that further enhance our sustainability efforts. Our R&D expense increased 4.6% to NT$25,499.4 million in 2023, compared to NT$24,369.9 million in 2022, accounting for 3.7% and 4.4% of operating revenues in 2022 and 2023. As of December 31, 2023, our research and development team comprise 12,125 employees, an increase of 9.9% compared with 11,033 in 2022.



The advancements in 5G mobile communications have led to the availability of massive network capacities delivering ultra data speeds and low latency. It is also driving new application milestones in high performance computing, Artificial Intelligence (AI), Internet of Things (IoT), autonomous driving, and smart manufacturing that require highly integrated, multifunctional and high performance semiconductor chips. To that end, the semiconductor industry is geared towards the creation of a higher value, system level integration that will accelerate technologies for better performance and chip miniaturization. As a leader in advanced packaging, our innovations in heterogeneous integration have enabled the proliferation of smart and connected environments and electronic devices that greatly contribute to improving our lives.

Key products and technologies successfully developed in 2023 are as follows: (1) Flip Chip Packaging (FCP): HBM3 Memory stacking (2) Wire-bond packaging: Intelligent Wire-Bonding Defect Inspection Powered by Deep Learning and Computer Vision (3) Wafer Level Packaging: Fan-out WLP with Embedded Bridge Die and Passive Component Package, FOCoS-B (4) Advanced packaging and modulation: 3D voltage regulation module advanced packaging technology (5) Panel Level Packaging: Development of Embedded Tall Pillar, An Effective Uniformity Improvement for FOPLP Electroplating, Simulation Modeling of FOPLP for Warpage Behavior, Planarization of Material Topography (6) SiP Package: Highly Integrated SiP Module Packaged Module Solution (7) OEP: Optical module assembly development.

Our R&D teams work closely with our supply chain partners including material and equipment suppliers, as well as with key customers on new product and process innovations, to maximize scale and efficiency in technology development. In addition, we collaborate with academic and industry organizations such as the National Sun Yat-Sen University, National Cheng Kung University, National Taiwan University, Tsing Hua University, and ITRI on advanced packaging and testing technology development.

Technology Platforms

R&D is costly and time-consuming, and selecting the right products/ technologies in the early stages reduces the risk level. To address this, ASEH has established a market analysis taskforce consisting of an internal team of R&D staff, research institutions, suppliers, equipment manufacturers and customers. Through the taskforce, the Company is able to regularly exchange views on the latest market developments with players in the industry, focus on new product/technology development to meet emerging market demand, set short, medium and long-term R&D targets, and concentrate its resources on priority projects. In 2023, we held 95 seminars with research institutions, 115 workshops with suppliers and equipment manufacturers, and 198 technology blueprint alignment meetings with customers.

ASEH has formed a Technology Board consisting of experts from a wide range of professional disciplines to achieve horizontal integration and effective technology development through the integration of technology and knowledge sharing, and the creation of a platform for in depth analysis and discussions. Furthermore, we have set up a Knowledge Management (KM) platform that can be accessed globally to encourage employees to share innovative engineering technologies regularly. As of 2023, a total of 18 manufacturing sites and more than 6,800 employees had registered on the KM platform. The platform featured five categories, namely: e-OJT, Technology Board, BKM (Best Known Method), Green Innovation/Climate Change, and Customers/ Competitors/Suppliers/ External Consultants/Seminar Materials; and contained more than 11,000 technology related data records that had been viewed more than 50,000 times. ASEH will continue to improve the KM platform functions and strengthen the development of its core technology to increase the company's competitiveness and growth potential.

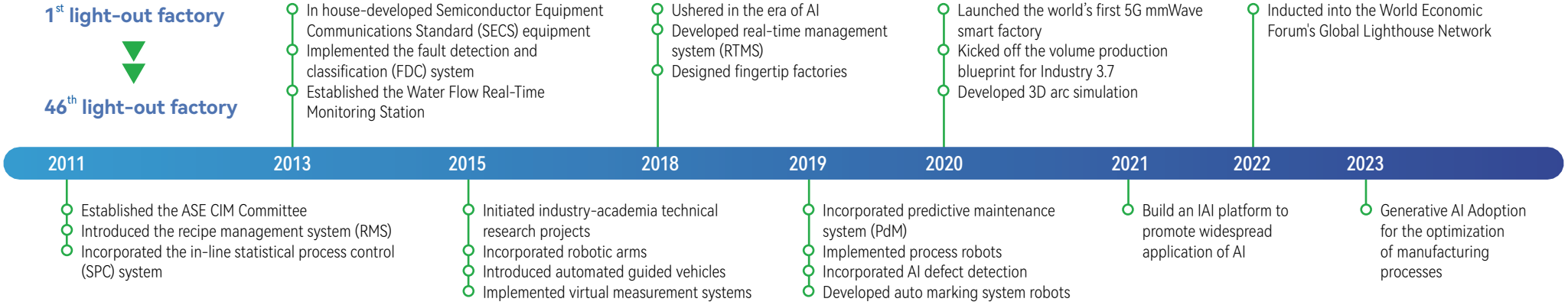
Smart Factories

Aiming to drive greater efficiency and improvements in our manufacturing process that will in turn deliver higher customer satisfaction in quality and delivery, ASEH began to invest in automated, lights-out factories in 2015. At ASEH, we are accelerating digital transformation in smart manufacturing through automation, heterogeneous integration in machine and production systems, and heterogeneous integration in systems-in-package (SiP). In 2011, ASE established the ASE CIM Committee, a strategic task force that is comprised of teams from various business units (lead frame packaging, ball-grid array packaging, flip chip packaging, wafer-level packaging, SiP packaging and test services) and the Information Technology Center. By 2023, the company has established 46 lights-out factories, trained more than 700 automation engineers, and developed over 57 industry-academia research projects. ASEH achieved another major milestone when its bumping facility in Kaohsiung was inducted into the World Economic Forum's Global Lighthouse Network, a community of production sites and value chains that are world leaders in the adoption and integration of the cutting-edge technologies of the Fourth Industrial Revolution (4IR).

Smart factories and automation transform our labor needs by allowing us to redeploy workers and train them for higher skilled jobs. The upgrade in our workforce will greatly improve productivity, increase employee engagement and create more sustainable value.

