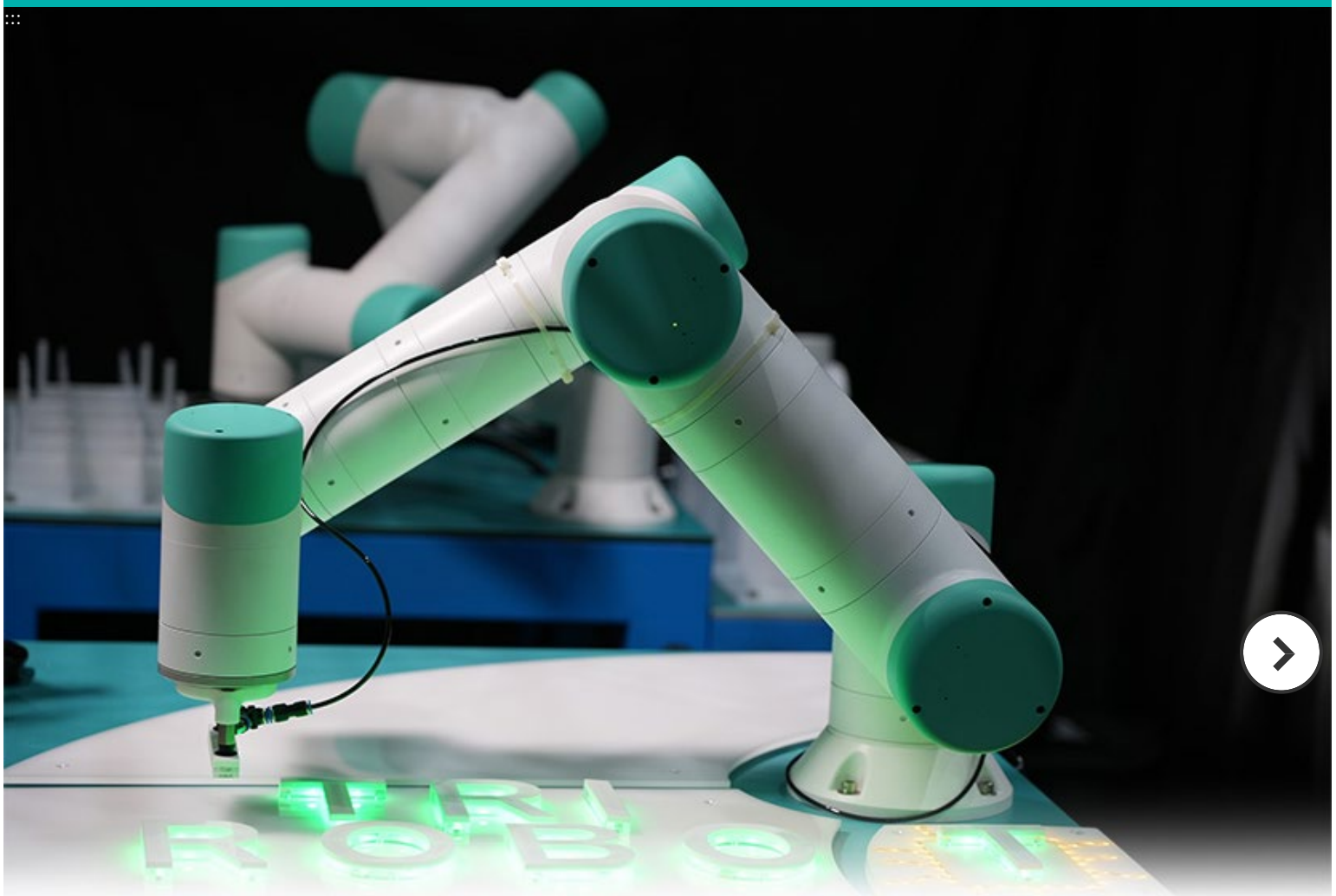


# ITRI TODAY

116

Spring Issue 2024



## AI, Sustainability, and Inclusivity

ITRI unveiled a diverse palette of 10 cutting-edge innovations at CES 2024. Explore our AI-powered display, digital health, smart sports, and robotics technologies that align with the visionary CES 2024 trend predictions in AI, sustainability, and inclusivity.

# ITRI TODAY 116 Spring Issue 2024

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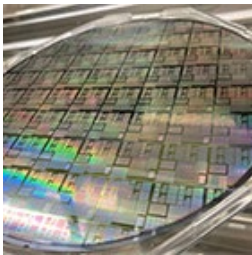
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*ITRI Today* is a quarterly publication reporting major events and  
achievements at ITRI.

Accessibility AA

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## ITRI's Snapshot at CES 2024



*ITRI's recap of CES 2024.*

The world's largest tech show, CES 2024, concluded this January, marking a significant return to full-scale in-person exhibitions after the challenges posed by the pandemic. As the tech industry gathered to witness the latest advancements, key trends identified by the Consumer Technology Association (CTA) included AI, sustainability, and inclusivity, reflecting the industry's collective focus on advancing technology responsibly. In tune with these trends, ITRI unveiled a dynamic array of 10 cutting-edge innovations at its booth, spanning AI display, digital health and smart sports, and AI robotics technologies.

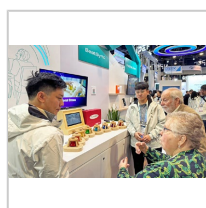
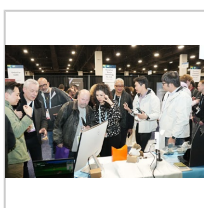
ITRI President Edwin Liu emphasized the significance of the Institute's eighth consecutive participation at CES, stating, "CES is the most influential tech event in the world. To be at CES, we have two main purposes: to showcase ITRI on the global stage and to provide our team with valuable exposure to the latest advancements worldwide." He further noted, "By participating in CES, we aim to gather valuable market feedback, aiding our R&D team in developing more market-oriented technologies."



Jessica Boothe, Director of Market Research at CTA, expressed her excitement about ITRI's showcase, highlighting its alignment with CES 2024 trends. "We find everything to be on-trend. The CES 2024 trends were predicted to be AI, sustainability, and inclusivity. And we have all of that right here in your booth," she remarked. "As we're celebrating CTA's 100-year anniversary, it's nice to say that we have exhibitors like ITRI coming back every year to CES, and we continue to see ITRI continue to innovate," she added.



***Jessica Boothe, Director of Market Research at CTA, engages with ITRI's Hyper-Realistic 3D Interactive Display, interacting with her digital avatar.***





Captivating industry professionals and media alike, ITRI's booth featured interactive experiences and eye-catching demos. The [Hyper-Realistic 3D Interactive Display](#), for instance, drew attention with its 3D virtual-real avatar. An attendee shared, "It got my attention right away. [...The mapping process] was really cool, but then coming around and seeing myself animated with my mouth moving—I can see a lot of application for this." Another standout exhibit, [iGolfPutter](#), a smart golf simulator offering the sensation of playing on an outdoor course, received praise from an industry attendee who noted, "Putting has been the thing

that's hardest to simulate, but this experience seemed really good and really smart. With the multiple camera setup, the ball tracking seemed accurate.”

ITRI's presence at CES 2024 not only showcased its commitment to innovation but also demonstrated its agility in adapting to the evolving landscape of global technology trends. To explore more about ITRI's CES 2024 innovations:

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 [Our Smart Sports and Digital Health Tech](#) 

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 [Our AI Entertainment and Robotics Tech](#) 

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## » Feature



## Exploring Our Smart Sports & Digital Health Tech

Our smart sports and digital health innovations at CES 2024 were **iGolfPutter**, a smart sports technology designed for indoor golf training; **iSwimWear**, a smart personal device designed to monitor physiological vitals in underwater environments; **Mountain Watch**, an outdoor safety system that helps prevent hikers from getting lost or separated from their group; **DeeGoo**, a science-based management solution designed to assess and stimulate cognitive functions; and **BeatSync**, an AI-powered interactive music training device designed to relieve emotional stress and enhance mental health.

