

Taiwan Regional Industrial Structure Transformation and Power Utility Operational Impact Analysis

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1. Research Objectives and Background

The rapid expansion of AI computing capacity, deepening of advanced semiconductor processes, and acceleration of net-zero transition policies have driven significant structural shifts in electricity demand across Taiwan's regions. Conventional power planning methods based on aggregated extrapolation are no longer adequate to capture complex inter-industry linkage effects and spatial disparities. This study develops a regional input-output (IO) analytical framework to strengthen Taipower's ability to anticipate local industrial structural changes and serve as a decision-making basis for medium- and long-term power sector planning. Drawing on Taiwan's Industrial and Commercial Census data from 2011, 2016, and 2021, the study constructs regional IO tables covering 22 counties and cities across 28 industry categories. An electricity consumption coefficient is introduced to estimate induced electricity demand changes across regions through 2040, while time-series models, production function regression, and S&P Global macroeconomic projections are integrated to forecast real GDP trends for each county and city and

national final demand growth trajectories from 2025 to 2050.

2. Research Findings

(1) Current Status of Industrial Electricity Consumption: National IO and Regional IO Analysis

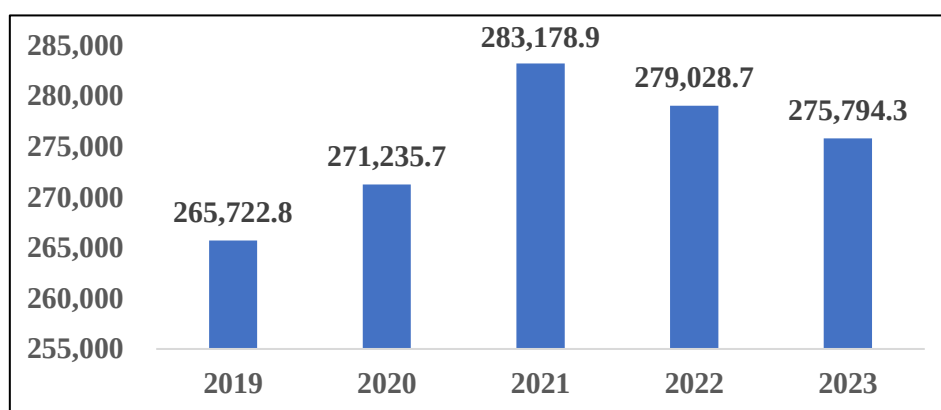
National electricity consumption grew from 265,722.8 million kWh in 2019 to 283,178.9 million kWh in 2021 before declining to 275,794.3 million kWh in 2023 (Figure 1). The industrial sector has consistently maintained its dominant position in national electricity consumption, recording a compound annual growth rate (CAGR) of 0.79%; the agricultural sector posted a CAGR of 1.84%, while the service sector recorded a modest 0.86% (Table 1). The regional IO model showed a national average deviation of only 0.00112, indicating sound overall accuracy. However, estimation errors were more pronounced in the semiconductor sector—Hsinchu City reached -3.43 and Miaoli County -2.04—reflecting that supply chain effects triggered by science park expansion exceeded the model's baseline scope.

Table 1. Electricity Consumption by Agriculture, Industry, and Services, 2019–2023

Unit: Million kWh

Category	2019	2020	2021	2022	2023	CAGR (%)
Agriculture	3,045.80	3,274.43	3,308.04	3,262.62	3,277.02	1.84
Industry	147,718.92	150,875.85	161,604.10	156,939.88	152,428.97	0.79
Services	46,681.78	46,118.03	45,396.01	47,412.56	48,299.92	0.86

Source: Energy Statistics Handbook



Source: Energy Statistics Handbook; Unit: Million kWh

Figure 1. National Electricity Consumption, 2019–2023

(2) Regional IO Projections and Electricity Consumption for 2040

This study uses AMI data to distinguish between regions and industries. Therefore, the total power consumption varies from the data in Table 1 and Figure 1. This study adopts a baseline scenario in which 2040 final demand is held constant at 2021 levels, isolating the marginal impact of industrial structural change on electricity demand. National electricity consumption is projected to increase from 12,358,481 to 13,041,298 million kWh, a rise of 5.53%, yet load shifts across regions are dramatic (Table 2). Northern Taiwan surges by 95.56%, with

its national share jumping from 25.17% to 46.64%; the Eastern region grows by 51.21%. Central and Southern Taiwan decline by 21.13% and 29.09% respectively, with the north-south divergence reflecting a northward shift in production nodes rather than southern industrial decline. The top five industries by electricity demand growth—chemical raw materials, basic metals and metal products, chemical products, textiles, and electronic components—collectively contribute 423,746 million kWh, accounting for the majority of the national increase of 682,816 million kWh (Table 3).

