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Social Infrastructure

May 2025



Macquarie’s Bold Surge: Capturing Control of Taiwan’s Pioneering Formosa 1, the Nation’s First-Ever Offshore Wind Project



Infrastructure as an Asset Class

Introduction

- Infrastructure has surged in popularity among institutional investors, driven by its **unique blend of stability, income generation, and long-term growth potential**. Unlike volatile equities or bonds, infrastructure involves tangible assets—think energy grids, highways, water systems, and telecommunications networks—that deliver essential services, ensuring steady demand. These assets often **yield predictable cash flows** through long-term contracts or regulated revenues, making them resilient to economic swings.



Figure 1: Infrastructure investment opportunities

Key Characteristics

- Stable and predictable cash flows:** Infrastructure assets often benefit from long-term contracts with inflationary protection built into their pricing structures, such as **power purchase agreements (PPAs)**, which provide predictable revenue streams. This stability is attractive to investors seeking to mitigate volatility in their portfolios, especially in an era of economic uncertainty and fluctuating interest rates. Increased inflation even tends to benefit infrastructure returns, as cash flows are often contractually linked to inflation.

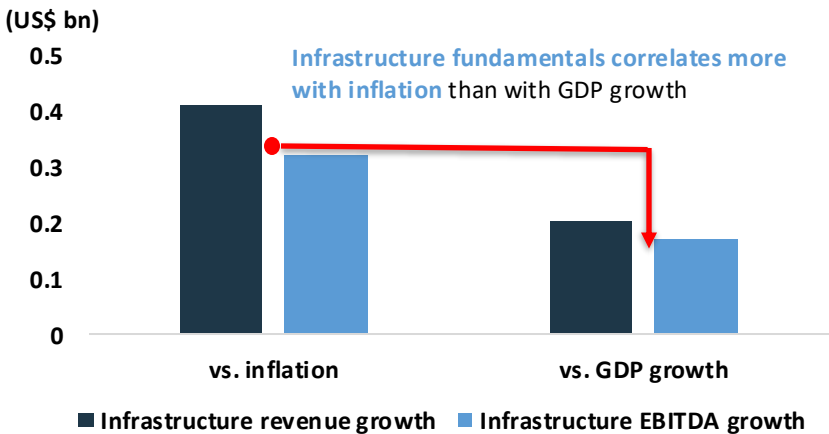


Figure 2: The relationship of infrastructure fundamentals and inflation

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- Low correlation to traditional investments:** Private infrastructure tends to be more defensive and **less exposed to economic cycles**, with stable ties to essential services and often monopolistic positions in the market that give strong pricing power. Therefore, infrastructure can act as a portfolio diversifier by depending less on broad market trends. Historical records showed private infrastructure outperformed public equities under high inflation and low GDP growth.

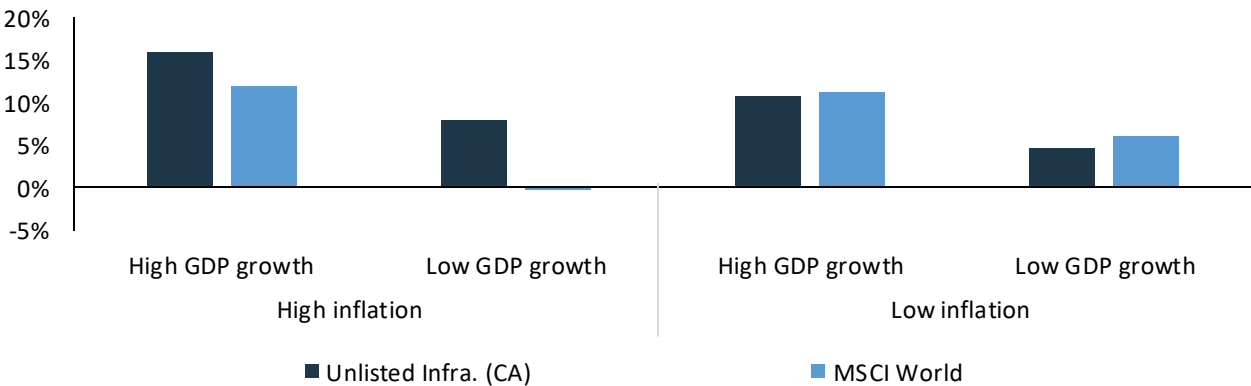


Figure 3: Private infrastructure performance

Key Characteristics

- Secular tailwinds:** The global push for decarbonization and sustainability has elevated renewable energy infrastructure, such as offshore wind, as a cornerstone of ESG investing. Governments worldwide are **incentivizing clean energy** through subsidies, tax breaks, and ambitious net-zero targets, enhancing the attractiveness of projects like Formosa 1.