### **iGolfPutter offers outdoor golf course playing simulation**

Powered by ITRI's 3D sensing AI analysis technology, [iGolfPutter](#) captures the player's posture, stance, and swing. iGolfPutter also combines skeletal data with embedded sensor data from the putter and golf ball to offer comprehensive simulation, analysis, visualization, and educational experience.



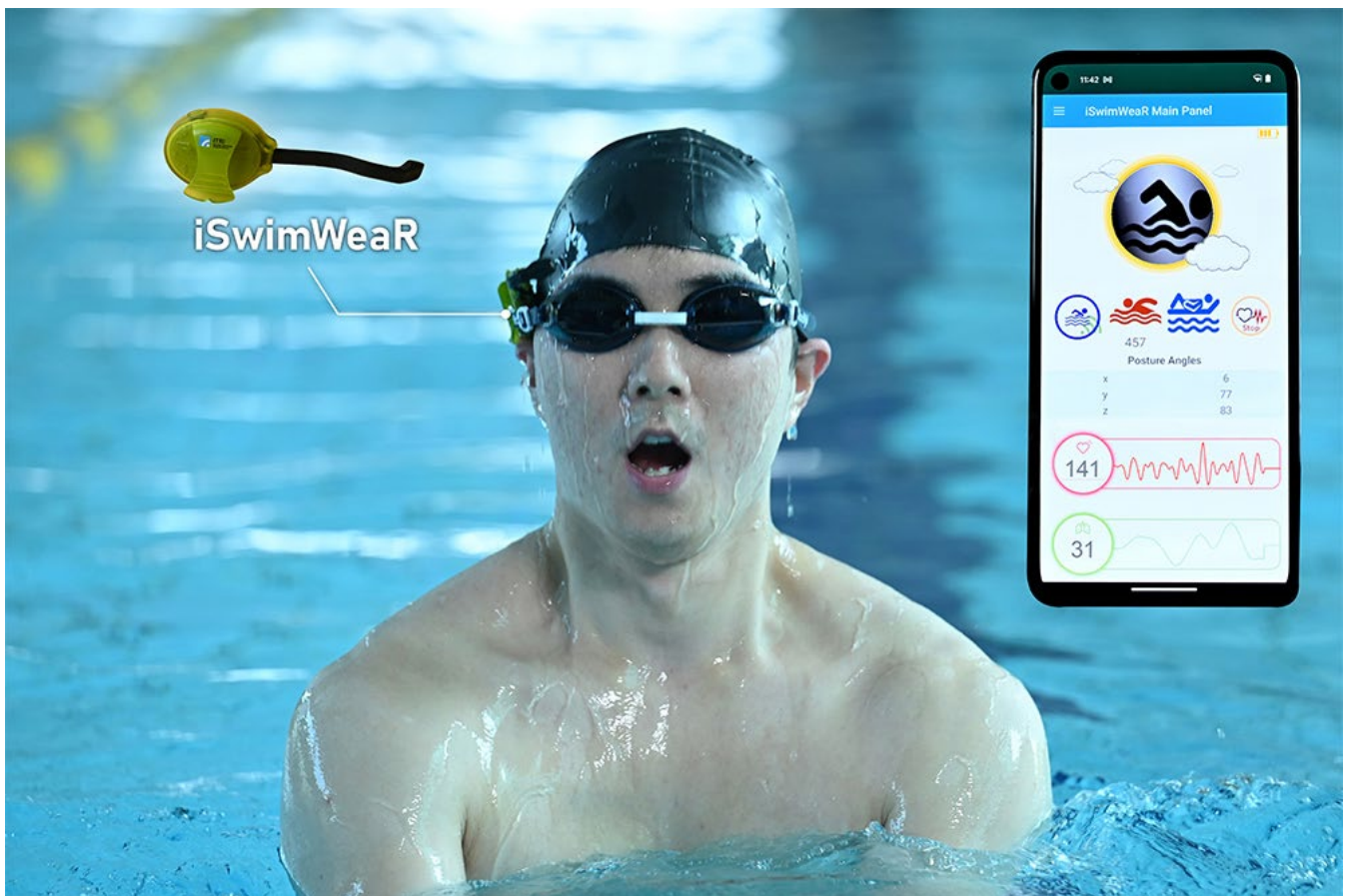
***iGolfPutter offers comprehensive analyses and recreates the terrain of real golf courses for your next shot.***



While the display provides a captivating view of the golf course, the AIoT green under the player's feet dynamically recreates after each swing the terrain of real golf course landscapes for the player's next shot. Furthermore, it enables multiple players to compete in both virtual and physical settings simultaneously. For instance, some players can play on an actual golf course, while others join the same game virtually from anywhere using iGolfPutter to simulate the same course.

### **iSwimWeaR tracks real-time vitals while submerged**

Unlike existing waterproof wearable devices that only transmit data once out of the water, [iSwimWeaR](#) monitors real-time diver or swimmer vitals while submerged. Using low-power microwave sensing technology combined with a user-friendly smartphone app, iSwimWeaR tracks and displays underwater vitals including heartbeat, breathing rate, and activity levels in real time with a 95% accuracy rate. The device easily integrates with diving masks and swimming goggles without direct skin contact.



***iSwimWeaR tracks real-time vitals even when submerged.***

When the heartbeat or breathing rate drops too low, iSwimWeaR sends visual safety alerts to the diver or swimmer and colleagues, enhancing safety in beginner swimming lessons and elevating the overall training experience for athletes.

## **Mountain Watch displays real-time locations in areas with no phone signal**

[Mountain Watch](#) includes a smartphone app and a mesh network device. Even in mountainous areas with weak or no mobile phone signals, hikers can use Mountain Watch to update and share their real-time location with emergency coordinators, other hikers, family, and friends.

Using ITRI's mesh network technology, the device features low power consumption, an extended communication range, and three-dimensional multipoint signal communication capabilities. These features enable the devices to serve as relay stations for one another through long-distance transmission. The device also features an emergency system that immediately sends emergency signals to other hikers in the vicinity. Hikers can also plan routes, navigate, and stay connected with family and friends through Mountain Watch.



***Mountain Watch can update and share real-time location in areas with weak or no mobile phone signals.***



## DeeGoo offers personalized cognitive assessment and exercises

[DeeGoo](#) helps seniors assess the risk of dementia and stimulate cognitive functions, prompting them to seek medical attention for early diagnosis and treatment. Compared to conventional time-consuming paper-based tests, DeeGoo tests can be completed within three minutes and can gather data such as response time and users' reactions to interactive tasks, providing doctors with a comprehensive data set for evaluation.



***DeeGoo personalizes cognitive exercises to train elders' perception, attention, memory, executive function, language, and motor skills.***

Through AI analysis, posture recognition, and algorithms for both body and cognitive functions, DeeGoo offers personalized cognitive exercises to train performance in perception, attention, memory, executive function, language, and motor skills. By tracking patients' progress, DeeGoo has demonstrated a significant impact on delaying cognitive decline and improving overall cognitive health.

### **BeatSync personalizes music scores to enhance mental health**

Through button-press musical instruments, [BeatSync](#) captures details including the number of button presses, accuracy, timing errors, and pressing force. This data is analyzed to instantly display results, serving as a health assessment reference for either the user or caregiver. BeatSync recommends personalized music scores based on performance results as analyzed by AI, tailoring the training experience to individual needs.



