Power-Saving Industrial Equipment with Embedded AIoT

Incorporate AIoT into Industrial Motors

Background

Taiwan's manufacturing, residential/commercial, and transportation sectors account for nearly 80% of the country's total emissions [1]. Among them, the manufacturing sector alone accounts for over half of Taiwan's carbon emissions. Further analysis of the manufacturing sector's 2022 emissions indicates that approximately 64% were from electricity, followed by non-electric sources (about 22%), and emissions from the manufacturing process (about 14%) [2]. Additionally, the production processes of industries that previously used fuels are gradually electrifying due to Taiwan's energy transition policies and industrial upgrading, which will lead to an increased demand for electricity in the future. In light of this, Taiwan should first address electricity consumption in the manufacturing sector to accelerate the achievement of national net-zero emissions goals.

In terms of industrial equipment, motors and their drive systems, whose wide use is expected to increase globally in the future, account for a high proportion of energy consumption. In addition, increasing international pressure on carbon management and sustainable supply chains has made "industrial motors" a key focus for carbon reduction in the industrial sector.

Thus, these comprehensive strategies focus on industrial motors as a critical starting point. By incorporating the Artificial Intelligence of Things (AIoT), these strategies aim to promote the efficient operation of equipment, improve energy-saving measures, reduce production costs, and mitigate the impact of carbon regulations by utilizing innovative approaches such as promoting "information flow" and integrating smart variable frequency control technologies. In addition, these strategies aim to enhance industrial competitiveness and strengthen Taiwan's advantages in the global value chain.

Global Outlook and Domestic Progress

According to the International Energy Agency (IEA) [3], motors and their drive systems account for approximately 53% of global electricity consumption, while in Taiwan, they represent around 78% of the industrial sector's electricity usage [4]. Additionally, motor use is expected to increase significantly as end-use energy sectors continue to electrify. However, motors can have a lifespan of up to 20 years, but gradually become less efficient over time due to electrical, mechanical, and electromagnetic deterioration. Motors will become a major obstacle on the path to net-zero emissions if they are unable to maintain operational efficiency.

According to market research findings [5], there are 1.043 million three-phase induction motors sold in Taiwan annually, with primary applications in fields such as industrial machinery and machine tools. Motors with power ratings between 1 and 10 horsepower

accounted for 48.3% of total sales. Several Taiwanese manufacturers (such as TECO, Tatung, and KUO SHUAY) have already mass-produced motors that meet IE4 (International Efficiency) efficiency standards. In addition, companies such as TECO and Tatung have also invested in the development of IE5 high-efficiency motors and have released related products. In the future, these companies plan to continue research and development efforts on permanent magnet motors, synchronous reluctance motors, and transformers.

In terms of technology research and development, relevant entities have been investing in the development of foresight energy-saving motor control technologies, materials, and drive systems. Additionally, these entities are working on improving energy-saving control technologies for existing systems, applying recycled materials in motor manufacturing, and establishing relevant energy efficiency standards. In recent years, technological projects have focused on the development of ultra-high power density motor drives, high-efficiency motors with reduced rare earth elements, and large flat wire winding processes.

On the other hand, the "DIGI+: Digital Nation and Innovative Economic Development Program" and "AI Taiwan Action Plan 2.0" are also actively promoting industrial investment in the research, development, and implementation of emerging artificial intelligence (AI) technologies. These efforts aim to maintain Taiwan's leading position in global technology by promoting the digital transformation of industry.

In sum, Taiwan already has a strong industrial foundation for producing high-performance motor equipment, as well as innovative capabilities for the research and commercialization of AI. In the future, it is essential to meet the urgent need for industry to reduce carbon by actively promoting the integration of AIoT applications in industrial sector equipment while continuously enhancing the capacities of key technologies.

Strategic Planning Frameworks

To further implement relevant comprehensive strategies, the following integrates four aspects—technology research and development, industry, society, and governance—into five major strategies (as shown in Figure 1). Moving forward, these strategies will shape the "Power-Saving Industrial Equipment with Embedded AIoT" by refining related implementation strategies while continuing to incorporate suggestions from experts and scholars to promote cross-agency and cross-sector exchanges and coordination.

Strategy 1: AIoT Integrate the Technological Development of Industrial Equipment

In addition to the continued development and validation of high-efficiency equipment technologies, such as permanent magnet motors, synchronous reluctance motors, transformers, and low-cost current integration testing technologies, priority will be given to AIoT technology development and validation to respond to Taiwan's digital transformation trends. This includes smart cloud analysis [6], operational monitoring and diagnostics (which can extend equipment life cycles and prevent downtime losses), and smart variable frequency control technology. Furthermore, efforts will be made to expand the range of equipment applicable for these technologies, including other industrial equipment such as boilers, and to enhance monitoring, evaluation, and the accuracy of AI algorithms.

Strategy 2: Train Industrial Energy-Saving Talent Through Digital Tools

The aging of Taiwan's labor force will impact labor supply and potentially jeopardize public sector operations and competitiveness. Given limited talent, achieving net-zero emissions targets by 2050 will require the use of digital tools to assist in cultivating talent for industrial net-zero sustainability. Future plans involve establishing an industry experience database and introducing AI tools to enhance learning efficiency by facilitating collaboration between industry associations and academic research institutions. For example, AI can address the impact of demographic changes and the demand for carbon reduction by accelerating the design process of green products.