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Taiwan Renewable Energy Market Overview

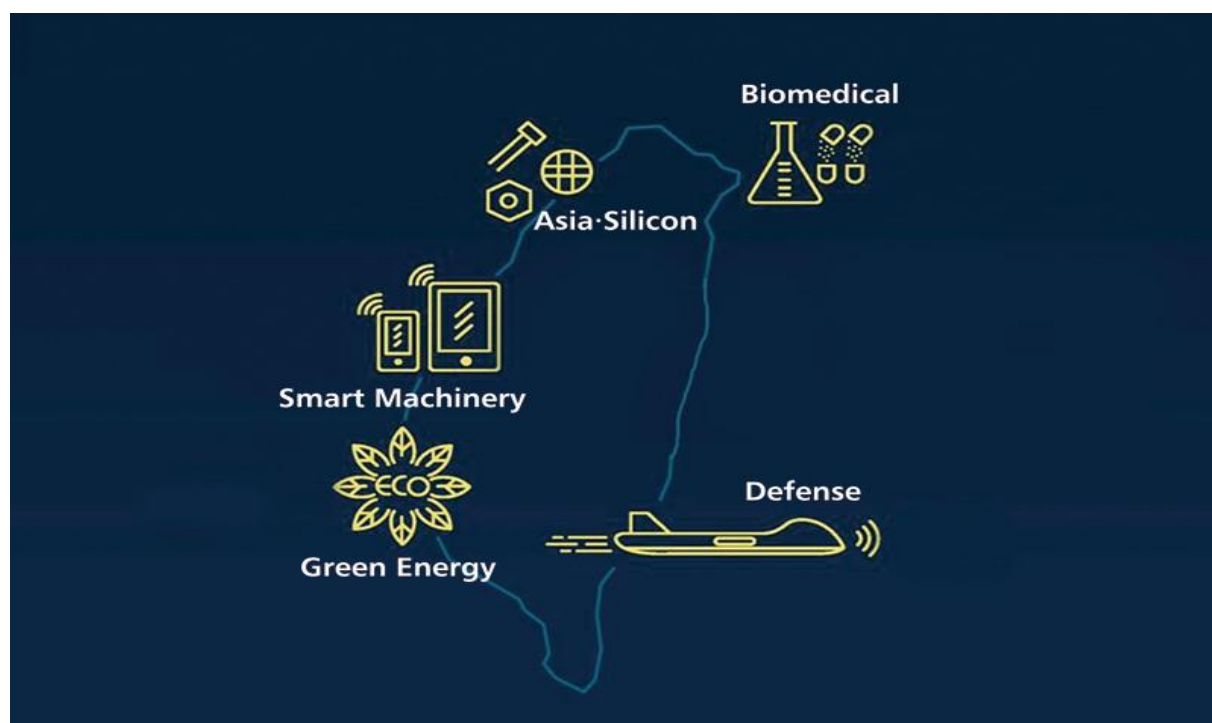


Figure 4: “5+2 Industrial Innovation Plan”

Government Ambitions

- Taiwan’s transformation toward renewable energy gained significant momentum in the late 2010s with the launch of the “[5+2 Industrial Innovation Plan](#),” which placed green energy at the forefront of national development strategies. Legislative reforms, including the [Renewable Energy Development Act \(REDA\)](#) and amendments to the Electricity Act, opened up the energy sector to independent power producers and ushered in a more competitive environment for renewable generation.
- The government set bold goals: by 2025, it aims to [source 20% of the country’s electricity from renewables](#)—an impressive leap from about 5% in 2016. Central to this vision are targets of 20 GW of installed solar photovoltaic (PV) capacity and 5.7 GW of offshore wind by the same year. Furthermore, Taiwan has committed to achieving net-zero carbon emissions by 2050, aligning itself with global efforts to combat climate change.
- To accelerate investment in renewables, the government has introduced numerous incentives, including generous feed-in tariffs, guaranteed grid access, and requirements for local content. The urgency of this transition is further heightened by a government mandate to [phase out nuclear power by 2025](#), making the development of robust, large-scale renewable alternatives an immediate necessity.