Smart Factory Transformation through Innovative and Breakthrough Approaches

Challenge	Problems encountered	Solution
Inadequate equipment connectivity	• To meet the needs of smart factories, production equipment information must be collected and stored in a central database so that real-time analyses and management can be conducted. • In the early days, due to the dearth of OSAT industry production equipment that met Semiconductor Equipment Communication Standards (SECS), equipment connectivity was the top challenge to be overcome.	• **Step 1:** Collaborate with procurement units to conduct negotiations with equipment suppliers and request that new production equipment meet SECS standards. • **Step 2:** Perform research on existing production equipment to find ways to achieve automatic connection and convert into compatible SECS formats. After years of development, ASEH's production equipment now meets SECS standards.
High complexity of product tracking	• Automotive customers require strict records of the production history of all automotive chips to facilitate tracking when problems occur. • In semiconductor chip manufacturing, product tracking begins at the wafer fabrication stage. The wafers will then proceed to the next process stage. Once the wafer is cut into individual dies for packaging, the dies do not have any markings for identification and tracking.	• Use 2D codes and RFID technology to accurately record the individual wafer and the location on the wafer that each die originated from, the location on the substrate and the locations on the die carrier and substrates. • All the location information are stored in the map system database that can be accessed any time. Customers are able to check production history, while our engineering teams can use the data to perform quality and yield analyses.
Lack of local automated equipment supply chains	• In the early stages, most automated equipment suppliers were large foreign suppliers that commanded high prices, were inflexible and provided long lead times. As a result, we faced delays in project completion and unsatisfactory outcomes.	• Actively look for local suppliers of automated equipment including automated guided vehicles, automatic storage and robotic arms, etc. In recent years, we have established business relationships with approximately 38 automation suppliers, strengthening the local automation industry chain in Taiwan.
Lack of qualified personnel	• When the ASE CIM Committee was initially established, there were only 30 engineers with expertise in automation.	• More than 700 smart factory automation engineers have been trained through the establishment of in-house automation and AI training modules as well as industry-academia research programs. • AI training modules. We launched the modules in 2018 to promote AI technology. Integrating the AI platforms into the production, engineering, and administrative departments help to popularize the IAI platform, and also ensure readiness for the upcoming No-code AI age. As of 2023, more than 10,000 individuals have been trained. • Intelligent Engineering training modules. Since the launch in 2022, our PE/EEs have received training in statistical analysis and equipment monitoring. The engineers also learnt how to optimize digital tools and ideas for project applications. As of 2023, more than 3,000 individuals have been trained. • Digital Application training modules: Starting in 2018, we created courses on digital tools such as RPA, Qlick View, Doc. Bee, and Co-know to train administrative and support staff to utilize digital tools effectively. As of 2023, more than 8,000 individuals have been trained.



Smart Factory Milestones

2011	Introduced the recipe management system (RMS)	As a control measure before mass production, the EAP transfers data to equipment through SECS/GEM, ensuring data validity and improving overall equipment efficiency (OEE).
2013	In house-developed Semiconductor Equipment Communications Standard (SECS) equipment automation program (EAP)	To overcome challenges in equipment connection program development, we designed a development platform for standardized equipment connection programs, solving process design problems, lowering program development complexity, and increasing human-machine ratios and operation time.
	Implemented the fault detection and classification (FDC) system	By collecting equipment production parameters in real-time, systems are able to report equipment status immediately and check formal functions automatically so that warning signals are issued when malfunctions occur, thereby preventing the repeated manufacturing of defective products and ensuring that reporting mechanisms are in place to detect malfunctions in real time.
2015	Introduced robotic arms and automated guided vehicles (AGVs)	AGVs and robotic arms were integrated to introduce the autonomous mobile robot (AMR) that can support transport operations, thus reducing manpower on the floor and maximizing packaging capacity.
2018	Ushering in the era of AI	Applying AI powered detection technology to identify and intercept any malfunctioning equipment that may compromise information security and prevent any information security incidents. The in house-developed technology helps mitigate information security risks and reduce investment costs.
2019	Incorporated the predictive maintenance system (PdM)	A predictive maintenance system helps determine equipment that is likely to require maintenance and predicts equipment component failures and malfunctions in advance. The system allows early notification of maintenance personnel to service the equipment, thereby lowering equipment failure time.
2020	Launched the world's first 5G mmWave smart factory	The 5G mmWave smart factory was a collaborative effort between ASE, Chunghwa Telecom and Qualcomm, showcasing the future of automation and smart factories. 3 use cases were developed to demonstrate the use of 5G mmWave in smart factories - automated production line inspection using AI+AGV, remote AR maintenance and the AR experience at the ASE green technology center.
2021	Build an IAI platform to promote the universal application of AI	ASEH ushered in the era of AI. In addition to actively cultivating AI technology talent, we began to build the IAI platform to create an AI no code environment and promote widespread application of AI throughout the company.
2022	Inducted into the World Economic Forum's Global Lighthouse Network	ASE's Bumping Factory in Kaohsiung adopts 4IR (Fourth Industrial Revolution) technologies across its manufacturing operations. In particular, the facility applies AI technology in the management of equipment and processes to improve yield and accuracies in production schedules. As a result of the remarkable integration of 4IR, the facility was inducted into the World Economic Forum's Global Lighthouse Network (GLN).
2023	Generative AI Adoption for the optimization of manufacturing processes	ASE Kaohsiung's smart manufacturing is continuously evolving and the team is actively harnassing AI to optimize production processes. Our manufacturing processes for a diverse range of products are complex, and AI adoption is helping to improve worker productivity that minimizes work-in-progress costs and maximizes yield. Applying AI enables better optimization of machine and shipment scheduling to meet delivery deadlines, ensuring the most efficient production schedules in the shortest possible time. The extensive data mining and analysis, combined with the factory's 24/7 operations have resulted in widespread AI applications at ASE Kaohsiung.

A Dual-axis Approach in Smart Manufacturing Transformation and Sustainable Development

ASEH is proud that its Kaohsiung bumping facility was inducted into the WEF Global Lighthouse Network (GLN), the gold standard for AI in manufacturing. We remain committed to a dual-axis approach that focuses on advancements in smart manufacturing and sustainable development simultaneously. The integration of Industry 4.0 technologies with AI will drive greater efficiencies into our operations and accelerate sustainability improvements at scale.

