Empowering the Silicon Shield: Taiwan's Energy Crisis and the Global Semiconductor Supply Chain

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Abstract: Taiwan's semiconductor sector is a lynchpin of the global electronics supply chain, but it faces critical energy security challenges that threaten both its economic future and worldwide technology markets. Taiwan's near-total dependence on energy imports and a phase-out of nuclear power has increased its reliance on fossil fuels, leading to frequent power shortages and vulnerability to geopolitical tensions. While renewable energy can help mitigate these challenges, progress is stalled by land constraints, community resistance, and grid limitations. This policy brief proposes a two-pronged approach: in the short term, prioritize household-level solar and battery installations to reduce residential grid demand and dedicate conventional fuels to high-intensity industrial users such as semiconductor foundries; in the medium-to-long term, reintegrate nuclear power through foreign direct investment (FDI) reforms and updated public-awareness campaigns. By combining distributed renewables with reliable baseload energy, Taiwan can strengthen its Silicon Shield, securing the semiconductor sector's global leadership while moving toward a more resilient, low-carbon energy portfolio. The paper then sheds some light on China's increasing prominence in the semiconductor play, and how Taiwan and other global players can help sustain Taiwan's monopoly.

I. INTRODUCTION

This paper looks at the energy insecurity Taiwan faces and its consequent impact on its homegrown semiconductor industry, leading to global implications. Section 2 talks about Taiwan's rise as the world's foremost manufacturer of semiconductors and its monopoly over the global markets. Section 3 offers a brief overview of the energy crisis and the accompanying implications on the semiconductor industry. Section 4 delves deep into the energy crisis, focusing on Taiwan's overdependence on fossil fuel imports and its accompanying issues, as well as the lack of renewables with a key focus on the phase-out of nuclear energy. Section 5 looks at the vulnerabilities in Taiwan's semiconductor dominance, focusing on the rise of Chinese semiconductor capabilities. Finally, section 6 concludes with both short-term as well as long-term policy recommendations, focusing on making households energy-independent, and revamping Taiwan's nuclear capabilities with a change in FDI regulations.

II. TAIWAN'S PROMINENCE IN THE SEMICONDUCTOR INDUSTRY

Taiwan's semiconductor industry is the backbone of modern electronics, telecommunications, and computing. The island dominates global semiconductor production, accounting for over 60% of the foundry market and 92% of the most advanced chips used in AI and high-performance computing. Taiwan Semiconductor Manufacturing Company (TSMC) alone holds a 56% market share, a position achieved through decades of strategic government policies and investments.

Taiwan's rise to a semiconductor monopoly was driven by a combination of government policy, strategic investments, and the creation of specialized institutions. In the late 1960s, the Taiwanese government led by the Ministry of Economic Affairs established the Industrial Technology Research Institute (ITRI), a government-backed research center to support industrial innovation, particularly in technology-intensive industries like semiconductors. ITRI negotiated licensing deals and partnerships with foreign companies that allowed Taiwanese firms to access critical semiconductor manufacturing technologies. Additionally, the government also encouraged FDI by creating science parks, tax incentives, and subsidizing the training of engineers. This foundation was essential in nurturing local talent and innovation.

