Strategic Vision 2035: Scenario-Based Strategic Roadmapping for Taipower

R&D Planning Office: Chen, Hsiao-Wei; Lin, Wen-Wen; Huang, Chung; Chen, Yu-Han; Chen, Pei-Lin; Huang, Ya-Chi; You, Shuei-Huei; Wu, Chou-Ping; Yao, Yu-Hsin

1. Research Background

In the global trend toward net-zero carbon emissions, our company, as Taiwan's only integrated electric utility, must achieve energy transition goals while ensuring a stable power supply, amid challenges such as growing electricity demand, equipment electrification, and geopolitical risks.

In this context, forward-looking strategic planning is crucial to our company's future development, enabling the early identification of potential risks, the capture of development opportunities, and the effective allocation of resources. However, traditional strategic planning approaches struggle to adequately address the high level of uncertainty in the external environment and fail to integrate diverse perspectives effectively. To proactively respond to future challenges, formulate viable strategies, and ensure that technology investments and strategic planning effectively support net-zero goals, the Company has decided to conduct this study. Through a systematic approach, we aim to envision the development of the power sector by 2035 as a foundational work for subsequent strategic planning.

This research adopts the Scenario-Based Strategic Roadmap (SBSR) methodology, integrating scenario analysis with strategy formulation. The decision focus is first established as "reducing the carbon emission coefficient per kWh to 0.3 kg CO_2e by 2035." International trends and reports are collected and organized into 27 driving factors using the PEEST framework. Through expert questionnaires assessing their "degree of uncertainty" and "degree of impact," ten key factors are identified to construct three scenarios: "most favorable," "most likely," and "least favorable."

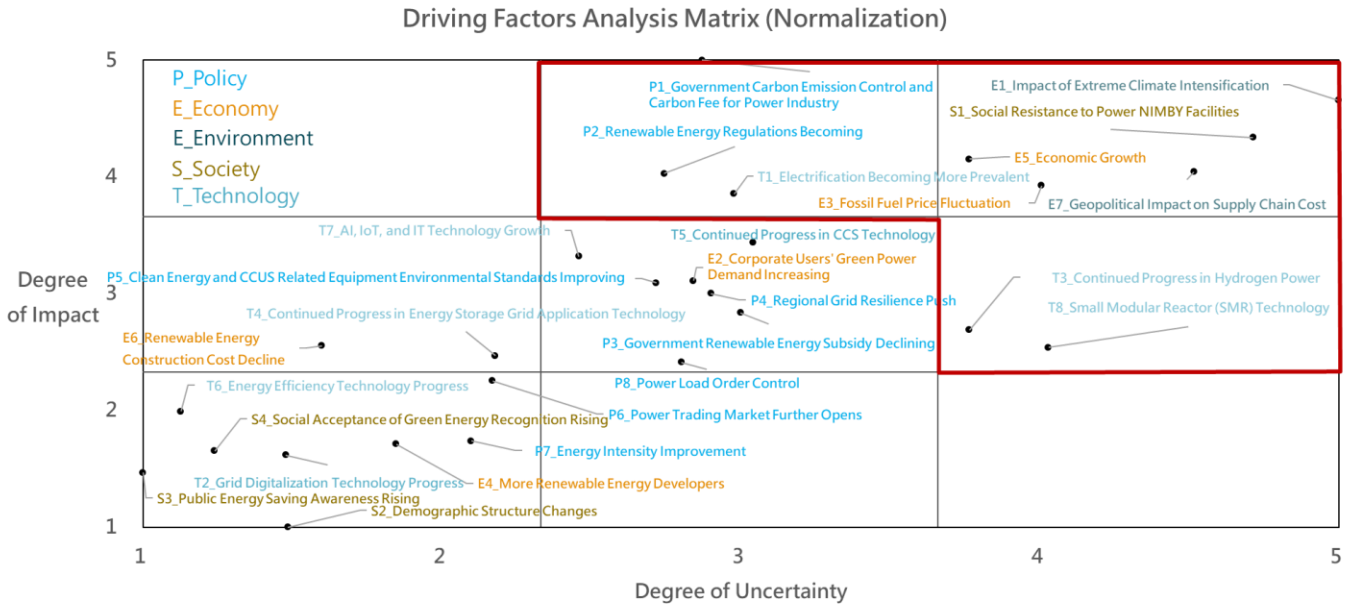
In strategy formulation, opportunities and threats derived from scenario analysis are used to identify eight important issues, from which three key issues are selected through senior management meetings for in-depth study. Through expert workshops to shape the strategy space and the employment of a strategy evaluation matrix for prioritization, a time-phased strategic implementation pathway is ultimately developed, presenting Taipower's carbon-reduction strategic roadmap for 2035.

2. Research Content

1. In the scenario construction phase, the research team collected 162 responses to expert questionnaires across industry, academia, and research sectors. Ten key driving factors exhibiting high uncertainty and significant impact were distilled from 27 factors (as shown in Figure 1). These factors encompass five major categories: Policy (P), Economy (E),

Environment (E), Society (S), and Power Generation Technology (T).