***BeatSync tailors the music score training and can serve as a health assessment reference.***



## » Feature

# Glimpse into Our AI Entertainment & Robotics Tech

Our AI display and entertainment innovations exhibited at CES 2024 included the **AR Interactive Vehicle Display**, a transparent display for sightseeing passengers in a moving vehicle to view and interact with augmented reality (AR) content regarding attractions they pass by; the **Hyper-Realistic 3D Interactive Display**, delivering 3D animations and live broadcasts with a digital avatar; and **PetPet Cam**, the world's first Gen AI pet camera that accurately captures our furry friends' cute moments and generates mashups for personal cherishing or easy sharing.

The AI robotics innovations ITRI presented are the **Detachable Robot Joint System**, a highly flexible robot joint module that allows rapid assembly into a plug-and-play robotic arm with customizable axes, and **RoboTwin: Metaverse Smart Factory Simulation Platform** for creating a realistic virtual reality (VR) simulation of a manufacturing facility.

### AR Interactive Vehicle Display brings AR to sightseeing

The [AR Interactive Vehicle Display](#) allows tour bus passengers to view and interact with AR content regarding attractions along their route. When passengers spot a site of interest, the location name is presented in real time, following their line of sight. A simple touch on the screen provides detailed information, such as attraction features, local history, and geography. This versatile technology can also be applied to light rail systems, cable cars, cruise ships, and more.





***Passengers can interact with AR content regarding the attractions on a sightseeing bus.***

This technology has expanded its reach through collaboration with leading display solution provider [AUO](#) on a ferry operating in the Port of Kaohsiung. AUO has taken the infotainment concept from the water to the road, transforming it into the [Interactive Transparent Window](#). This innovation was named a CES 2024 Best of Innovation Honoree, showcasing ITRI's commitment to empowering Taiwanese companies on the global stage.

### **Hyper-Realistic 3D Interactive Display interacts with your avatar**

The [Hyper-Realistic 3D Interactive Display](#) is the world's first interactive system that can interact with your digital avatar and deliver 3D animations and live broadcasts. Powered by generative AI (Gen AI), the system can carry out real-time image processing, including 3D models, image matting, expression, motion generation, single 2D to 3D imaging, and 3D virtual-sense fusion, making it ideal for creative advertising and marketing campaigns.



***Through Gen AI, it can generate your interactive 3D avatar from a 2D image in real time.***

Key features include:

- **Gen AI 2D to 3D imaging:** Using advanced AI technology, the system swiftly converts 2D images into an intricate avatar in 3D.
- **Smart virtual-real 3D image fusion:** The avatar appears 3D to the naked eye and can maintain eye contact with viewers from various angles.
- **AI expression and motion generation:** Continuous expressions of the avatar can be synthesized from a single image and voice. Its movements are also lifelike and accurate because of the automatic skeleton binding technology.

### **PetPet Cam captures pets' “cute events”**

[PetPet Cam](#) utilizes Gen AI to train a deep neural network (DNN) model to accurately capture “cute events” of pets, such as yawning, belly showing, stretching, and playful interactions with family members. It automatically generates photo and video mashups that owners can effortlessly share on social media platforms.

The onboard edge AI works like an experienced photographer, reacting instantly to the pet's actions and deftly controlling the shutter. PetPet Cam's autonomous photo capturing reaches 95% accuracy for defined events, saving the owner from searching through hours of footage to find a specific frame.





***PetPet Cam captures “cute events” of pets and generates photo and video mashups automatically.***

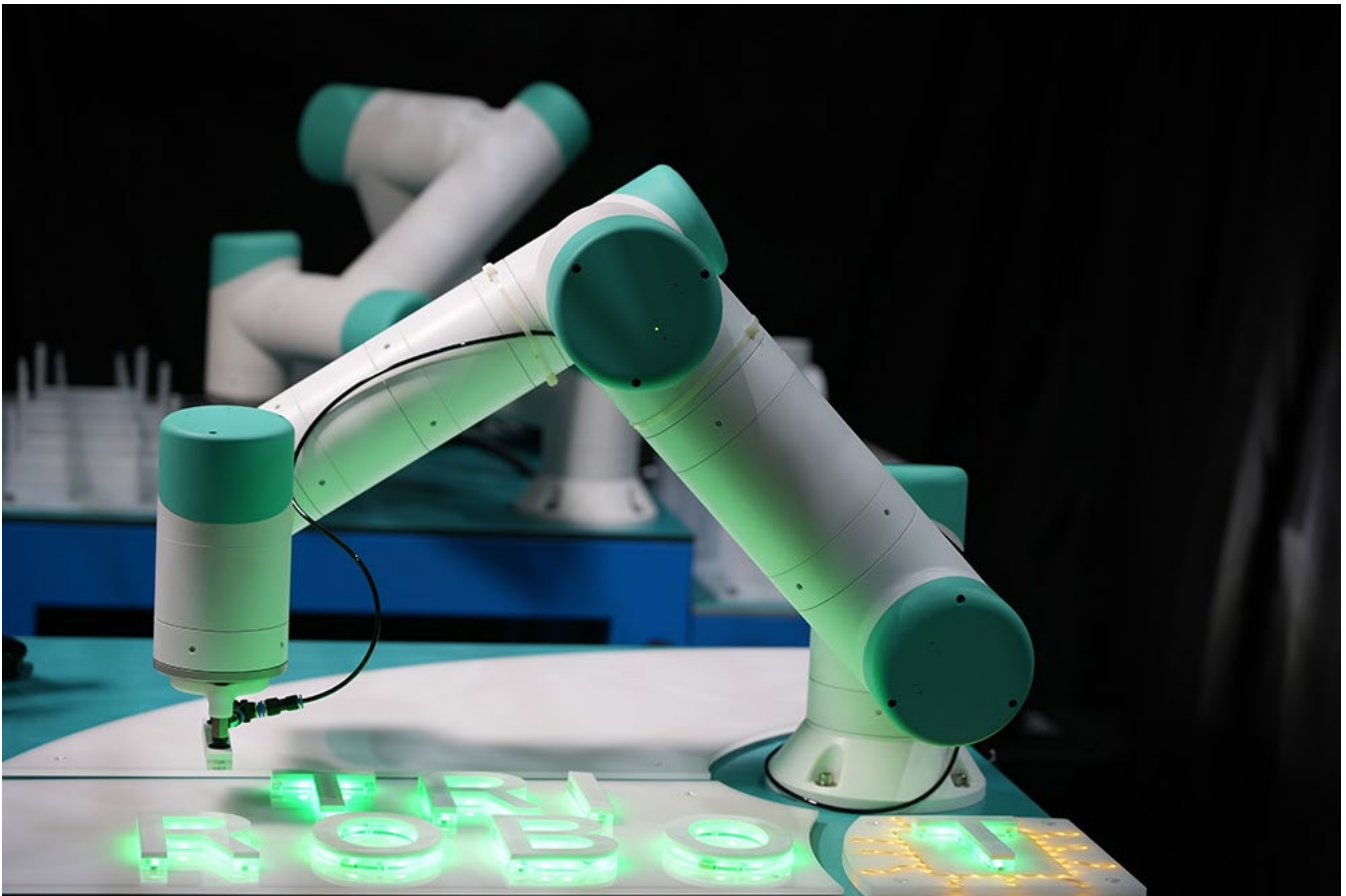
PetPet Cam identifies individual pets, tracks their drinking and feeding frequency, and provides valuable insights for pet owners and healthcare professionals. Its versatile design allows users to set it up in the pet’s living area or use multiple cameras to cover various spaces.

### **Detachable Robot Joint System enables rapid robotic arm assembly**

The [Detachable Robot Joint System](#) can be rapidly assembled into a plug-and-play robotic arm with a customizable number of axes for real-time motion commands. It enables the customized creation of robots with high payload, multiple axes, or wide-ranging operations, catering to the demand for flexible and small-batch production.