Market Structure and Key Players

- The backbone of Taiwan’s electricity system remains the state-owned [Taiwan Power Company \(Taipower\)](#), which oversees both grid operations and a significant portion of power generation. However, the market landscape has evolved considerably, with an increasing number of private and international stakeholders participating, especially in the renewable sector. Today, Taiwan supports both large, utility-scale renewable projects and decentralized solutions—most notably, the widespread adoption of rooftop solar. Among the leading domestic players are Taipower itself, [the Formosa Plastics Group](#), which is active in development and investment, and [TSMC](#), a technology giant now recognized as a major purchaser of green power through long-term power purchase agreements.
- On the international front, prominent offshore wind developers such as [Ørsted from Denmark](#), [wpd AG from Germany](#), and [Copenhagen Infrastructure Partners \(CIP\)](#) have established a strong presence, alongside various Japanese, European, and American firms specializing in solar and wind engineering, procurement, construction, and financing. This influx of expertise and capital has spurred the rapid emergence of a local supply chain, particularly in sectors like wind turbine manufacturing, marine engineering, and the assembly of solar modules.

Taiwan Renewable Energy Market Overview (continued)

Project	Location	Properties
	2 to 6 kilometers off the coast of Miaoli County in northwestern Taiwan	• Plan Capacity: 128 MW • Number of Turbine: 22 • Area: 10.27km² • CO₂ Emission reduction: 33,402 Ton
	4 – 10km off the coast of Miaoli County in northwestern Taiwan	• Plan Capacity: 376 MW • Number of Turbine: 47 • Area: 68.81km² • CO₂ Emission reduction: 18.75mn Ton
	strategically located in the Taiwan Strait , 8 to 17 km off Taiwan's west coast	• Plan Capacity: 640 MW • Number of Turbine: 80 • Area: 82km² • CO₂ Emission reduction: 1,507,307 Ton

Figure 5: Project Background

Offshore Wind

- Taiwan has quickly positioned itself as the leading offshore wind market in Asia outside of China, thanks to a well-structured development program, transparent auction processes, and attractive feed-in tariffs. By 2025, the country is projected to have nearly **6 GW** of offshore wind capacity either operational or under construction, with an official target of **5.7 GW** by that year and ambitions to expand to **15 GW by 2035**. Landmark projects such as **Formosa 1 and 2, Yunlin, and Greater Changhua** have not only brought significant capacity online but have also attracted major international players and large-scale foreign direct investment.
- To maximize the benefits for the domestic economy, the government has implemented local content requirements, which have led to the localization of supply chains and the creation of new jobs. As a result, associated industries such as port **infrastructure, marine engineering, and component manufacturing are experiencing accelerated growth**. Despite these successes, the sector faces ongoing challenges, including the complexities of marine permitting, the need for thorough environmental impact assessments, and the delicate balance between local content policies and the realities of global supply chains.

Onshore Wind

- While offshore wind dominates the headlines, onshore wind power remains a valuable but smaller component of Taiwan’s renewable mix, with about **1.2 GW of capacity installed by 2025**—primarily in the central and southern regions. The development of onshore wind projects is increasingly challenged by stricter environmental regulations and concerns from local communities, but it continues to contribute meaningfully to the nation’s energy security. Hydropower, constrained by Taiwan’s mountainous geography, offers little room for large-scale expansion, though micro and small hydro installations persist, providing essential support for rural electrification and grid reliability.
- Beyond these established technologies, Taiwan is also exploring a range of emerging renewables. **Geothermal energy has shown promise**, particularly through pilot programs **in the island’s volcanic areas**, although regulatory and technical barriers have slowed progress. Other alternatives—such as biomass, tidal, and wave energy—are still in the early demonstration stages, but they reflect Taiwan’s ongoing commitment to diversifying its renewable energy portfolio and fostering innovation in sustainable power generation.