To address the production scheduling of varied products in a smart manufacturing environment, key factors are collected and AI algorithms are used to train and create an optimized production model. The model removes the need for manual scheduling and machine programming; saving time, and maximizing production schedules, productivity and manufacturing efficiency. Advanced process control systems utilizing AI image recognition, machine learning, large language models, and feature engineering enable real-time monitoring of various production information, and trigger alerts in the event of any anamolies. In addition, the system is capable of predicting equipment lifespan, thereby allowing timely maintenance to reduce downtime and impact, and maintain optimal yield.

In line with our sustainability goals, we have implemented smart energy management across our manufacturing facility to reduce energy consumption and greenhouse gas emissions. By applying a comprehensive AI-augmented database and monitoring system to establish automatic control, we were able to efficiently adjust manufacturing equipment such as chillers and filter fans in the clean room according to environmental conditions and production needs. In regard to water resource management, we monitor post-process water discharge with the latest fluorescence identification technology to detect trace organics. Combined with the power of AI computation, we were able to optimize the use of water resources to reduce tap water consumption, prevent wastage, and improve recycling. For our waste management, we work closely with multiple partners to create circular solutions for resource optimization. Digital tracking and AI tools are used to closely monitor the movement of vehicles transporting residual waste, ensuring proper treatment of waste disposal and mitigating environmental impact.

In light of fierce competition and climate change, ASE Kaohsiung is capitalizing on its people-centric culture to advance smart transformation and sustainable development simultaneously. The company is investing in resources to train and upskill its employees, reshaping their value and demonstrating our commitment to the environment and net zero. Most importantly, we hope to lead and influence the industry toward a more sustainable future.

Sustainable Impact of Smart Factories

Our smart factory concept began with a strong foundation in automation, and the heterogeneous integration of customers, suppliers and production processes, to drive the semiconductor industry onto a higher value chain and accelerate technology advancements. Smart factories represent the next leap for the semiconductor packaging and test industry to play an enabling role beyond More than More.

Suppliers of Automated Equipment in Taiwan

Software solutions, Internet of Things sensors/controllers, automated transport systems, automated guided vehicles, robotic arms, etc.

Promoting technology innovation and development

- Co-chair of the Smart Manufacturing Committee of the Semiconductor Equipment and Materials International (SEMI)
- Served as Deputy Convenor of the Intelligent Automation Committee of the Taiwan Printed Circuit Association (TPCA)
- Cooperate with the Institute for Information Industry, Industrial Technology Research Institute, and Metal Industries Research & Development Center, to jointly develop advanced automation technology such as artificial intelligence, big data, unmanned handling

Talent cultivation for the semiconductor

- Conduct Industry and University Collaborations with 7 universities on automation technology, cooperate more than 50 projects, cooperate with more than 60 professors and cultivate more than 60 graduate students.
- The topics of Industry and University Collaborations include Virtual Metrology, Social Listening, Electronic Fence, Face Recognition, Defect Detection, etc.

Scholarships and Internship Programs

National Cheng Kung University, National Sun Yat-sen University, National University of Kaohsiung, National Kaohsiung University of Science and Technology, I-Shou University, Southern Taiwan University of Science and Technology, and Cheng Shiu university

Procurement

8.1 billion in Local Procurement

- Promoted economic development through local procurement, generating nearly NT$2.6 billion of output value in equipment supplier and facilitating NT$8.1 billion in local procurement[1]

1,073 Indirect Job Opportunities

- Cultivated approximately 38 local automation suppliers, creating 1,073 jobs in the supply chain

Manufacturing

990 million Social Cost Reduction

- Accelerated ASEH's digital transformation in manufacturing, lowered employee overtime, resulting in a reduction of social costs by approximately NT$990 million[2]

700 AI Talents

- Increased the value of our human capital through up skilling in automation and AI for more than 700 employees

Customer Service

10 billion output value

- Enabled customers to obtain market opportunities and develop innovative product applications, creating an output value of more than NT$10 billion

46 lights-out factories

- Completed 46 lights-out factories to improve product yields shorten time to market, and helping customers develop new markets

[1] The amount of revenue generated and the number of jobs created in the supply chain were calculated using input-output analysis (IOA). In our calculation, we used the data from the OECD Input-Output Tables and the EXIOBASE 2 database as references and assumed that all suppliers are based in Taiwan

[2] Employee overtime was calculated using accumulated data since the adoption of digital transformation. We referenced data from the Eco-costs database to analyze the reduction in risks to health damage due to a reduction in overtime and work hours from the implementation of factory automation. The data was converted into monetary value according to OECD (Organization for Economic Co-operation and Development, 2012) guidelines

Automation technologies introduced in 2023:

<table>
<tr><th>Technology</th><th>Solutions and Achievements</th></tr>
<tr><td>IAI Platform 2.0</td><td>The IAI platform aims to accelerate the spread of AI education, knowledge and experience-sharing, and foster a corporate culture of “AI for everyone.” The platform is capable of developing forecast models based on available data to meet production, quality and process goals. For the upgraded 2.0 platform, improvements have been made to 58 algorithms in 11 categories, support for NPI, NPD, and MP operations has been added, and a wider array of AI services for problem-solving is offered.</td><td>
2023 Achiements
The number of AI Project is 587
(2.66 times that of the previous year)
The number of deployments is 377
(1.27 times that of the previous year)
The number of Models is 7,407
(4.28 times that of the previous year)
The cumulative number of people who passed the verification is 15,199
(4.92 times that of the previous year)
<table>
<tr><th></th><th></th><th>Image Recognition</th><th>Numerical Analysis</th><th>Abnormal Detection</th></tr>
<tr><td>Multi-objective</td><td>Difficulty: 70~100
Professor Level Data Scientist
AI maintenance and management</td><td>AI Project:
QA X-Ray AI Detection</td><td>AI Project:
NPI yield and cost optimization /predictive maintenance/AI knowledge map</td><td>AI Project: Gap analysis between different machines</td></tr>
<tr><td>No-Code</td><td>Difficulty: 0~70
Amateur Level Data Scientist
No Code</td><td>Self-developed:
CV Platform</td><td>Rent first and self-develop later:
No-code AI Platform</td><td>Self-developed:
AD Platform</td></tr>
</table>
</td></tr>
<tr><td>AIoT For ESG</td><td>Through the use of AIoT technology, we were able to improve the operation of our fan filter units (FFUs), implement an intelligent wastewater management module, and employ a carbon footprint verification system. This allows us to individually control the load of different clean rooms, optimize the amount of chemicals in water treatment plants, and monitor our carbon footprint information in real time, all of which contribute to energy savings, lower abatement costs, and carbon reduction.</td><td> 