While traditional robotic-arm repairs can take days, this innovative module can have its axis replaced in just five minutes, significantly enhancing production efficiency while reducing costs, time, and manufacturing risks. Compared to industry-standard joint modules, the Detachable Robot Joint System is not only lighter but also boasts a superior load-to-weight ratio and the world’s highest torque-to-volume ratio.





*The Detachable Robot Joint System can customize robotic arm modules and have its axis replaced within just a few minutes.*

### **RoboTwin brings virtual reality to factories**

Through state-of-the-art AI and Sim2Real technologies, [RoboTwin: Metaverse Smart Factory Simulation Platform](#) creates a realistic VR simulation of a manufacturing facility based on real-world data. Engineers and operators wearing VR headsets can immerse themselves in the virtual factory, simulating production-line adjustments and performing tasks.



***With RoboTwin, engineers and operators can conduct human-robot interactive simulations as well as remote troubleshooting and maintenance through VR.***

RoboTwin's customizable applications include industrial metaverse experiences, human-robot interactive simulation, and various applications for multi-agent collaboration, remote troubleshooting, and maintenance via teleoperation.

Leading Taiwanese manufacturers, China Steel Machinery Corporation ([CSMC](#)) and TECO Electric & Machinery Co., Ltd ([TECO](#)), have utilized RoboTwin to create virtual factories, enhancing efficiency in their production processes. RoboTwin also holds significant application potential in industries such as semiconductors, machining, and manufacturing.



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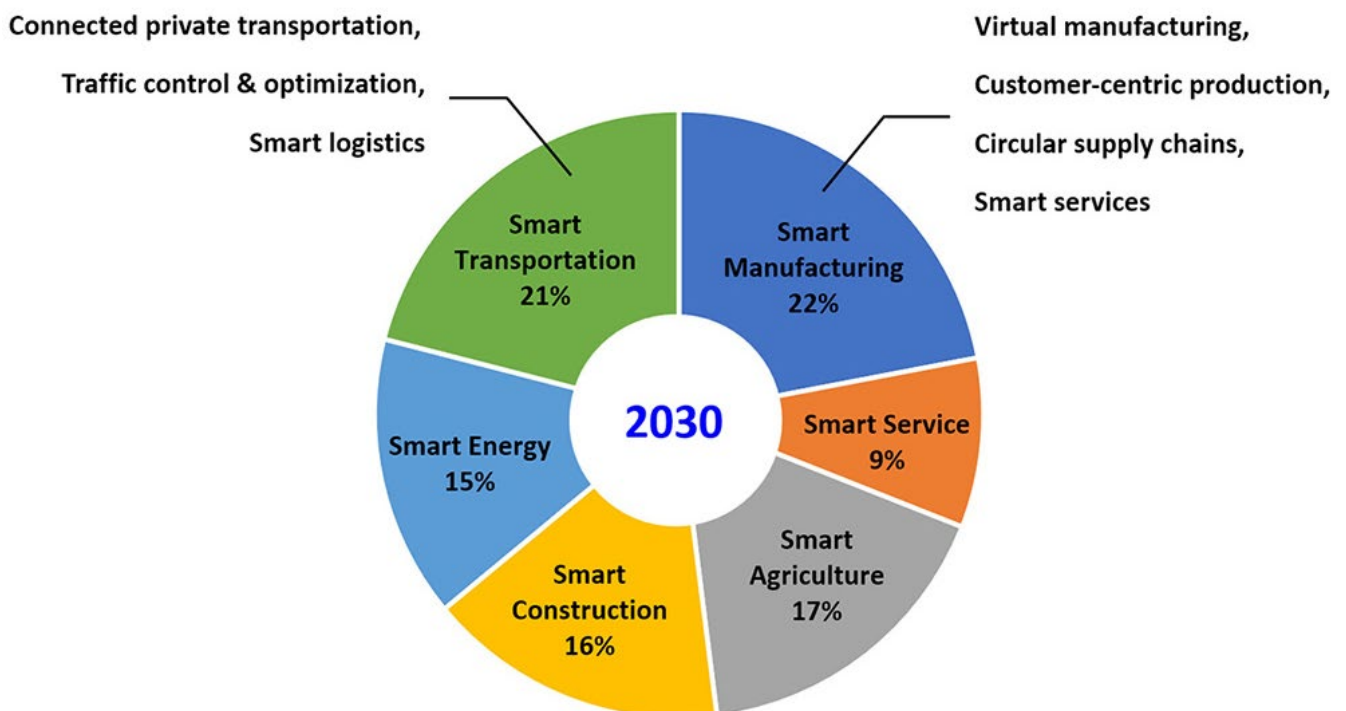
## » Special Article Part 1

# Global Trends of Enhancing Sustainability by ICT Products

Senior Vice President Stephen Su, Chun-Hao Yueh, and Chia-Ying Chen

The United Nations Climate Change Conference (COP28), which concluded on December 13, 2023, reached an agreement by negotiators from 198 countries to commit to transitioning away from fossil fuels in energy systems and accelerating actions to achieve net zero before 2050. This is the first time in the history of the climate summit that the term “fossil fuels” was explicitly mentioned in the resolution. This resolution, however, did not include “phasing out fossil fuels” as expected by various European and American countries, but used a more neutral word “transitioning.” In addition, the resolution recognized that global carbon emissions will peak before 2025 and promised to phase out “inefficient fossil fuel subsidies.”

In pursuit of practical solutions, the Global Enabling Sustainability Initiative (GeSI) SMARTer2030 report projected that by 2030, information and communication technology (ICT) products could lead to a reduction of 1.25 billion tons of CO<sub>2</sub>e, equating to 1.97% of global emissions in various global industry sectors. The primary contributors to this reduction are identified in key sectors, with **smart manufacturing** leading the charge at 22%, followed closely by **smart transportation** (21%), **smart agriculture** (17%), **smart construction** (16%), and **smart energy** (15%), accounting for a total of 91%.



**2030 ICT CO<sub>2</sub>e Abatement Potential by Use Case (GeSI, 2015).**



As the frontrunner in carbon reduction, smart manufacturing encapsulates a multitude of critical applications for energy-saving opportunities:

- **Virtual Manufacturing:** This involves the fusion of cyber-physical systems (CPS) with the industrial internet of things (IIoT), and machine-to-machine (M2M) technologies to create digital twins of physical manufacturing and simulated manufacturing. This integration optimizes efficiency in production processes, enhances resource utilization, and reduces energy consumption for better sustainable industrial practices.
- **Customer-Centric Production:** Incorporating customer preferences into both the development and production phases, it fosters a tailored strategy that minimizes waste and optimizes energy usage. It also adopts decentralized production networks and distributed manufacturing models to increase energy efficiency by reducing transportation-related energy consumption.
- **Circular Supply Chains:** As a pivotal component in enhancing the sustainability of smart manufacturing, circular supply chains engage in practices such as remanufacturing products, components, and waste, as well as adopting circular packaging. This not only reduces the overall demand for new resources but also minimizes the environmental footprint typically associated with the disposal of manufacturing by-products.
- **Smart Services:** These services help create a cross-sector ecosystem that seamlessly integrates both upstream and downstream manufacturing processes. The interconnected services enhance operational efficiency, reduce energy-intensive tasks, and contribute to a more sustainable and interconnected smart manufacturing environment.