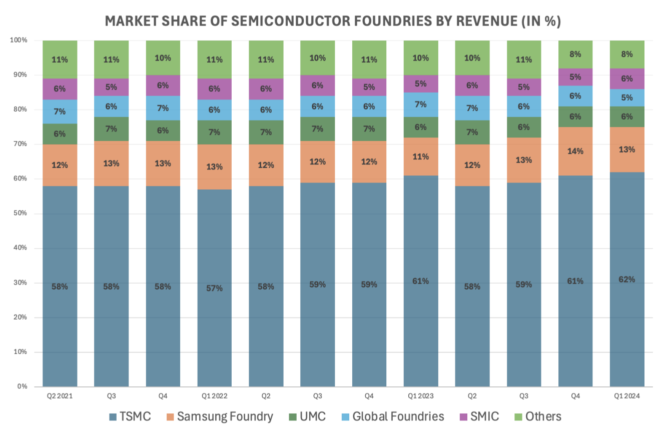

FIG. 1. Source: Counterpoint Research

Taiwan focused on specialization in the semiconductor industry and brought Morris Chang as the ITRI Chair. Morris Chang is also known as the father of Taiwan's semiconductor industry. Chang noticed that there was an increase in the number of fabless companies, which are companies that design and market chips but don't manufacture them, and saw an opportunity to manufacture for them. In 1987 he established TSMC, pioneering the pure-play foundry model. TSMC was concentrated on only manufacturing for fabless companies and conducting R&D. This model attracted global clients, including major tech firms, and enabled TSMC to scale rapidly and reach economies of scale. "TSMC focused on developing proprietary process optimization IP and skill base from the very beginning... TSMC focused on learning through research and converting it into higher yield. This is a fundamental difference between TSMC and many other manufacturing service providers." (Zaman). For almost two decades TSMC and Taiwan were lagging behind Integrated Device Manufacturers (IDM) in technological capabilities. But TSMC's relentless pursuit of research paid off, as of today, TSMC is the only player in the market who can produce 2nm chips which gives Taiwan a big advantage.

Taiwan has a dense network of suppliers, a skilled workforce, and infrastructure creating a self-sustaining ecosystem. By consistently advancing its technology and maintaining high-quality standards, Taiwan solidified its dominance in the global semiconductor market, making it indispensable to the tech industry. However, maintaining such a technological edge comes with challenges, particularly in the form of an energy crisis. The country's semiconductor industry is highly energy-intensive and depends on a stable and uninterrupted power supply, with the energy infrastructure being heavily reliant on imported fossil fuels. This has led to concerns over energy security, with periodic power outages threatening industrial operations. Given that semiconductor manufacturing accounts for 9% of Taiwan's total electricity consumption, the country's ability to sustain its leadership in advanced chip production is increasingly dependent on addressing these energy challenges.

III. SEMICONDUCTORS AND TAIWAN'S ENERGY CRISIS

Semiconductors are at the very core of modern technology - they drive innovations in computing, communications, and transportation. In Taiwan, the importance of these components is heightened by the presence of major global chipmakers - particularly 'TSMC'. Fabrication processes for advanced chips demand highly controlled environments and an immense amount of power. Any sudden blackout or voltage fluctuation can corrupt entire batches of wafers which results in costly losses and production setbacks. As semiconductors become more sophisticated, energy consumption intensifies, which places additional strain on a grid already operating near its limits.

The phaseout of nuclear power has forced Taiwan to rely more on coal and LNG, which balances energy security with environmental concerns. Coal provides stable base-load capacity but contributes to air pollution, but LNG (which is a cleaner alternative) is vulnerable to price volatility and supply chain disruptions. Meanwhile, efforts to expand renewable energy—like solar and offshore wind—have been hindered due to land scarcity, community resistance, and technical challenges. Thus, renewables still account for only a modest share of Taiwan's energy mix.

With energy demand rising, especially from the semiconductor sector, Taiwan's power grid is under increasing strain. Reserve margins (amount of unused available capability) drop to critical levels during peak consumption periods, particularly in the summer. Any disruption to electricity supply poses a direct threat to semiconductor manufacturing, potentially triggering global chip shortages. Reliable power is Taiwan's most pressing challenge for which they have to bridge the gap between nuclear phaseout and renewable expansion.

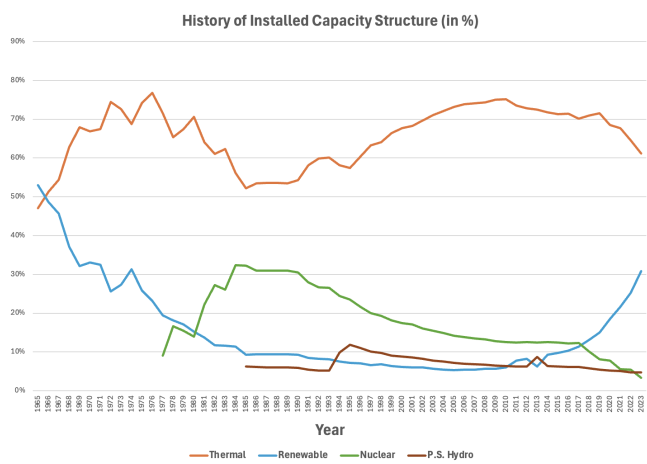

FIG. 2. Source: Taiwan Power Corporation

IV. VULNERABILITIES IN ENERGY

Taiwan faces significant energy vulnerabilities due to its heavy reliance on fossil fuels, limited renewable energy capacity, and geopolitical challenges. Over 93% of Taiwan's electricity comes from fossil fuels, primarily oil (44%), Coal (30%), and LNG (20%) (Ghenai and Chausovsky). However, the island has almost no domestic fossil fuel reserves, forcing it to import nearly all its energy needs. This dependence on imports exposes Taiwan to global energy price fluctuations and supply chain disruptions. For instance, Taiwan imports 97% of its energy, making it one of the most import-dependent economies in the world. Now, 5 major blackouts since 2017, and the confluence of energy demands and delays show that Taiwan is in an energy supply crisis (Fairley). Demand has only been on the rise, but due to global supply chain disruptions, and an abnormally high im-