Strategy 3: Introduce AIoT Incentive Mechanisms into Regulatory Support Measures

To promote energy-saving and carbon reduction, Taiwan's regulatory authorities have launched subsidies for high-efficiency power and public equipment. However, it is difficult to effectively manage the subsequent operational efficiency of the equipment as current measures mainly focus on purchasing. To address this, this strategy will encourage relevant agencies to include additional incentives for manufacturers that include AIoT technologies within their subsidy programs. This will also be supplemented by green finance support to alleviate the financial burden of purchasing equipment.

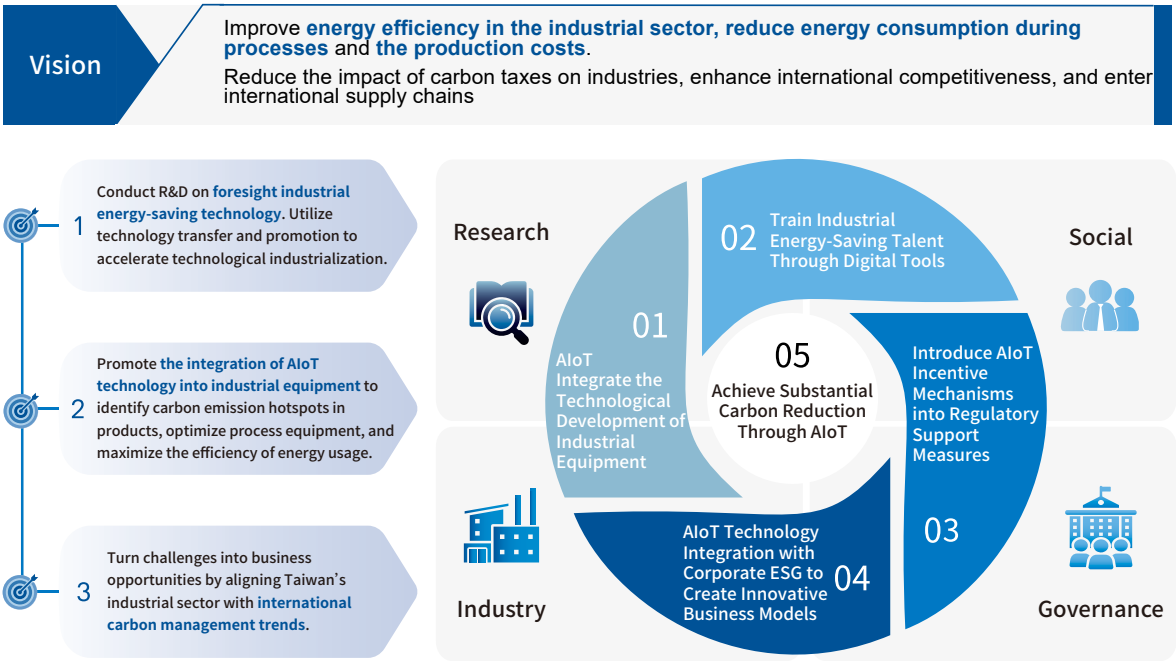

Figure 1 Power-Saving Industrial Equipment with Embedded AIoT

Source: Taiwan Science and Technology Office for Net-zero Emission (T-STONE) (2024).

To ensure the equipment continues to operate efficiently, manufacturers receiving subsidies will be encouraged to upload motor equipment operational efficiency data to the regulatory authority's cloud platform, without disclosing company trade secrets. Furthermore, regulatory authorities will promote voluntary product certification for equipment manufacturers and provide additional subsidies for purchasers of such certified equipment. This approach aims to increase manufacturers' profit margins and create stronger economic incentives to adopt high-efficiency motors.

Strategy 4: AIoT Technology Integration with Corporate ESG to Create Innovative Business Models

Recently, economic incentives for equipment users to adopt AIoT technologies have increased due to international carbon regulation policies, the Financial Supervisory Commission's Environmental, Social, and Governance (ESG) disclosure policies, and pressure from sustainable supply chains. This strategy is part of an overall approach that accounts for motor equipment users, technology service providers, and financial institutions. Furthermore, integrating "information flow" into smart control technologies promotes energy conservation while creating both economic and environmental win-win incentives for all participants.

Additionally, it is expected that through large-scale demonstration sandboxes, policies, regulations, and green financial measures will be adjusted on a rolling basis. In the future, this approach could be expanded to other industrial equipment.

Strategy 5: Achieve Substantial Carbon Reduction Through AIoT

Currently, financial institutions find it difficult to assess whether the carbon reduction measures of a given company meet their targets due to the lack of quantitative information in many corporate sustainability reports. As such, it is challenging for financial institutions to effectively engage in relevant investment and financing. In addition, to comply with International Financial Reporting Standards (IFRS), the definitions and methodologies of data collection (such as climate risk and emissions data) in Taiwan must align with international standards. Therefore, future plans involve promoting collaboration among government, industry, university and institute to improve methodologies for the measurement of carbon reduction.

Integrating AIoT smart control technologies into equipment can help record and transmit real carbon reduction data that conforms to established methodologies. In addition, digital audits will help reduce verification costs, and technologies such as blockchain will ensure information reliability and reduce the likelihood of companies engaging in greenwashing.

Potential Benefits

In addition to balancing competitiveness with needs such as carbon reduction, performance, and quality, the Power-Saving Industrial Equipment with Embedded AIoT is a critical factor for Taiwan to achieve net-zero by 2050. This is also critical in fostering future economic development by creating digital and net-zero transformation throughout industry. This strategy aims to achieve tangible carbon reduction benefits by investing in the development of AIoT smart control technologies that enhance energy efficiency by up to 30% [7], nurture talent by utilizing digital tools, adjust regulatory support, and promote innovative business models. These efforts also align with the key strategic action plan for energy conservation and achieving net-zero by 2050.

References

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