## » Special Article Part 2

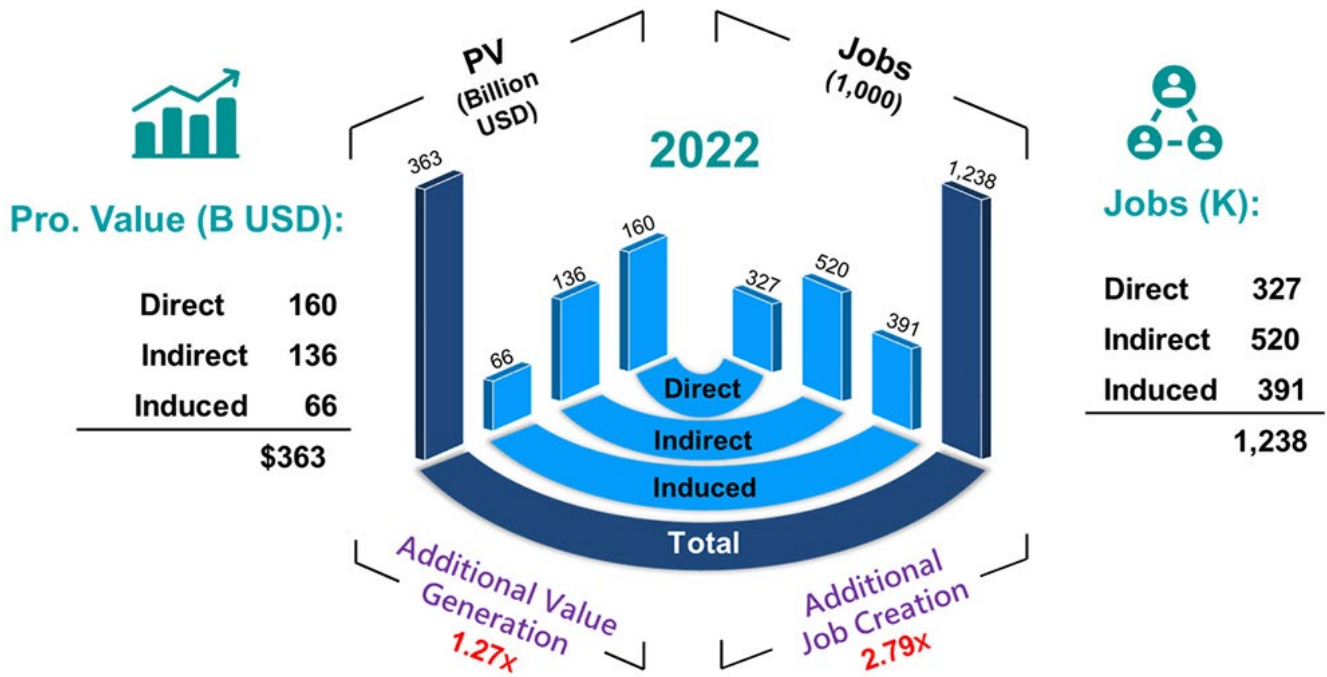
# Contribution to Sustainability by Taiwan Semiconductor Industry

The EU's Carbon Border Adjustment Mechanism (CBAM) serves as a strategic tool by imposing a "carbon price" on imports of high-carbon-intensity items. This compels product companies and their upstream/downstream suppliers to work together for emission reduction of their products and manufacturing processes. The long-term strategic goal for CBAM is to realize a 55% reduction in EU industries' CO<sub>2</sub> emissions between 1990 and 2030.

Initially, CBAM will mainly apply to steel and other industrial goods such as iron, aluminum, fertilizers, ammonia, and cement imported into the EU starting in 2027. Although semiconductors are not among the initial list of high-carbon-intensity items, due to semiconductor manufacturing's nature of high energy consumption, the increasing pressure for the semiconductor industry to reduce energy consumption and enhance sustainability in the near future should not be underestimated.

The semiconductor industry in Taiwan holds a prominent position, not only for its significant economic contributions but also due to the attention it draws regarding carbon emissions and electricity consumption. In 2021, the top 10 carbon-emitting companies accounted for 39% (about 107 million metric tons). These companies include electricity, petrochemical, steel, plastic, cement, and semiconductor industries. The semiconductor industry, known for its advanced chip manufacturing processes with high value but requiring higher electricity consumption and carbon emissions, often becomes the focus of attention from media and environmental groups.

The high value of Taiwan's semiconductor industry can be demonstrated by a research study of the Industry, Science and Technology International Strategy Center (ISTI) of ITRI. In 2022, the semiconductor industry in Taiwan reached US\$ 160 billion in revenues with employment of 327,000 people. When the additional outputs based on supply chain industries (indirect) and disposable income used in related service industries (induced) are included, the semiconductor industry also generated an additional 127% in revenues and 279% in employment.



**Total Revenues and Employment Generated by Taiwan’s Semiconductor Industry (IEK Consulting, 2024).**

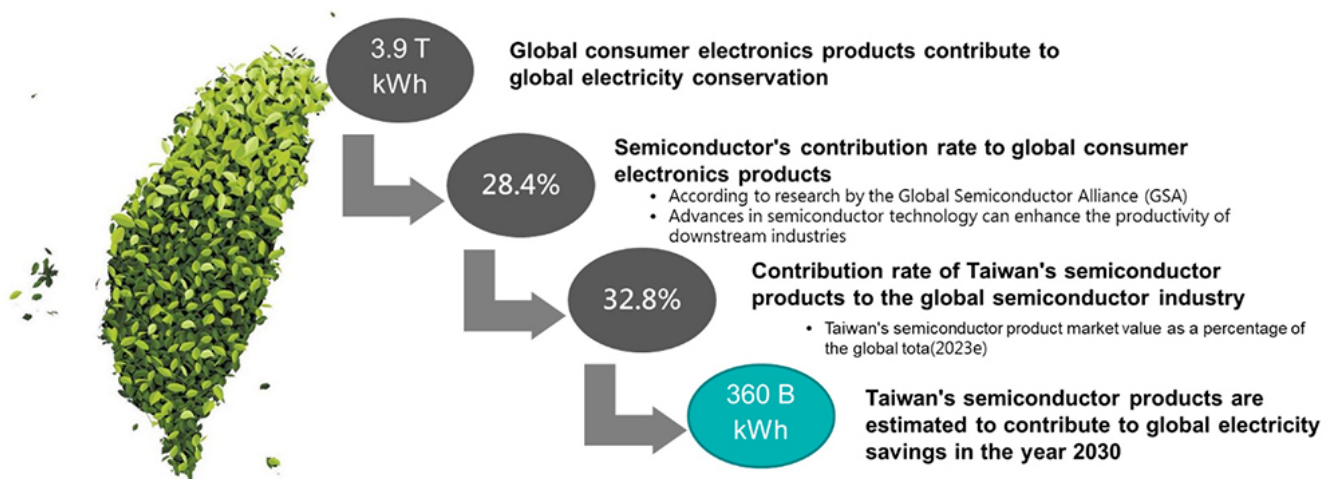
According to another study (2021) conducted by ISTI of ITRI, the semiconductor industry in Taiwan has demonstrated strong performance in electricity consumption competitiveness, an index defined by the ratio of “an industry’s total value added” to “its total electricity consumption.” Compared to other industry sectors in Taiwan, the semiconductor industry created a value of 26.8%, higher than the overall manufacturing industry (NTD 59.7 value-add per kWh vs. NTD 47.1).

Despite already surpassing the overall average within Taiwan, the electricity consumption competitiveness of the semiconductor industry can still be improved in three key directions: (1) **vertical integration** of advanced wafer manufacturing, packaging, and testing to increase added value; (2) **product efficiency review** to assess power efficiency from a product perspective and phase out of inefficient products; (3) **global presence expansion** by strategically planning investments and establishing facilities to leverage complementary technology, materials, and talent outside Taiwan.

According to another study by ISTI of ITRI, ICT products with embedded semiconductors manufactured by TSMC and used in AI computing, 5G, HPC, among others, are estimated to currently contribute to global energy savings of over 200 billion kWh by 2030, roughly more than four times the electricity consumption for production. In other words, for every kWh of electricity used in production by TSMC in Taiwan, its IC products can be used in smart electronic products or services to save 4 kWh of electricity globally. With advantages in chip market share, computing speed, and expanded application scope, there is a future trend of increasing energy-saving benefits year by year.