Project Overview: Formosa 1 Offshore Wind Farm

Background

- The Formosa 1 Offshore Wind Farm is Taiwan’s first utility-scale offshore wind farm, located 6 km offshore of **Miaoli County** in the **Taiwan Straits** over an area of 11 km². The total operation capacity from 22 wind turbines is 128 MW—commissioned in two phases: the first phase in 2017 with 8 MW, and the second phase in 2019 with 120 MW. This capacity is equivalent to **powering 128,000 Taiwanese households annually** and **offsetting over 33,402 tons of CO₂ emissions**—equivalent to the CO₂ absorption of 84 seats of Daan Forest Park over a year. As of now, Formosa 1 has achieved a cumulative power generation of 53.9 GWh. Moreover, the wind farm supports the **average annual electricity consumption of households over 9,000 days**.
- The project was divided into 2 phases, with the first one as a demonstration, brought into operation in April 2017. Phase 2 of the project was then constructed and completed in December 2019. The Formosa project was **one of the three approved by the Taiwan Ministry of Economics Affairs Bureau** with an attempt to construct 1,000 wind turbines by 2030 in order to achieve a wider target of producing 4GW of electricity through offshore wind. The electricity generated would be distributed to the Taiwan Power Company with a 20-year power purchase agreement (PPA) based on the Feed in Tariff (FIT) scheme.
- The whole Formosa 1 Offshore Wind farm operation is monitored and remotely controlled from its onshore operation base. During Phase 1, this was the **Miaoli Zhunan substation** but since the completion of Phase 2, this has **moved to Taichung harbor**.

Technology

- During Phase 1, **the total installed capacity was 8MW**, including 2 units of 4MW Siemens turbines, each with a 130m diameter rotor, 58.5 m long rotor blades, and an 11,300 m2 swept area. Phase 2 facilities consisted of a further 20 units x 6 MW Siemens turbines, each with a 154 m diameter rotor. Each turbine was installed on monopile foundations and had a crane to hoist tools and equipment for maintenance. Each monopile weighed from 752 to 1,230 tons together with a maximum diameter of 8.4 meters and a length ranging from 60.1 to 79.5 meters. The transition pieces **weigh 465 tons and consist of five internal platforms**, an external platform, and a boat landing.
- **CWind Taiwan** was the provider of cable route clearance and **pre-lay grapnel run (PLGR)** work for both phases of the project and assisted in clearing approximately 26km of planned cable route to minimize the risk of debris. CWind Phantom, a CTV of CWind Taiwan also supported the transfer of **more than 7,300 personnel** between sites.

Approx 2 to 6 km off the coast of Miaoli County

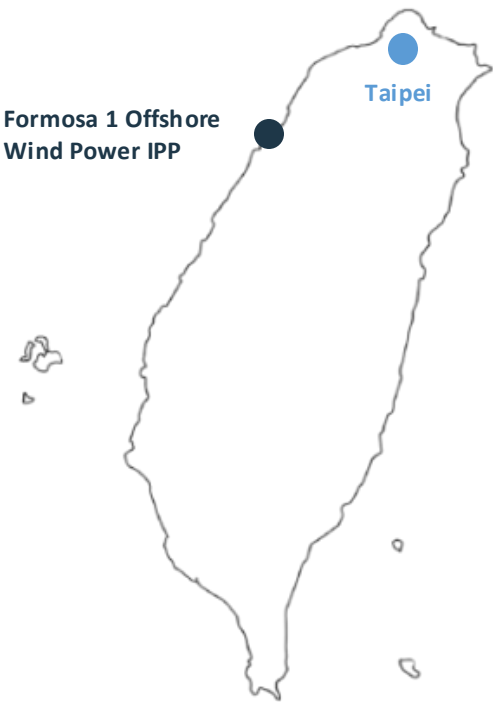


Figure 6: The location of Formosa 1

	Phase 1	Phase 2
Company Name	Formosa I Wind Power Co., Ltd.	
Generation Type	Offshore Wind Power Generation	
Generation Capacity	8MW	120MW
Number of Generators	2 Units	20 Units
Commercial Operation Date	Apr. 2017	Dec. 2019
Investors	JERA, Ørsted A/S, Macquarie, Swancor	

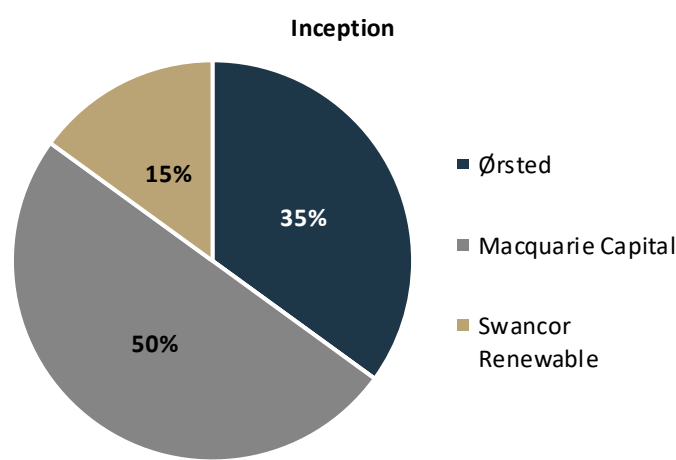
Figure 7: Project Outline Phases

Project Overview: Formosa 1 Offshore Wind Farm (continued)