</td></tr>
<tr><td>PHM</td><td>PHM is designed to examine and monitor equipment health and predict when maintenance is required.
PHM is highly effective in increasing the safety of industrial machinery by lowering the likelihood of catastrophic failures.</td><td>• Technological innovation and data-driven solutions, including real-time monitoring, data analysis, and machine learning - quick equipment diagnosis and repair
• Reduces risks and enhances efficiency, minimizes equipment failures, and boosts production efficiency - robotic arm stability assessment
• Generates benefits for sustainability and the environment, reduces energy use and equipment waste - motor diagnostics</td></tr>
</table>

Intellectual Property Management

Intellectual property (IP) rights are important achievements in research and development, and a key aspect of innovation management. Effective IP management helps to maintain ASEH's leading position in corporate innovation.

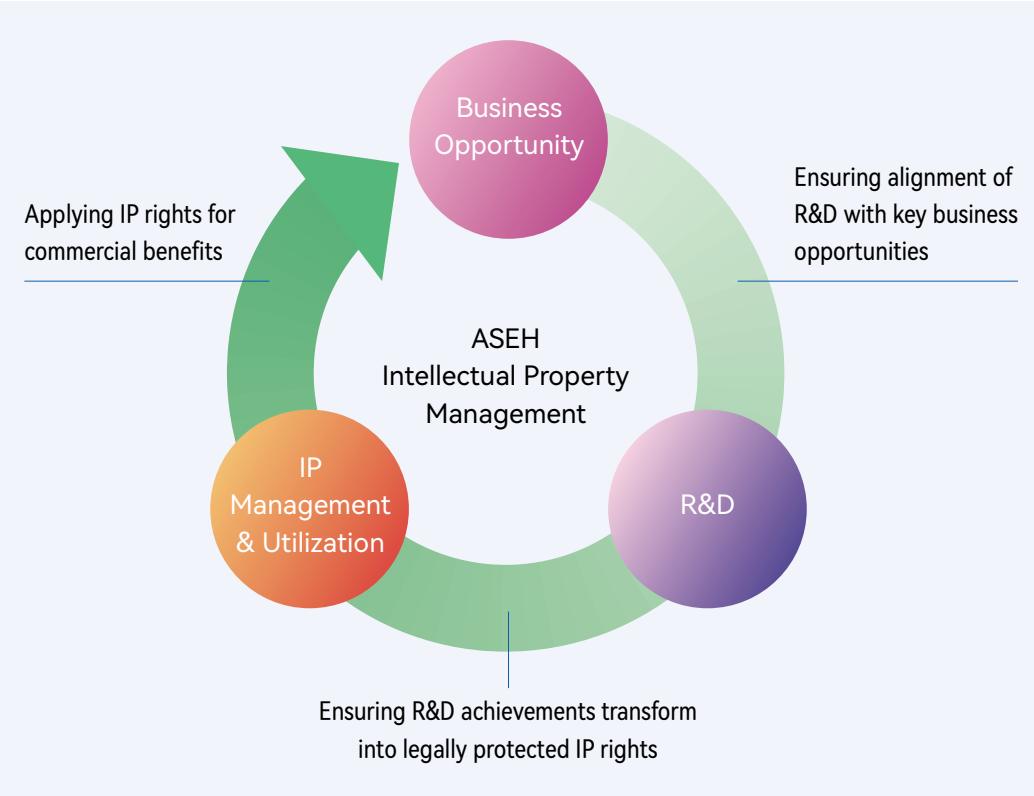
ASEH has established an IP policy that serves to protect the company's technological innovations and its global leading position. In addition to continuously striving towards R&D innovation and developing IP management strategies that conform with the company's development trends, ASEH's IP management also helps to generate commercial benefits for the company.

ASEH's IP management is tightly embedded into the company's business operation blueprint, forming a continuous innovation cycle that encompasses business opportunities and R&D, to IP management and utilization that includes the following three phases:

Step 1: To maintain ASEH's technology leadership and to better respond to future market needs, the company invests aggressively in research and development, aligns R&D with key future business opportunities and invests heavily in talent development and R&D resources.

Step 2: Our robust IP application system and tools ensure that R&D achievements are transformed accurately, thoroughly and effectively into legally protected intellectual property rights. To ensure comprehensive protection for key technologies and strengthen patent quality, ASEH adopts a 3-pronged approach: developing a comprehensive portfolio, re-assessing patents to identify those of value and, revitalization to increase the value. Patents must also provide business value in order to maximize R&D investment returns. ASEH puts in place a system of measures to protect the company's trade secrets and maintain its unique competitive advantage, including information security systems, employee awareness training and education and systematic management. Where appropriate, the company will enforce applicable laws and regulations to prevent improper use, leakage or misappropriation of the company's intangible assets by others to ensure that ASE's investments, rights and interests are duly protected.

Step 3: High-value IP helps to facilitate business success, obtain customer orders and develop more business opportunities, thereby creating a positive sustainable cycle. Our robust IP management prevents unauthorized use of ASEH's technologies by others and helps to defend against any threats from competitors.



To learn about the benefits of intellectual property rights to ASEH sustainable development, please refer to ASEH website-ESG | Sustainability Governance | Intellectual Property Management. The link is https://www.aseglobal.com/csr/sustainability-governance/ip-management/

Advanced Semiconductor Engineering, Inc., the subsidiary of ASEH, filed with Certification Body – the Institute for Information Industry – an application for the renewal of Taiwan Intellectual Property Management System (TIPS) (A Class) certification first issued by the Industrial Development Bureau of the Ministry of Economic Affairs in 2021and successfully accomplished the recertification process. The renewal of TIPS certification (A Class) is valid until December 31, 2024.