Furthermore, still another study by ISTI of ITRI adopted the simulation models from the American Council for an Energy-Efficient Economy (ACEEE) for different scenarios of energy-saving effects based on the use of electronic products with embedded semiconductors. The results indicated that by 2030, the global ICT products could save approximately 11.8% of the world's total electricity consumption (3.9 trillion kWh). Within the ICT products, the contribution by global semiconductors will be about 28.4%. Considering that the semiconductors produced by Taiwan account for 32.8%, Taiwan's semiconductor industry could help reduce the world's total electricity consumption by about 360 billion kWh, representing 1.1% of the global total electricity consumption.



***Taiwan's Semiconductor Industry Contributes to Global Electricity Saving (IEK Consulting, 2024).***

Of the 360 billion kWh saving by 2030, Taiwan's semiconductor products are expected to make an even more significant impact on global energy saving, contributing to an estimated saving of 22% (80 billion kWh) from **smart manufacturing**. ICT products with embedded semiconductors can enable smart manufacturing applications in cyber-physical systems (CPS), industrial internet of things (IIoT), embedded system production technology, data analytics and cloud computing, 3-D printing, as well as drones and robotics.

Also, from **smart transportation**, Taiwan's semiconductor products are expected to assist in global energy savings of 21% (76 billion kWh) by 2030. Energy-saving benefits include traffic control and optimization (e.g. automated driving, autonomous vehicles, driverless cars), connected private transportation (e.g. car/route sharing, intermodal transport), and smart logistics (e.g. fleet management and optimized routes, digital warehouses, operational agility).

Although the semiconductor industry in Taiwan faces environmental concerns for its carbon emissions and electricity consumption, its electricity consumption competitiveness outperforms other manufacturing sectors. Moreover, products manufactured by TSMC are expected to contribute to a significant impact on global energy savings, including an estimated

total of 43% from smart manufacturing and smart transportation. This underscores the potential positive impact of Taiwan's semiconductor products on global energy efficiency in the coming years.

Regarding global policies, there is a critical concern related to the EU's 2050 net-zero emissions goal and CBAM. The mechanism's imposition of carbon price on Scope 3, which includes suppliers, distributors, and product use of imported products to the EU, raises potential challenges. For example, the semiconductor industry in Taiwan, currently manufacturing and assembling products or modules locally before exporting to brand companies overseas, may face additional financial and societal burdens due to CBAM's carbon levies. There is a call for recognizing the benefits of ICT products with embedded semiconductors in reducing carbon emissions and electricity consumption through carbon credits or reduced carbon prices. The suggestion is that, similar to industries like Tesla in the sustainability sector, semiconductor contributions to enhancing sustainability should be acknowledged, and ICT products and their suppliers should receive proportional carbon credits for their positive environmental impact.





## » Special Article Part 3

# Outlook to Leverage Taiwan's Semiconductor for Sustainability

The call for green transformation in Taiwan, driven by the urgency of addressing climate change, has become a new paradigm for establishing industry or corporate competitiveness. Not only has the National Development Council (NDC) published Taiwan's Pathway to Net-Zero Emissions in 2050, providing actions to achieve 2050 Net-Zero Emissions, but the National Science and Technology Council (NSTC) has also developed the 5-year Chip-based Taiwan Industrial Innovation Program in 2023 to solidify Taiwan's international competitive advantage in semiconductors. This program aims to leverage Taiwan's strengths in semiconductor manufacturing and packaging, extending them to the front-end IC design, thereby establishing Taiwan as an international hub for IC design.

Key elements of the program focus on using IC design as an engine for international innovation, with a commitment to:

- establishing a global IC design training and innovation hub in Taiwan
- utilizing Gen AI to drive industrial innovation
- strengthening the foundational environment to attract global talent
- accelerating innovation in industrial technologies, and
- attracting international startups and investments to Taiwan.

The program's goal is to enable industrial innovation across various application sectors, including smart agriculture, smart homes, and autonomous vehicles, all highly related to enhancing sustainability.

While Taiwan has built the semiconductor industry as the foundation rock with more than 50 years of development, the semiconductor sector continues to position Taiwan as a global key partner. Therefore, it is crucial for Taiwan to help drive global carbon reduction by enhancing industrial value and improving energy efficiency through the empowerment of new semiconductor technologies and smart applications. Taiwan can effectively assist the world in



moving towards the goal of net-zero sustainability in three major directions:

1. **Resource Efficiency:** Having the control over scarce resource inputs, such as water and electricity, is essential for maintaining a competitive advantage in the semiconductor industry. Ensuring superior resource efficiency indicators is crucial for sustaining Taiwan's position.
2. **Green Energy Investments:** Evaluating the feasibility of diverse green energy investments includes assessing long-term contracts for group purchase of green energy, self-construction, and self-generation of green energy.
3. **Global Contribution to Sustainable Development:** Grasping worldwide trends in AI and global manufacturing supply chains represents a golden opportunity for Taiwan in the next stage to contribute to global goals related to sustainable development. In the post-pandemic era, Taiwan could become an indispensable key partner in the global resilient industry ecochains, accelerating digital and sustainable twin transformation and leveraging diverse applications and services in technology, humanities, and innovation. The vision is encapsulated in the concept of “Smart Taiwan Value” to assist the world in envisioning a better future.

In conclusion, Taiwan’s semiconductor industry, with its influential role in energy-saving initiatives, is poised to be a key global leader in resilient industry ecochains, demonstrating a commitment to a sustainable future through collaboration with global partners.



## About the Authors



**Stephen Su** is the Senior Vice President of ITRI and the General Director of ITRI’s Office of AI Application Strategy, while also serving as the esteemed RIN Chair for EARTO. After joining ITRI, he served as the head of ISTI, overseeing industry market research, technology scouting, and global technology collaboration. He received his Bachelor’s degree in Electrical Engineering and Computer Science from the University of

California, Berkeley, alongside dual Master’s degrees – an MBA from the Kellogg School of Management at Northwestern University, and another in Electrical Engineering from the California Institute of Technology (Caltech).



**Chun-Hao Yueh** is the Division Director within the Mechanical and System Research Division at ITRI, where he spearheads initiatives to advance smart manufacturing, machine tools, next-generation vehicles, and associated consulting services. He received his Ph.D. degree from National Taipei University and was a visiting scholar at IDE-JETRO in Japan.



**Dr. Chia-Ying Chen** is currently a researcher at the Industry, Science and Technology International Strategy Center (ISTI) at ITRI. Her research portfolio spans a diverse range of areas including statistical modeling and econometric analysis, industry analysis and market research, as well as energy efficiency and ESG considerations. She earned her M.A. in Economics from the University of Michigan and her Ph.D. from Tsinghua University in Beijing.