Financing

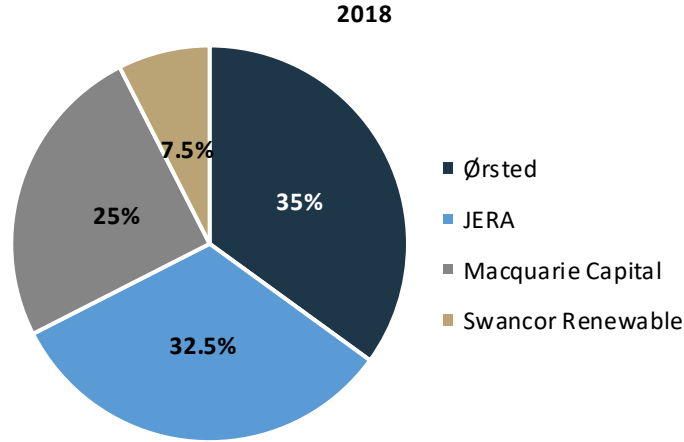
- Initially, Formosa 1 was a **joint venture** between Ørsted, and Macquarie Capital with Swancor Renewable, a subsidiary of chemical and composite material manufacturer **Swancor Holding**, acting as the **project developer**. In December 2018, JERA signed a deal with Swancor and Macquarie Capital, for the acquisition of a combined **32.5% equity interest** in the offshore wind project.
- A consortium of 11 international and Taiwanese banks as well as **EKF Denmark’s Export Credit Agency** completed the **NT\$18.7Bn (US\$628M), 16-year financing deal**. **Four local Taiwanese banks** included Cathay United Bank, Taipei Fubon Commercial Bank, EnTie Commercial Bank, and KGI Bank; and **seven international banks** were ANZ Banking Group, BNP Paribas, Crédit Agricole Corporate and Investment Bank, DBS Bank, ING Bank, MUFG Bank and Société Générale. Clifford Chance is the advisor to the project’s sponsors.

Figure 8: The ownership of Formosa 1



Societal Impacts

- Project developers have carefully considered Formosa 1’s impact on the surrounding environment and have **made efforts to minimize the environmental impact**. A series of environmental surveys have been carried out covering all aspects including noise, underwater acoustic, marine ecological, marine mammal, bird, and marine topography. Specifically, **state-of-the-art noise reduction techniques had been applied** together with regular noise measurements in order to guarantee its efficiency.
- Local fishermen and coastal communities** were also closely engaged. Local staff had been employed wherever possible by companies behind the construction. Attempts have been made to understand and apply knowledge about local customs and traditions to the project.



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Transaction Overview

Overview

- Macquarie initially acquired a 50% stake in Formosa 1 to develop Taiwan’s first offshore wind farm, marking the country’s entry into the offshore wind energy industry. This stake was eventually sold to a Japanese consortium made up of Mitsui OSK Lines, Toho Gas and Hokuriki electric Power Company.