Based upon the foundation of long-term practices on intellectual property management, ASEH further enhanced the scheme of its intellectual property management, strengthened employees' intellectual property value awareness, intensify all aspects of protections of R&D achievements, and promoted the trust of its shareholders and customers in company by introducing TIPS framework and obtaining external certification.

As of January 31, 2024, ASEH owned 6,433 patents, primarily in various assembly and testing technologies as well as electronic manufacturing services technologies, including 2,179 patents in Taiwan, 2,015 patents in the U.S., 2,088 patents in the People's Republic of China, 104 patents in Europe and 47 patents in other countries.

Intellectual Property Management and Utilization

Trade secret

- Create a registration management system to protect trade secrets.
- We continuously enhance best practices through information security protocols, awareness promotion, comprehensive training, and systematic management.
- Where appropriate, we apply applicable laws to deter unauthorized access to company information and assets, protecting our investments and safeguarding our interests.

Patent

- Place equal emphasis on patent quantity, quality, and value. Focus on three major approaches on patent management: comprehensive planning, curating patents of value, and value enhancements.
  - ➤ Develop a comprehensive patent plan for critical technologies at an early stage.
  - ➤ Regularly evaluate patents, identifying those of value, and dropping those of low or no value from renewal.
  - ➤ Revitalize patents to enhance their value and scope of application.
- Foster strategic partnerships with key customers, and academic research institutions, to collaborate on R&D, develop plans for patent applications, and acquire critical patents.

4.2 Sustainable Manufacturing

Sustainable Manufacturing Concepts and Principles

As a manufacturing service provider, ASEH embraces the concept of "doing more with less"and committed to four sustainable manufacturing principles, namely sustainable designs, sustainable procurement and material selection, sustainable production and sustainable packaging and logistics. In the initial product/process design stage, sustainable manufacturing practices (as shown in the diagram below) are incorporated into the entire product life cycle; from raw materials, manufacturing, distribution, usage, to disposal, as well as at subsequent stages of product manufacturing and distribution. Our approach allows us to provide customers with sustainable products of higher value while minimizing the impact to the environment and improving eco-efficiency.

We are committed to:

- Compliance with all applicable laws and regulations
- Managing hazardous substances in components and raw materials used in manufacturing
- Creating solutions for the design of lightweight, thin, small and energy-efficient products
- Reducing the environmental impact from manufacturing, packaging, and transportation

In 2023, 61.46% of our products revenue provide resource efficiency benefits by saving energy during use phase to avoid emission of 403,004 metric tons CO_2e, having smaller form factors thereby enabling reduced material consumptions in terms of compliant with EU's WEEE directive.

Green Laboratory

The ASEH green laboratory conducts R&D and indepth analysis of green materials right from the source. The lab is part of ASEH's initiative to strengthen the company's green solutions by actively developing green manufacturing processes and using environmentally friendly packaging materials.

- Evaluation and development of green materials: Non-toxic/ mildly toxic raw materials and chemical products
- Development of environmental testing technology: Establish monitoring technology, mechanisms and standards in compliance with global environmental regulations
- Developments in green manufacturing: Evaluate the technologies in recycling, reduction, and reuse of materials and waste
- Development of environmental-friendly packaging: Develop bio-composite material packaging

Sustainable Raw Materials

ASEH recognizes that the semiconductor and electronics manufacturing industry consumes a substantial amount of raw materials. The ASEH Board of Directors have approved the following Sustainable Raw Materials Policy based on the company's sustainable manufacturing principles.

	Raw Materials	Raw Material Suppliers
Tracing and Collecting Data	• **Material Tracking and Origin Tracing:** Regularly tracking the volume of raw materials consumed from ASE's conflict mineral, cobalt, mica and other key raw material suppliers. In 2023, we conducted extensive source tracing of 18 additional metals, including copper, iron, nickel, aluminum, silicon, and silver.	• **Proactive investigation:** We conduct preliminary assessments on our suppliers based on key factors like level of business relationship and procurement value. At the same time, we review the risks of potential negative impacts on the environmental, social, and governance dimensions with respect to the supplier's category type (including raw material suppliers etc.).
Risk Assessment	• **Non-toxicity:** Enhancing product compliance with regulations and customers' sustainability requirements by establishing a hazardous substance process management system to ensure that the raw materials used for production do not contain substances harmful to humans or the environment. • **Recyclability:** Our environmental laboratory conducts green material assessments, develops non-toxic (or low-toxicity) raw materials, as well as analyzes material and waste recycling, reduction, and reuse technologies. • **Eco-friendliness:** Using Life Cycle Assessment (LCA) techniques to analyze the environmental impact of products and raw materials, and identifying improvement opportunities through hotspot analyses to enhance the eco-friendly content of products and raw materials. • **Conflict Materials:** Aligning with the due diligence process established by the Organization for Economic Cooperation and Development (OECD) to regularly examine the country of origin of raw materials (including conflict minerals) to avoid using materials from conflict zones.	• **Sustainability risk:** A Sustainability Risk Assessment Questionnaire (SAQ) was developed based on the RBA Code of Conduct and international standards such as the UN Universal Declaration of Human Rights. Sustainability risk assessments for all first-tier raw material suppliers are conducted regularly. • **Climate Risk:** Utilize the World Resources Institute (WRI) database to assess supplier water stress, and integrate data on extreme rainfall conditions to identify suppliers at risk of experiencing flooding and landslides. • **Biodiversity:** Determine if raw material suppliers' production locations are biodiversity-sensitive by using data from the International Union for Conservation of Nature's (IUCN) World Database on Protected Areas (WDPA)
Coordinated Action	• **Eco-Design Guidelines:** Eco-design guidelines have to be incorporated throughout all advanced technology development and new product development stages, especially in the selection of sustainable raw materials (choosing materials with lower negative sustainability impacts, avoiding materials from key biodiversity areas, and prioritizing the use of recycled metals, minerals and materials with third-party certifications).	• **Supplier Guidance:** Conducted programs to guide raw material suppliers in managing carbon inventory, renewable energy development, carbon reduction and water conservation. Supported a total of 102 suppliers in 2023.
Targeted Action	USI has set a target of 17% by 2025, for the use of recycled plastic in its products.	Target number of on-site sustainability audits for raw material suppliers: 100 (by 2030)

	2021	2022	2023
the proportion of recycled plastic used in products	NA	NA	16.72%

	2021	2022	2023
the number of on-site sustainability audits for raw material suppliers	125	187	201

We conduct training for employees involved in managing the sustainability aspect of raw materials, educating them on green products (hazardous substance control), environmental protection, business ethics, supplier sustainability management, and conflict minerals. In 2023, 46,563 people participated in these training courses resulting in the increase of environmental awareness, and understanding the significance of utilizing appropriate raw materials for sustainability.