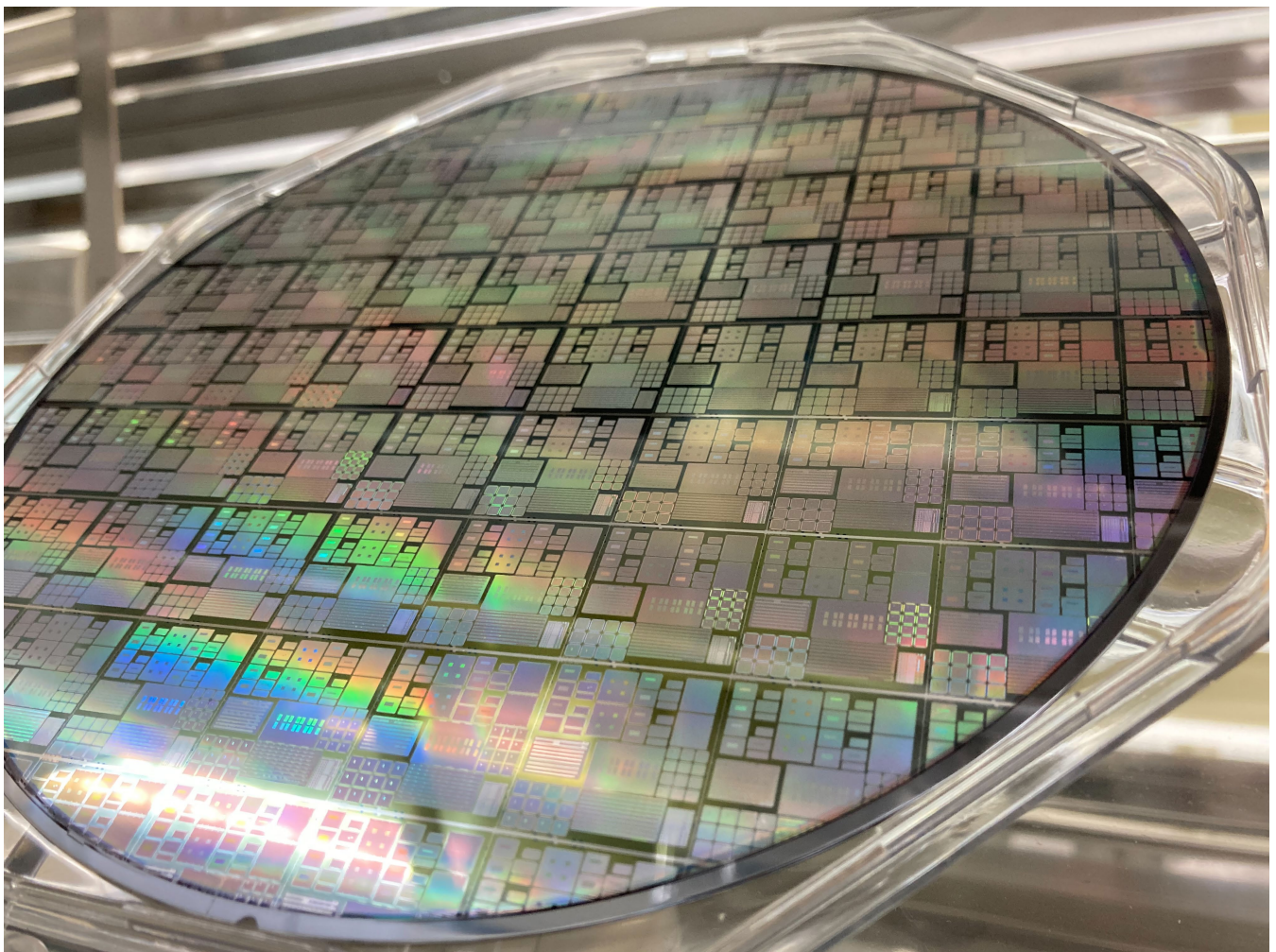


## » R&D Focus



## ITRI and TSMC's High-Speed Breakthrough: SOT-MRAM

ITRI has joined forces with Taiwan Semiconductor Manufacturing Company (TSMC) for pioneering research into the development of a spin-orbit-torque magnetic random-access memory (SOT-MRAM) array chip. This SOT-MRAM array chip showcases an innovative computing in memory architecture and boasts a power consumption of merely one percent of a spin-transfer torque magnetic random-access memory (STT-MRAM) product.



***The SOT-MRAM array chip showcases innovative computing in memory architecture and boasts a power consumption of merely one percent of an STT-MRAM product.***

Their collaborative efforts have resulted in a research paper on this microelectronic



component, which was jointly presented at the 2023 IEEE International Electron Devices Meeting ([IEDM 2023](#)), underscoring the cutting-edge nature of their findings and their pivotal role in advancing next-generation memory technologies.

Dr. Shih-Chieh Chang, General Director of Electronic and Optoelectronic System Research Laboratories at ITRI, highlighted the collaborative achievements of both organizations.

“Following the co-authored papers presented at the Symposium on VLSI Technology and Circuits last year, we have further co-developed a SOT-MRAM unit cell,” said Chang. “This unit cell achieves simultaneous low power consumption and high-speed operation, reaching speeds as rapid as 10 nanoseconds. And its overall computing performance can be further enhanced when integrated with computing in memory circuit design. Looking ahead, this technology holds the potential for applications in high-performance computing (HPC), artificial intelligence (AI), automotive chips, and more.”

The advent of AI, 5G, and AIoT has created a significant demand for rapid processing, necessitating new memory solutions characterized by enhanced speed, stability, and energy efficiency. The successful collaboration between ITRI and TSMC not only shines a light on the path toward next-generation memory technology but also strengthens Taiwan’s international competitive advantage in the semiconductor sector.



## » Collaboration

# Unveiling ITRI-Intel Lab for Immersion Cooling Tech

ITRI and [Intel Taiwan](#) inaugurated the ITRI-Intel Joint Lab for HPC Cooling Certification. This facility is dedicated to the development and validation of industrial immersion cooling solutions for high-performance computing. Targeting liquid cooling technology, the lab offers comprehensive verification services, including materials property testing, compatibility assessments with server components, and service life cycle evaluations. A letter of intent was signed between Intel Taiwan and ITRI.



*The ITRI-Intel Joint Lab for HPC Cooling Certification unveiled.*

Dr. Shih-Chieh Chang, General Director of Electronic and Optoelectronic System Research Laboratories at ITRI, emphasized the critical need for enhancing data center efficiency while reducing energy consumption. “According to the International Energy Agency, the energy consumption of data centers around the world ranged from 0.9% to 1.3% of total electricity consumption in 2022, with carbon emissions accounting for 0.3%. The global proliferation of data centers, driven by the surging demand for data volume and transmission speed, underscores the urgency of our mission,” he stated.



***The lab focuses on developing and validating industrial immersion cooling solutions for high-performance computing.***



Tzong-Ming Lee, Vice President and General Director of ITRI's Material and Chemical Research Laboratories, states that compared to the conventional data center devices, the immersion cooling technology can dissipate the heat from components to liquid coolant with no other active cooling devices, which could reduce 45% of the carbon emission and become one of the best heat dissipation options. ITRI is developing the single-phase immersion coolant technology that is extremely low energy consumption and fluoride-free, aligning with the requirements of EU legislation.

Grace Wang, Intel Vice President in the Sales, Marketing and Communications Group and General Manager of Intel Taiwan, affirmed Intel's commitment to sustainable solutions for enterprises. "Our recently launched Open IP Immersion Cooling Solutions were designed to enhance operational efficiency. As a leader in data center innovation, Intel is collaborating with ITRI to explore further advanced immersion cooling technology. ITRI's active support in providing real-world machine verification and testing platforms will facilitate the industrial adoption of the technology. Through this collaboration, we aspire to promote advanced cooling solutions within Taiwan's supply chain, contributing to the realization of sustainable data centers.



## » Collaboration

# Fostering Science Park Development with Sonora

ITRI has signed a consulting service agreement with the state of Sonora in Mexico for science park planning and advising, deepening Mexico-Taiwan cooperation in the fields of technology and industry. The effort includes regional competition analysis, strategy consulting, business development, capability enabling, and implementation support, aiming to create a competitive and sustainable science park in Sonora. This venture also extends its benefits to Taiwanese manufacturers eyeing expansion opportunities in Mexico.