2. Based on these key driving factors, this study constructed three scenarios (as shown in Table 1.) and identified opportunities and threats from these three scenarios.
3. In the strategy formulation phase, based on an analysis of opportunities and threats as well as the company's internal organizational needs, the study identified eight important carbon reduction issues (as shown in Table 2). Through senior management meetings, three key issues were selected for in-depth study: "Increase hydrogen-ammonia co-firing ratio," "Expand Carbon Capture and Storage (CCS) installation and application," and "Expand renewable energy generation share.



Source: Compiled by this study

Figure 1. Impact–Uncertainty Analysis Matrix

Table 1. Basic Assumptions Under Three Carbon Reduction Scenarios

Scenario Driving Axis	Most Favorable Scenario	Most Likely Scenario	Most Unfavorable Scenario
Policy	**Strict**	**Strict**	**Strict**
P1. Power Industry Total Carbon Emission Control and Carbon Fee	Carbon fee levy 1,800 NTD/tCO_2e	Carbon fee levy 1,800 NTD/tCO_2e	Carbon fee levy 1,800 NTD/tCO_2e
P2. Renewable Energy Regulations	Major electricity users 15% green energy installation obligation	Major electricity users 15% green energy installation obligation	Major electricity users 15% green energy installation obligation
Environment	**Severe**	**Severe**	**Severe**
E1. Extreme Climate Impact	76 days exceeding 35°C	76 days exceeding 35°C	76 days exceeding 35°C
E7. Geopolitical Impact on Supply Chain Cost	Geopolitical Risk Index (GPR) 129	Geopolitical Risk Index (GPR) 129	Geopolitical Risk Index (GPR) 129
Economy	**Slowing**	**Growth**	**Growth**
E5. Economic Growth + T1. Increasing Electrification Prevalence	Annual power consumption growth 1.86%	Annual power consumption growth 2.8%	Annual power consumption growth 3.0%
E3. Fossil Fuel Prices	Gas LCOE 3.36 NTD/kWh	Gas LCOE 2.83 NTD/kWh	Gas LCOE 2.28 NTD/kWh
Society	**Ideal**	**Realistic**	**Realistic**

Scenario Driving Axis	Most Favorable Scenario	Most Likely Scenario	Most Unfavorable Scenario
S1. Social Resistance to Power NIMBY Facilities	28% of the public opposes NIMBY facilities	61% of the public opposes NIMBY facilities	61% of the public opposes NIMBY facilities
Power Generation Technology	**Breakthrough**	**Breakthrough**	**Slow**
T3. Hydrogen Energy Development - Hydrogen-Mixed Thermal Power Generation	Hydrogen mixing ratio reaches 20%	Hydrogen mixing ratio reaches 20%	Hydrogen mixing ratio reaches 5%
T8. Small Modular Reactor (SMR)	Internationally commercialized	Internationally commercialized	Not commercialized

Source: Compiled by this study

Table 2. Eight Carbon Reduction Issues

No.	Issue	Carbon Emission Impact	Technology Maturity (IEA Clean Energy Technology Guide)	Taipower Net-Zero Strategy Framework
1	Increase the hydrogen-ammonia co-firing ratio	Direct	TRL5 (ammonia co-firing), TRL9 (hydrogen co-firing)	Supply side
2	Expand CCS installation and application	Direct	TRL8~9	Supply side
3	Expand the renewable energy generation share	Direct	TRL9~10	Supply side
4	Evaluate SMR introduction opportunities	Direct	TRL6~7	Supply side
5	Promote Energy Hub development	Indirect	Varies by technology combination (e.g., offshore wind green hydrogen production TRL6)	Supply side, Grid side, Demand side
6	Expand demand response/time-of-use (real-time) pricing participation	Indirect	TRL10 (Automated demand response TRL7)	Demand side
7	Innovative business models	Indirect	Non-technical item	Demand side
8	Strengthen grid intelligence	Indirect	TRL7~10	Grid side