Management of Hazardous Substances and Chemicals

To achieve sustainable manufacturing, effective management of hazardous substances is crucial. At ASE, we have formulated a comprehensive framework that includes optimizing the green product management system (GPMS), establishing a database of all substances, and ensuring compliance with customer requirements, the EU RoHS Directive, REACH regulations, Energy Star and the Energy-related Products (ErP) directives. Our policies for the management of hazardous substances are designed to be much stricter than regulatory procedures and governing trends.

We have expanded our control measures for chemicals that cause health hazards and increase environmental risks, including bioaccumulation, persistent pollutants, and materials that affects fertility, are carcinogenic or mutagenic. In addition to managing the chemical content in our products, any newly introduced chemicals that fall within the scope of customer restrictions or the EU REACH Restricted Substances List, during the manufacturing process will be prohibited for use and replaced with another qualified substance. Our policies are aimed at providing employees with a safe and healthy environment that allows them to work with a peace of mind, and advancing towards the goal of a green industry.

ASEKH, ASECL, SPIL and USI have selected Mineral oil aromatic hydrocarbons (MOAH) consisting of 1 to 7 aromatic rings and Mineral oil saturated hydrocarbons (MOSH) consisting of 16 to 35 carbon atoms as Hazardous Substances. MOAH consisting of 1 to 7 aromatic rings has been controlled at < 10000ppm and by below targets:

- MOAH consisting of 1 to 7 aromatic rings < 1000ppm by 2025/1/1
- MOAH consisting of 3 to 7 aromatic rings < 1ppm by 2025/1/1
- MOSH consisting of 16 to 35 carbon atoms < 1000ppm by 2025/1/1

Product Lifecycle Assessments

We have incorporated the ISO 14067 product carbon footprint and ISO 14045 eco-efficiency assessments into our operations and have completed the inventory and evaluation of our five major packaging product series (i.e., BGA, Lead Frame, CSP, Flip Chip, Bumping). We have also extended the analyses of key "substrates" and conducted environmental impact analysis of product life cycles. In addition, we have established databases and incorporated simulation algorithms for product research and development to increase product value while elevating ecological efficiency. We provide our customers a complete suite of manufacturing services as well as the development of energy-saving products such as wireless communication modules, POS machines, ATX power supplies that connect to multiple desktop outputs, motherboards, smart handheld devices, NAS systems, SSDs and server systems.

Category	Product Series	Carbon Footprint	Eco-efficiency Assessment/ Environmental Footprint	Improvement Strategies and Actions
Assembly	BGA	Updated	Updated	**Design** • Consider factors such as product lifecycle, circulation and eco-efficiency during the design stage • Develop a new generation of energy efficient products • Upgrade technology, strengthen product functions, and reduce material inputs Example: Develop high density QFP to replace traditional QFP led to a decrease in material usage by 60% **Procurement and materials** • Select environmentally compatible materials that generate low-carbon emissions Examples: Copper wires are used to replace gold wires, lowering product carbon emissions • Utilize environmentally friendly alternative materials Examples: Use of boron-free developers, non-reproductive toxic photoresist stripping solutions, halogen-free materials • Research and develop recycled materials or extend product service life **Production** • Introduce smart system controls to improve efficiency in energy utilization • Enhance manufacturing process equipment or components to increase product lifecycles • Value chain cooperation and material recycling Examples: Organic compound cyclopentanone, acetone recycling, plastic carbonization application • Adopt innovative technologies to reduce the impact on ecology Examples: O_2 gas replaces CF_4 gas to reduce carbon emissions in the process **Packaging and logistics** • Material recycling Examples: Recycling of buffer materials, pallets and logistics boxes • Avoid the use of foams with a substantially negative impact on the environment • Promote low-carbon transportation Examples: Switch from air freight to sea freight, use green energy vehicles
	Lead Frame	Done	Done	
	CSP	Done	Done	
	Flip Chip	Updated	Updated	
	Bumping	Done	Done	
	SiP Technology	Done	Done	
Substrate		Done	Done	
Test		Done	Done	
Electronic Manufacturing Services,EMS	4G dual frequency communication module	Done	Done	
	XnBay smart storage server	Done	Done	
	Printer head	Done	Done	
	LCD Drive Board Series	Done	Done	
	Industrial tablet	New	New	
	Clickshare button	New	New	
	Wiper controller	Ongoing	Ongoing	
	Charger for hearing aids	Ongoing	Ongoing	
	Motherboard for Automated Teller Machine	Ongoing	Ongoing	

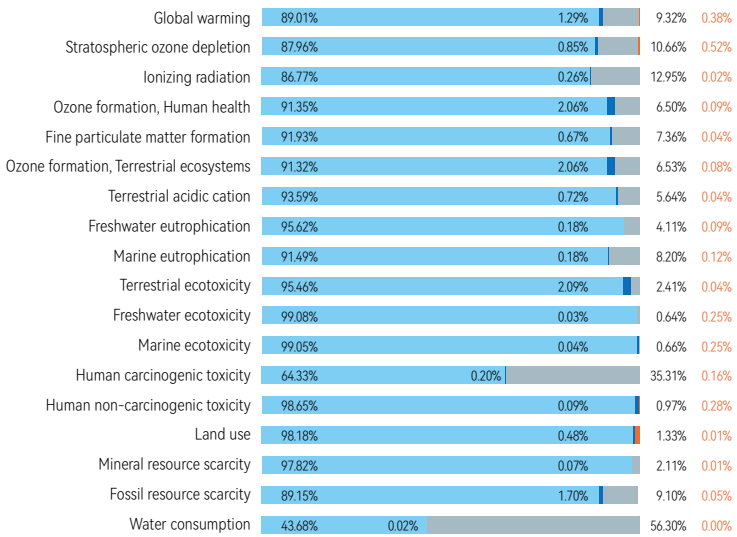
In addition to conducting product lifecycle assessments, we also form collaborations with experts to incorporate the use of assessment software such as SimaPro and the ReCiPe 2016 Midpoint(H) methodology that measures the impacts from 18 different environmental aspects. The methodologies were applied to our Flip Chip Packaging process, where we analyzed the environmental impact based on the different types of wires used in the bonding process. Through the study, it was discovered that gold wire bonding produced the greatest impact. As such, we began gradually replacing gold wires with copper wires. We have also been developing packaging technologies that do not require wirebonding, and advanced packaging solutions that help reduce the impact to the environment.