ITRI's Senior Vice President Stephen Su emphasized the strategic significance of Mexico in the global supply chain, particularly in the burgeoning electric vehicle industry. He highlighted Mexico's advantageous geographical location, coupled with competitive production costs and labor expenses, comprehensive automotive manufacturing clusters, rich mineral resources, as well as the privilege of zero tariffs under the United States-Mexico-Canada Agreement (USMCA). This collaboration emerges against the backdrop of Mexico as Taiwan's largest export market and trading partner in Latin America. Through this partnership, bilateral exchanges in sectors such as semiconductors, electric vehicles, artificial intelligence, and automation industries will be deepened, supporting Taiwanese companies seeking to expand their operations in the thriving Mexican market.



***ITRI's Senior Vice President, Stephen Su (sixth from the left), and Sonora Governor Francisco Alfonso Durazo Montaño (fourth from the right) sign the agreement for science park strategic planning consultancy services.***

Governor of Sonora Francisco Alfonso Durazo Montaño expressed his pleasure in partnering with ITRI, recognizing ITRI's role as a key driver in Taiwan's semiconductor and ICT industries. Sonora, aligning its vision with "Plan Sonora," the state's sustainability development strategy, has noted the surge in international companies relocating their supply chains to Mexico. In response, the state has launched the development of the Sonora Science and Technology Park to meet the growing demands of emerging industries such as ICT and electric vehicles. The Governor articulated his hopes that the collaboration with ITRI will enable both entities to leverage their strengths and jointly explore international markets.





## » Activity

### First 5G-ACIA General Assembly in Taiwan

The 5G Alliance for Connected Industries and Automation ([5G-ACIA](#)), the world’s largest 5G industrial alliance, held its annual General Assembly in Taiwan for the first time, drawing participation from industry heavyweights such as Bosch, Ericsson, Mitsubishi Electric, Nokia, Qualcomm, and Siemens. ITRI facilitated the signing of a memorandum of understanding (MoU) between 5G-ACIA and Taiwan Association of Information and Communication Standards (TAICS), aligning Taiwanese manufacturers with global 5G Industrial Internet of Things (IIoT) standards.



***The MoU is signed by Wolfgang Weber, CEO of ZVEI e.V. (third from the left), and Jyuo-Min Shyu, Chairman of TAICS (third from the right).***

“ITRI has been actively working on the R&D of 5G and B5G technologies for industrial upgrading, and this year our commitment extended beyond that,” said Pang-An Ting, General Director of ITRI’s Information and Communications Research Laboratories. “As a world-class think tank with global connections, ITRI facilitated the 5G-ACIA General Assembly to take place in Taiwan and promote global standards for 5G smart manufacturing through the

collaboration between 5G-ACIA and TAICS. Bringing together leading telecommunications players is advantageous for Taiwan to access the global supply chain and market,” said Ting.

Jyuo-Min Shyu, Chairman of TAICS, highlighted, “5G-ACIA aggregates worldwide needs and regulations for 5G IIoT technologies, while TAICS focuses on local IoT technology and industrial standards. This collaboration enables us to exchange technical documents, industrial standards, and current developments in 5G smart manufacturing. It also empowers us to expedite Taiwan’s industrial products entering the global supply chain as we compete for 5G/6G communication standards set by [3GPP](#), the international organization dedicated to developing the next generation of global communications specifications.”

Bosch’s Dr. Andreas Mueller, General Chair of 5G-ACIA, noted, “Building on 5G-ACIA’s leading role in globally driving and shaping Industrial 5G, our collaboration with TAICS signifies another crucial step in taking Industrial 5G from theory to practice. Together, we are committed to creating a vibrant ecosystem that drives innovation and sets a new benchmark for wireless connectivity in the industrial domain. This marks an exciting phase in our journey with a bright future ahead, as we pave the way for the practical implementation of Industrial 5G solutions in Taiwan and around the globe.”

The Industrial 5G Day by 5G-ACIA was also held at the venue, showcasing 32 cutting-edge technologies and applications for 5G smart factories from leading companies and institutions such as Qualcomm (along with Advantech, Smart Tag and Aviron), Ericsson, Nokia, NXP, Keysight, Rohde & Schwarz, Litepoint, Pegatron, Compal, Lite-on, Moxa, Askey, Quanta Cloud Technology (QCT), Hwacom, Jorjin, Sercomm, Ataya, Inventec, Lions, CTOne, Telecom Technology Center (TTC), Tangram, O’Prueba, and Saviah.



## » Activity



## 2024 VLSI TSA to Kick Off in April

ITRI will host the 2024 International VLSI Symposium on Technology, Systems and Applications ([VLSITSA](#)) from **April 22 to 25, 2024** at **the Ambassador Hotel Hsinchu, Taiwan**. Experts from leading companies and prestigious academic institutions, including IBM, MediaTek, Sony, Intel, CEA-Leti, Stanford University, and Yale University, will share their insights and latest research findings on hot issues such as 2nm technology, energy-efficient computing, power devices and electronics, novel quantum computing devices and materials, emerging technologies for high-performance computing, and energy-efficient CMOS materials.

The symposium is a four-day event, consisting of three half-day tutorial sessions and three days of technical presentations of contributed papers, as well as plenary sessions and special sessions on topics including energy-efficient computing, power devices and electronics, novel quantum computing devices and materials, process technology on nanosheet and GAA devices, and emerging high-performance computing technologies.

The technical presentation will start with joint plenary sessions presented by distinguished keynotes: Huming Bu, VP at IBM, will deliver the keynote speech on 2nm technology; Thomas Mikolajick, Scientific Director at NaMLab gGmbH of TU Dresden, will share his insights on ferroelectrics for enhanced semiconductor devices; Yasunori Tanaka, Director of Advanced Power Electronics Research Center of AIST will talk about power devices for automotive vehicles; Yoshihisa Kagawa, General Manager at SONY, will present 3D stacking process technologies for advanced CMOS image sensors; and Yosuke Aragane, VP of NTT, will deliver a speech on how innovative optical and wireless network (IOWN) will enable next-generation sustainable ICT infrastructure.



## Plenary Sessions



Yosuke Aragane  
NTT



Naoto Horiguchi  
imec



Yoshihisa Kagawa  
Sony



Thomas Mikolajick  
TU Dresden and  
NaMLab gGmbH



Raja Swaminathan  
AMD



Yasunori Tanaka  
AIST

***The VLSI TSA will take place in Hsinchu, Taiwan on April 22 to 25, 2024.***

Following these sessions, experts from industry and academia worldwide will discuss the latest technologies related to energy-efficient computing during the joint special sessions. Dr. Leon Heng-Liang Huang from MediaTek will illustrate what people can trade for energy-efficient foundation IP in the FinFET process. Professor Hajime Tanaka of Osaka University will share his findings on the modeling and simulation of carrier transport in 4H-SiC. Professor Priya Panda of Yale University and Dr. Kuo-Ken Huang of Everactive Inc. will unveil the secrets of neuromorphic computing for energy-efficient edge intelligence and ultra-low-power receivers in self-powered industrial IoT applications.

The 2024 VLSI TSA incorporates an in-person symposium and on-demand video presentations after the physical event. Following the physical event, the symposium will provide on-demand video presentations for registered attendees for one month.

## » About Us



Industrial Technology Research Institute (ITRI) is one of the world's leading technology R&D institutions aiming to innovate a better future for society. Founded in 1973, ITRI has played a vital role in transforming Taiwan's industries from labor-intensive into innovation-driven. To address market needs and global trends, ITRI has launched its 2035 Technology Strategy and Roadmap that focuses on innovation development in Smart Living, Quality Health, Sustainable Environment, and Resilient Society.

Over the years, ITRI has been dedicated

to incubating startups and spinoffs, including well-known names such as UMC and TSMC. In addition to its headquarters in Taiwan, ITRI has branch offices in the U.S., Europe, and Japan in an effort to extend its R&D scope and promote international cooperation across the globe. For more information, please visit <https://www.itri.org/eng>.

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