Source: Compiled by this study

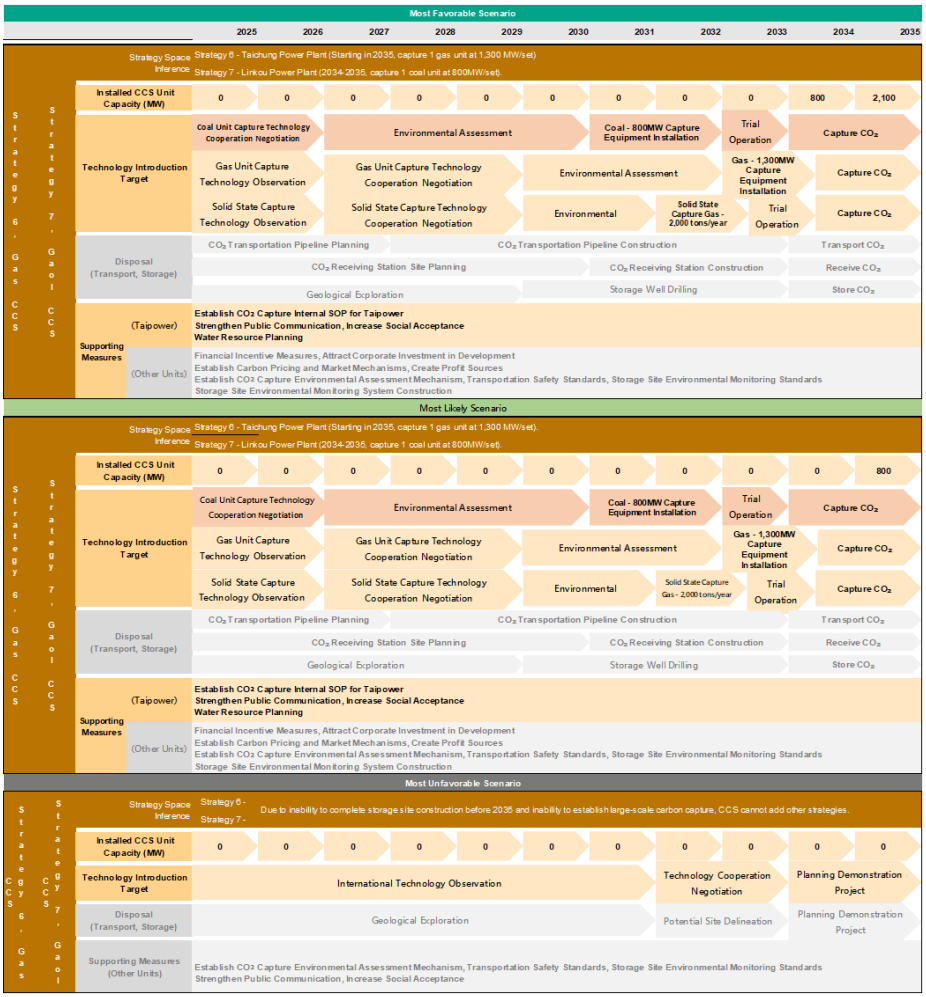
4. For the three key issues, the study constructed seven specific strategic options.
   A. Under the issue of “Expand renewable energy generation share,” four strategies were formulated: offshore solar PV development, onshore wind power repowering, procurement of offshore wind power through bidding, and deep geothermal development.
   B. Under the issue of “Increase hydrogen-ammonia co-firing ratio”: a gas-hydrogen co-firing power generation strategy was proposed.
   C. Under the issue of “Expand Carbon Capture and Storage (CCS) installation and application,” two strategies were established: gas CCS and coal CCS.

   Each strategy incorporates distinct development assumptions and targets tailored to the three scenarios and evaluates

its contribution to the 2035 carbon reduction target.

5. The study further integrates supporting dimensions, including regulatory policy, technical support, financial resources, and communication advocacy, to map out a time-based strategic roadmap for each strategy. Taking gas CCS and coal CCS strategies as examples (as shown in Figure 2), the strategic roadmap covers four major supporting dimensions: capture technology options, storage site selection and assessment, social acceptance, and regulatory and monitoring mechanisms.

6. According to the study's calculations (as shown in Table 3), under the most favorable scenario, the integration of seven strategies can reduce the 2035 carbon emission coefficient to 0.2537 kg CO_2e/kWh, achieving Taipower's carbon reduction target of 0.3 kg CO_2e/kWh. Under the most likely scenario, the carbon emission coefficient can be reduced to 0.2937 kg CO_2e/kWh, also achieving the carbon reduction target. However, under the most unfavorable scenario, the carbon emission coefficient drops only to 0.3265 kg CO_2e/kWh, failing to achieve the carbon reduction target.



Source: Compiled by this study

Figure 2. Scenario Strategic Roadmap for Gas CCS and Coal CCS Strategies

Table 3. Achievement Status of Taipower's 2035 Carbon Reduction Target

2035 (Unit: kg CO_2e / kWh)			
Strategy	Most Favorable Scenario	Most Likely Scenario	Most Unfavorable Scenario
Original carbon emission coefficient by scenario	0.3043	0.3200	0.3294
S1: Develop Offshore PV	-0.0036	-0.0017	-0.0006
S2: Renew Onshore Wind Power	-0.0014	-0.0006	-0.0002
S3: Purchase Bidding Offshore Wind Power	-0.0142	-0.0068	-0.0015
S4: Develop Deep Geothermal	-0.0101	-0.0010	-0.0001
S5: Gas-Hydrogen Co-firing Power Generation	-0.0054	-0.0022	-0.0005
S6: Gas CCS	-0.0104	-0.0092	---
S7: Coal CCS	-0.0055	-0.0048	---
Final carbon emission coefficient	0.2537	0.2937	0.3265

Source: Compiled by this study

7. In summary, this study provides a systematic decision-making framework for Taipower's 2035 carbon reduction strategy through the scenario-based strategic roadmap method. This framework can assist Taipower in rapidly assessing various scenarios and adjusting resource allocation amid policy changes, technological evolution, or market fluctuations. This enables Taipower to maintain strategic flexibility in a highly uncertain environment and lays an important foundation for Taiwan's power sector net-zero transition.