Deal Timeline

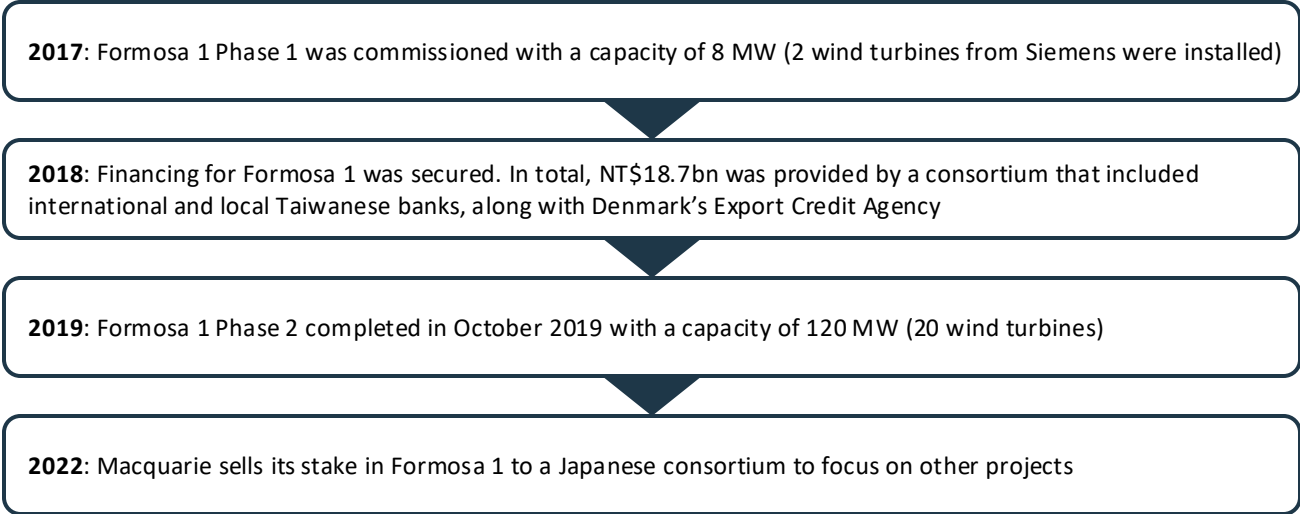


Figure 9: Deal timeline

Key Factors

- Promising returns for renewable energy infrastructure as an asset class:** As a leading investor in infrastructure assets, Macquarie sees strong tailwinds for renewable energy infrastructure assets, including continuous decreases in costs, consistent policy support, and rising corporate demand for green energy. Moreover, investor appetite is on the rise, with institutional investors looking for stable assets with recurring, consistent cashflows in an increasingly turbulent geopolitical environment. Macquarie hopes to leverage these favorable structural trends, along with their sectoral knowledge/expertise, to invest capital in promising renewable energy opportunities.
- Further partnerships in Taiwan:** Taiwan has the goal of increasing electricity generated from renewable power from 8.3% in 2022 to 60-70% by 2050. Furthermore, the country is also targeting 13.1 GW of offshore wind capacity by 2030, aiming to reach 40-55 GW by 2050. These targets show that the offshore wind energy industry in Taiwan has a long runway and much growth potential within Asia. Since completing Formosa 1, Macquarie has partnered with JERA and TotalEnergies in building Formosa 2 and Formosa 3, respectively. These offshore wind farms have a much larger capacity (376MW for Formosa 2 and 600MW for Formosa 3) than Formosa 1, and likely would not have been possible without Macquarie’s initiative in helping finance and develop Formosa 1.
- Foundation for Corio Generation:** Corio Generation is a subsidiary of Macquarie’s Green Investment Group (GIG) and was launched in April 2022 with a 15+ GW developmental pipeline. Its main responsibilities included moving offshore wind projects from origination to construction and long-term operations and partnering with Macquarie for long-term financing where needed. It must be noted that Corio Generation was launched immediately after Macquarie’s Formosa 1 stake was sold, and the subsidiary now oversees a 25 GW pipeline of offshore wind projects across Europe, APAC, and the Americas. Recently, Macquarie halted the sale of Corio Generation, as a result of low investor interest due to the global tariff war.

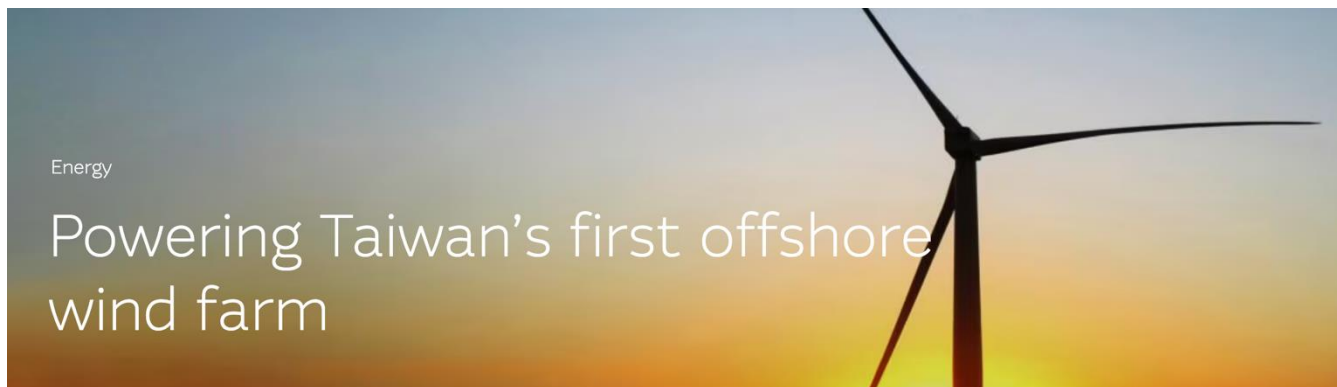
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Deal Implications and Future Outlook