Table 2. Regional Electricity Consumption Changes in 2040 under the Baseline Scenario

Unit: 10,000 kWh

Rank	Region	2040 Electricity Consumption	Share of National Total	2021 Electricity Consumption	Share of National Total	Growth Rate (vs. 2021)
1	Northern	6,083,052.632	46.64%	3,110,524.075	25.17%	95.56%
2	Eastern	84,552.03457	0.65%	55,915.49701	0.45%	51.21%
3	Central	3,525,494.217	27.03%	4,470,258.709	36.17%	-21.13%
4	Southern	3,348,198.82	25.67%	4,721,782.937	38.21%	-29.09%
National Total		13,041,297.7	-	12,358,481.22	-	5.53%

Source: AMI electricity consumption data; compiled by this study; ranked by growth rate.

(Note: Northern region: Taipei, New Taipei, Keelung, Taoyuan, Yilan, Kinmen; Central region: Taichung, Nantou, Changhua, Hsinchu County and City, Miaoli, Matsu; Southern region: Tainan, Kaohsiung, Pingtung, Yunlin, Chiayi County and City, Penghu; Eastern region: Hualien, Taitung.)

Table 3. National Electricity Consumption Ranked by Industry, Ranked by Volume Change

Unit: 10,000 kWh

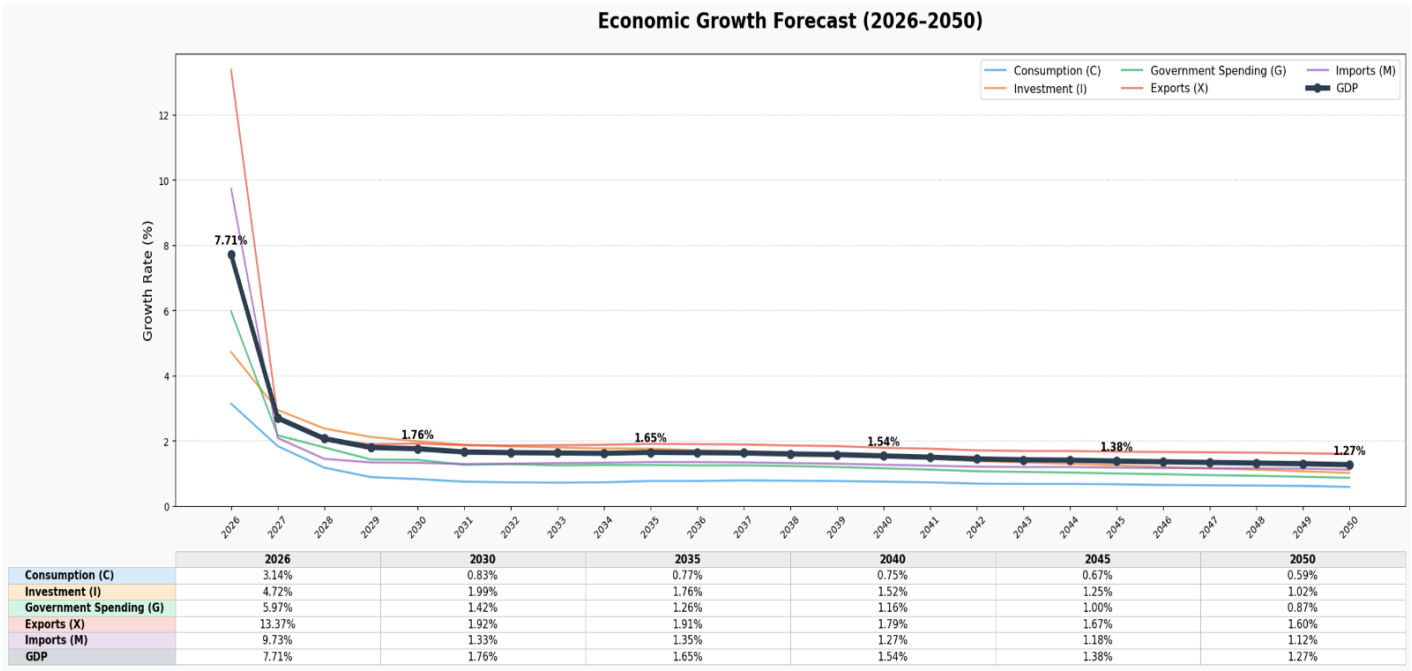
Rank	Industry	2040 Electricity Consumption	2021 Electricity Consumption	Change	Growth (%)
1	Chemical Materials	1,256,062.52	1,104,932.64	151,129.90	13.68%
2	Basic Metals and Metal Products	1,539,860.97	1,401,202.78	138,658.20	9.90%
3	Chemical Products	627,832.65	544,362.44	83,470.21	15.33%
4	Textiles	514,997.98	480,320.08	34,677.90	7.22%
5	Electronic Components	820,206.45	805,397.07	14,809.37	1.84%
National Total		13,041,297.7	12,358,481.22	682,816.48	5.53%

Source: Compiled by this study; ranked by the difference between the two years.