Life Cycle Assessment Results

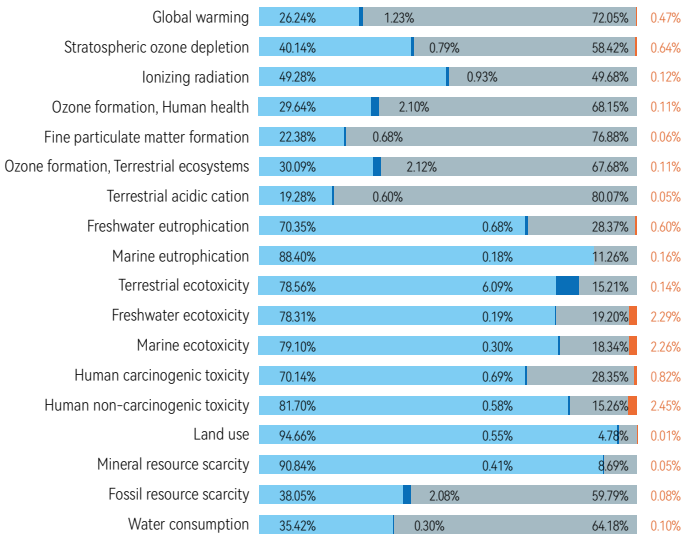
According to the analysis results, particulate matter formation, climate change impacts on human health, and carcinogenic toxicity are the main environmental impact categories along the life cycle of industrial tablet and smart wireless conference products.

Raw materials
Transportation
Manufacture
Manufacture (Waste)

Environmental impact of industrial tablet

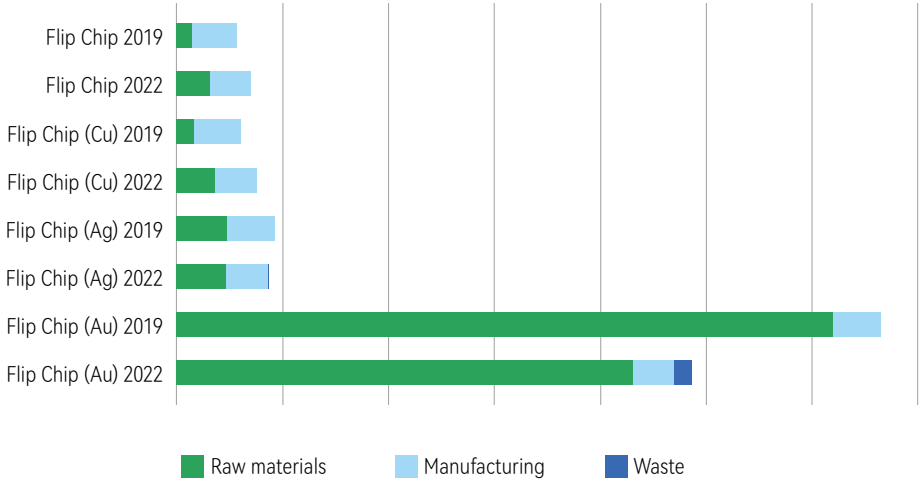


Environmental impact of clickshare button



In 2023, we updated our Flip Chip packaging product LCA, excluding the IC chip in raw materials. (Note 1) We discovered that the environmental impact of our Flip Chip packaging products ranged between 73% and 123% of the results from the 2019 analysis. However, when focusing specifically on the manufacturing stage, the environmental impact was only 90% of the 2019 results, indicating that our process improvements have effectively reduced environmental impacts. Some of our products have recorded an increase in ecological impacts during the raw material stage. This is primarily because our technological advancements have led to the miniaturization of the package sizes, increasing the material density per unit volume and consequently, increasing the environmental impact per unit volume. Nevertheless, due to the vastly reduced size of the package over the entire product life cycle, the environmental impact for the completed product has also decreased.

Environmental impact of Bumping process



Note 1: IC chips are specified by customers and have a high environmental impact that cannot be mitigated, so they are excluded to better reflect the company's performance.

4.3 Products and Service

ASEH provides the design, manufacturing and enabling of many electronic end products, including smartphones, PCs, tablets, game consoles, security chip cards, automotive sensors, entertainment systems and many more. We offer a broad range of advanced and legacy semiconductor packaging and testing services as well as electronic manufacturing services. The semiconductors we package are used in a wide range of end-use applications, including communications, computing, and consumer electronics, industrial, automotive and other applications. Our testing services include front-end engineering testing, wafer probe, final testing and other related semiconductor testing services.

Our electronics manufacturing services are used for various applications, including computers, peripherals, communications, industrial applications, automotive electronics, and storage and server applications.

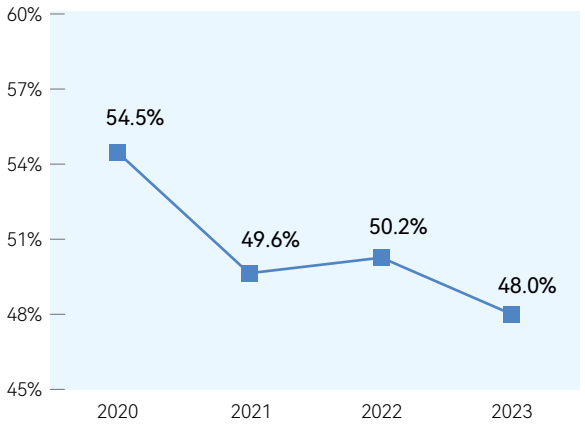
Customer Service

Our key customers typically operate in the semiconductor and electronics industries. In 2023, our five largest customers together accounted for approximately 48% of our operating revenues. To achieve total customer satisfaction, we uphold world-class quality and reliability for our products and services through thoughtfully defined quality assurance methodologies. Our quality assurance systems impose strict process controls, statistical in-line monitors, supplier control, data review and management, quality controls and corrective action systems. There were no product recalls (arising from health or safety concerns) issued by customers in 2023.