Deal Implications

- **Market Entry:** Macquarie's acquisition of a stake in Formosa 1, Taiwan's inaugural commercial-scale offshore wind farm, established a strategic foothold in Asia's second-largest offshore wind market. By entering the market during the operational phase (post-2019), **Macquarie mitigated greenfield development risks** while securing critical insights into Taiwan's regulatory framework, local supply chain dynamics, and stakeholder engagement protocols. This positions the firm to competitively pursue Phase 3 project tenders (2026–2035), where developers with proven operational expertise in Taiwan are anticipated to receive preferential consideration.
- **ESG Credibility - Reputation Boost:** Formosa 1 supports Macquarie's net-zero goals by **offsetting 250,000 tons of CO₂ annually** and **contributing to Taiwan's 20% renewable energy target by 2025**. Its alignment with ESG priorities enhances appeal to institutional investors. Successful collaboration with local fishing communities also reinforces Macquarie's social license and sets a model for community-driven development.
- **Partnership Leverage:** Strategic collaboration with Ørsted, a global leader in offshore wind development, and JERA, Japan's largest power utility, **provides Macquarie with access to advanced turbine technology and region-specific operational intelligence**. These alliances reduce risks associated with typhoon-prone environments and enhance compliance with Taiwan's stringent local content requirements, which mandate 60% domestic sourcing by 2025.
- **Stable Cash Flow:** A 20-year Power Purchase Agreement (PPA) with Taipower **guarantees fixed revenue of approximately NT\$5.8/kWh until 2039**, delivering projected annual returns of 8–10%. This shields Macquarie from volatility in Taiwan's spot electricity market, where fossil fuel supply disruptions drove a 15% price surge in 2023.

Future Outlook

- Macquarie is strategically positioned to capitalize on Taiwan's offshore wind expansion, with active evaluations underway for participation in Formosa 3 and Phase 3 auctions. The government's target of **40–55 GW of offshore wind capacity by 2050 presents a \$30 billion investment opportunity**, supported by annual installations exceeding 1.5 GW post-2026. Technological advancements are central to this growth, including the adoption of 15 MW turbines and pilot projects for floating wind solutions, which are projected to reduce energy costs by 25–30% by 2030. Collaborations with **Siemens Gamesa** and domestic manufacturers such as **TPI Composites** aim to localize turbine production, enhancing cost efficiencies and supply chain resilience.
- Concurrently, Macquarie is engaging Taiwanese policymakers to advocate for extended feed-in tariffs beyond 2025 and accelerated grid infrastructure upgrades. These efforts address curtailment risks, which **resulted in a 20% loss of Formosa 1's potential energy output in 2023** due to grid limitations. By combining operational expertise, technological innovation, and policy advocacy, Macquarie is poised to solidify its leadership in Taiwan's renewable energy transition while replicating this model across high-growth Asian markets.

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Risk and Consideration



Natural and Environmental Risks

- **Extreme Weather and Typhoon Threats:** The Taiwan Strait is a global typhoon-prone area. Formosa 1, located offshore of Miaoli County (water depth 15-30 meters), requires monopile foundation designs to **withstand strong winds, massive waves, and salt spray corrosion**. For example, typhoons may cause structural fatigue or even fractures in wind turbines, increasing operational and maintenance costs. Studies indicate that the vertical wind speed gradient in the Taiwan Strait varies with wave height and atmospheric stability, further impacting turbine efficiency.
- **Earthquakes and Geological Conditions:** Taiwan lies on the Pacific Ring of Fire. Taiwan's building codes require structures to **remain intact under a 2,500-year return period earthquake**. However, offshore wind designs prioritize operational stability (e.g., foundation tilt $\leq 0.5^\circ$). While Formosa 1's jacket foundations adapt to local geology, long-term seismic activity may affect monopile durability.
- **Marine Ecological Impacts:** Wind farm construction and operations may disrupt marine ecosystems, such as **benthic habitats disturbed by cable laying or noise affecting fisheries**. The necessity of environmental impact assessments (EIA) to avoid lawsuits from environmental groups or regulatory penalties is required.
- **Environmental Compliance:** Delays in **approvals, unfavorable findings**, or stricter regulations could increase costs or halt progress. Macquarie must confirm that all environmental permits are secured and compliant with local and international standards.