(3) Projections of Final Demand and Regional GDP through 2050

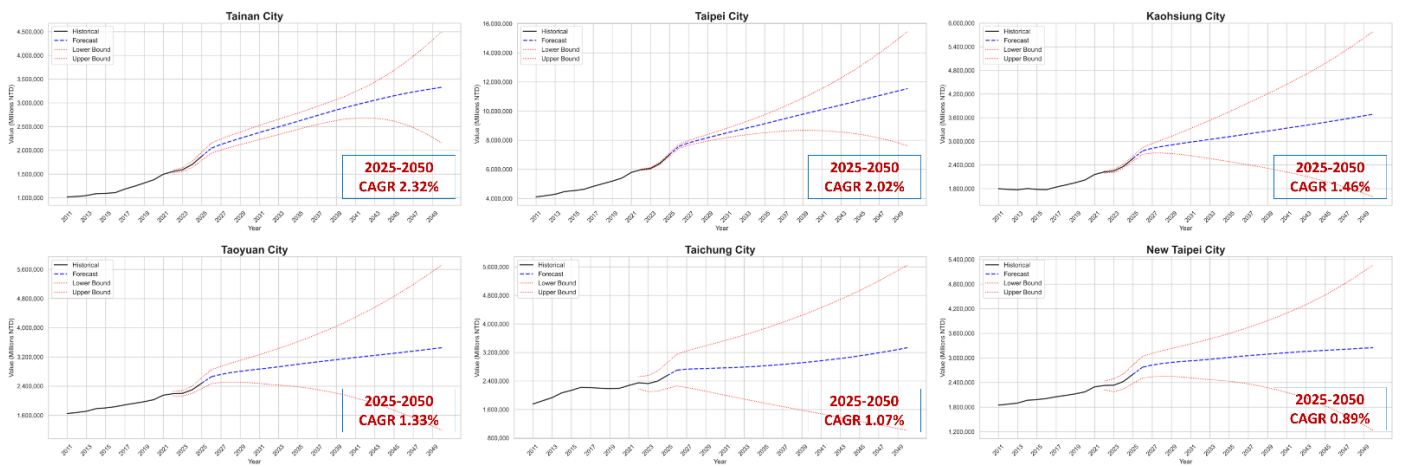
Integrating three forecasting methods, Taiwan's export share is projected to rise from 73.56% to 81.87%, private consumption to decline from 44.43% to 35.12%, and national real GDP to grow from NT\$25.9 trillion in 2025 to NT\$40.7 trillion in 2050, with a CAGR of approximately 1.83% (Figure 2). Of the 22 counties and cities, 12 are projected to maintain positive growth, concentrated in northern and southern technology clusters,

while the remaining 10 are expected to see their shares converge downward, mostly comprising agricultural counties and outlying areas including Hualien, Taitung, and the offshore islands (Figure 3). Among the six special municipalities, Tainan leads with a CAGR of 2.32%, driven by the Southern Taiwan Science Park and TSMC's supply chain clustering effect. Taipei follows at 2.02%, maintaining the highest GDP share nationally, while Kaohsiung, with a CAGR of 1.46%, is actively transitioning into a hub for technology and green energy.



Source: Compiled by this study

Figure 2. Projected Growth Rates of the Components of Final Demand Source: Compiled by this study



Source: Compiled by this study

Figure 3. Projected Real GDP of the Six Special Municipalities, 2025–2050

3. Conclusion

The analysis results indicate that while national electricity consumption is projected to increase by only 5.53% by 2040, significant structural load shifts will occur across counties and cities. Electricity demand pressure will continue to build in northern Taiwan, where high-tech industries and core final demand are concentrated, while central and southern Taiwan are expected to see relative load reductions driven by

improvements in process energy efficiency and industrial structural transformation. Cross-referenced with the 2050 regional GDP projections, Taipower will be better positioned to proactively respond to the differentiated electricity demand trends across regions—deploying transmission and distribution infrastructure in advance to ensure stable power supply and support the sustainable industrial and economic development of communities across Taiwan.