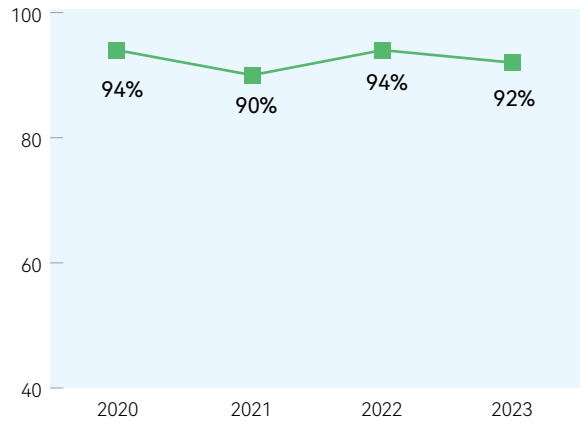
To ensure that customer suggestions are properly processed, we have a dedicated team in place for reporting feedback and managing customer communication. We have designed multiple communication channels with customers which include technical forums, and regular email updates on significant events, milestones and business highlights. In addition, we actively participate in various technology forums to promote our advanced manufacturing processes and innovative technologies.

In order to provide the best customer service, we reach out to our customers through various means and at different intervals, including monthly/quarterly customer surveys for evaluating quality, cost, delivery, technology, and service/sustainability, customer surveys, annual/quarterly/monthly meetings and the supplier award program. We have also set our annual customer satisfaction target at 90% (i.e. at least 90 of our top 100 customers remain satisfied.) We continue to focus deeply on improving customer satisfaction to establish trust and value for our customers.

Top 5 Largest Customers Together Operating Revenues Accounted (%)



Key Customers[1] Satisfaction Trend



[1] Key customer: ASEH's top 100 customers, which contributed more than 90% of the company's operating revenues in 2023

GREEN MANUFACTURING AND LOW-CARBON TRANSFORMATION

ASEH is committed to improving our eco-efficiency and protecting the environment by continuously enhancing resources recycling, and reducing greenhouse gas emissions, waste generation, wastewater effluent, and chemical usage.

ASEH strives to develop and promote an environmentally friendly manufacturing and service concept in all facets of its enterprise. From material procurement, design, manufacturing, product use, and disposal, we conscientiously incorporate environmental impact factors at all stages of the life cycle to provide green and low-carbon manufacturing services.

Supplier identification and assessment of climate and natural risks

SER Leaderboard

On the CDP Supplier Engagement Rating leader board for 5 consecutive years

CDP

Water Security A List

Awarded CDP Water Security for 4 consecutive years

CDP

Climate Change Leadership

On the CDP Climate Change list for 8 consecutive years

CDP

Concrete actions to restore biodiversity

28

Green certifications

100%

Identification and assessment of climate and natural risks

Net Zero

Net-Zero emissions target by

2050

574 carbon reduction solutions to reduce GHGs emissions by

603,327 tCO_2e

20%

Total electricity consumption achieved through renewable energy or REC

SDGs	Business Actions and Contributions	2023 Key Aspects	KPI	2023 Target	Status	2023 Performance	2024 Target	2030 Target
	• Develop and implement holistic water strategies within the scope of our business and supply chain operations that are socially equitable, environmentally sustainable and economically beneficial • Protect and/or restore water-based ecosystems across our operation and supply chain	Water Resource Management	Water withdrawal intensity (water withdrawn/revenue)	8% reduction compared to 2015	Achieved	46% reduction compared to 2015	31% reduction compared to 2015	52% reduction compared to 2015[1]
			Days of production shutdown caused by phase 3 water rationing in Taiwan (water supply reduced by 30%)	0 days	Achieved	0 days	0 days	0 days
	• Significantly increase energy efficiency, obtain remaining energy needs from renewable sources, and leverage support from suppliers to promote the similar actions across our supply chain	Energy Management	Energy saving rate achieved through energy saving and carbon reduction projects	Equivalent to 2% of the electricity demand in 2023	Achieved	Equivalent to 4% of the electricity demand in 2023	Equivalent to 2% of the electricity demand in 2024	Equivalent to 2% of the electricity demand in 2030
	• Develop and implement business models that deliver sustainable energy and energy efficiency technologies to new markets and communities		Renewable energy ratio	Renewable energy consumption accounts for 21% of total electricity consumption	Not Achieved	Renewable energy consumption accounts for 20% of total electricity consumption	Renewable energy consumption accounts for 24% of total electricity consumption	Renewable energy consumption accounts for 42% of total electricity consumption
	• Design and adopt a responsible, circular business model • Shift to a portfolio of goods and services that requires less resources and produce less waste	Waste and Circular	Non-hazardous waste recycling rate	90%	Achieved	97%	90%	90%
			Hazardous-waste intensity (hazardous waste output/ revenue)	8% reduction compared	Achieved	58% reduction compared to 2015	37% reduction compared to 2015	61% reduction compared to 2015[2]
	• Align with science based climate targets to substantially reduce emissions associated with our business and supply chain operations	Climate Strategies	GHGs intensity (Scope 1 & 2 emission/revenue)	8% reduction compared to 2015	Achieved	45% reduction compared to 2015	9% reduction compared to 2015	15% reduction compared to 2015
			Absolute GHGs reduction (Scope 1 and 2)	17.5% reduction compared to 2016	Not Achieved	2% reduction compared to 2016	20% reduction compared to 2016	35% reduction compared to 2016
			Absolute GHGs reduction (Scope 3)	4.5% reduction compared to 2020	Achieved	50% reduction compared to 2020	6% reduction compared to 2020	15% reduction compared to 2020

[1] ASEH was able to reduce 46% water withdrawal intensity in 2023 from the 2015 level, exceeding the 2030 target of 15%. As such, the 2030 goal was changed from 15% to over 52% in 2024
[2] ASEH was able to reduce 58% hazardous waste generated intensity in 2023 from the 2015 level, exceeding the 2030 target of 15%. As such, the 2030 goal was changed from 15% to over 61% in 2024