Financial Risks

- **High Capital Expenditure and Long Payback Periods:** Offshore wind projects **require massive upfront investments** (e.g., Formosa 2 costs ~376MW/47 turbines) with payback periods of 15-20 years. Macquarie's reliance on short-term capital (average 2-year holding period) necessitates balancing long-term returns with liquidity pressures for Formosa 1.
- **Cost Overruns:** Offshore wind projects require significant **upfront capital for construction** (e.g., turbines, foundations, and grid connections) and **ongoing operational costs** (e.g., maintenance and repairs). Macquarie may need to assess whether cost estimates are realistic and account for potential increases due to supply chain issues, inflation, or delays.
- **Exchange Rate and Financing Cost Volatility:** **Currency fluctuations** (e.g., TWD depreciation) **may increase debt servicing costs**. Hedging to mitigate risks, though financial instruments incur transaction costs.

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"Taiwan is rapidly becoming Asia's foremost offshore wind market. The Formosa projects demonstrate our commitment to this market, and we are proud to be at the forefront of Taiwan's renewable energy transition."

Anthony Lamb
Head of GIG, Taiwan

Technical and Operational Risks

- **Equipment Adaptability and Maintenance Difficulties:** Formosa 1 uses Siemens Gamesa's 6MW and 8MW turbines with rotor diameters up to 154 meters, **requiring stability in complex marine conditions**. However, high humidity and salt spray accelerate mechanical corrosion, necessitating frequent maintenance. **Offshore maintenance costs are 2-3 times higher than onshore**, and repairs are constrained by weather windows.
- **Grid Connectivity and Power Transmission:** Power transmission via submarine cables to onshore grids faces risks of cable faults causing outages. For instance, Formosa 2 completed 114 km of submarine cable installation in 2022, but long-term seabed terrain changes could threaten cable integrity in Formosa 1.

Management and Reputational Risks

- **Regulatory Compliance and ESG Pressures:** Macquarie's recent additional licensing conditions from **Australian ASIC** due to risk management shortcomings. Similar failures in Taiwan (e.g., environmental or labor violations) could damage reputation and trigger legal risk.
- **Community and Stakeholder Conflicts:** Local stakeholders, such as fishermen or environmental groups, may object to the project due to concerns about marine ecosystems, fishing grounds, or visual impact. Formosa 2 **requires a 20-year power purchase agreement with local utilities**, but community protests causing delays could jeopardize revenue. Macquarie may need to engage these groups early to build support and avoid delays for Formosa 1.
- **Reputational Impact:** Negative publicity—**whether from environmental incidents, safety issues, or community disputes**—could harm Macquarie's reputation. A proactive communication strategy and commitment to sustainability can mitigate this risk.

Policy Risks

- **Uncertainty in Policy Support:** Taiwan's government aims for 5.5GW of offshore wind capacity by 2025. However, the third-phase auction (launching in 2025) may revise subsidy mechanisms. **Policy shifts reducing subsidies or increasing localization requirements** (e.g., supply chain mandates) could impact Macquarie's return.
- **Localized Supply Chain Pressures:** Taiwan mandates gradual increases in localization ratios (e.g., towers, blades). While Formosa 1 Phase II relies on international equipment, future projects failing to meet localization targets risk fines or permitting delays. **Taiwan's tense relationship with China introduces political risk**. Escalating tensions or shifts in government policy toward foreign investment could disrupt the project. Macquarie must consider how political instability might affect operations or funding.

Market and Competitive Risks

- **Reducing Margin:** Taiwan's offshore wind market is **becoming increasingly competitive**, with projects like Formosa 2 and Greater Changhua squeezing profit margins.
- **Power Market Dynamics:** **Oversupply or reduced demand** may also affect project economics. Developers must balance innovation and cost-efficiency to maintain competitiveness.