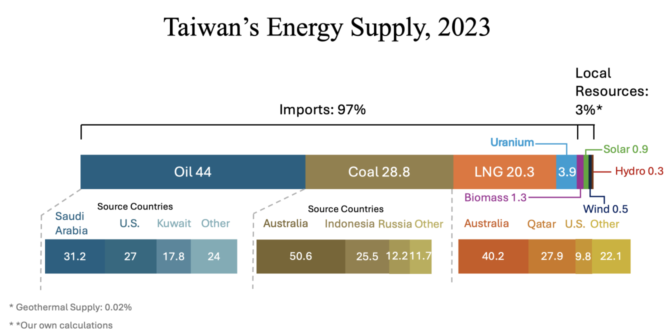

FIG. 3. Source: Taiwan Energy Administration, Ministry of Economic Affairs (Energy Statistics Handbook)

port dependence, Taiwan faces immense issues related to a regular supply of energy.

Another problem that emerges due to this, is the fact that Taiwan imports its energy from the usual maritime routes, many of which pass around China. For example, Taiwan mainly purchases crude oil from the Persian Gulf countries such as Saudi Arabia and Kuwait. The crude oil Taiwan imports is shipped by seaborn routes through the South China Sea. The Middle East's instability and the South China Sea's vulnerability to military blockade both pose a threat to Taiwan's energy supply stability (Cole et al. 51). With the US-China trade war over semiconductors escalating, Taiwan's monopoly on chip supply faces serious risks of energy blockades from China. While most of Taiwan's energy comes from allies (Taiwan's Energy Supply, 2023), China could still cause temporary disruptions. Given Taiwan's limited energy stockpiles—11 days for natural gas and 39 days for coal—such disruptions could have global implications (Chausovsky). These threats present urgent challenges requiring immediate attention from the current administration. A simple way out of this for Taiwan seems to be the development of renewable energy sources. However, renewable energy accounts for only about 8-10% of Taiwan's energy mix, despite government targets to reach 20% by 2025. The transition to renewables has been slow due to regulatory hurdles, land scarcity, and technical challenges. Geographic limitations, such as mountainous terrain and dense urbanization, further constrain large-scale solar and wind projects. Offshore wind energy, which holds significant potential, faces additional obstacles, including environmental concerns and local opposition (Hilton). The intermittent nature of renewables also highlights the need for significant investments in energy storage and grid modernization, areas where Taiwan currently lags. For example, Taiwan's grid infrastructure is aging and vulnerable to extreme weather events, which are becoming more frequent due to climate change (Ghenai and Chausovsky).

Historically, nuclear power provided around 16% of Taiwan's electricity, offering a reliable baseload energy source that is not subject to the same geopolitical risks as fossil fuel imports. However, the decision to phase out nuclear power by 2025 has made Taiwan more dependent on imported fossil fuels, exposing it to global price volatility and supply chain disruptions. Retaining or expanding nuclear energy could provide a more stable and secure energy supply, reducing the island's exposure to external pressures. In conclusion, Taiwan's energy vulnerabilities are deeply intertwined with its geopolitical situation, making energy security not just an economic issue but also a matter of national survival. Any disruption to Taiwan's energy supply—whether due to fuel shortages, grid failures, or geopolitical tensions—could severely impact semiconductor production, leading to shortages that would ripple across industries worldwide, from consumer electronics to automotive manufacturing. If Taiwan's energy vulnerabilities persist, they could exacerbate global economic uncertainty, disrupt supply chains, and increase geopolitical risks, making energy security in Taiwan not just a domestic issue but a global concern.

V. VULNERABILITIES IN TAIWAN'S SEMICONDUCTOR DOMINANCE

There exists yet another vulnerability for Taiwan and the validity of its Silicon Shield. Currently, TSMC, and by extension Taiwan supply about 90% of the world's most advanced semiconductors. Their customers include companies such as Apple, NVIDIA, and most big-tech companies. However, Taiwan's monopoly is receiving a growing amount of worry from China- mainly because of their strides in the semiconductor industry. China has surprisingly been able to replicate less advanced chips that TSMC makes at a reasonable efficiency. The hurdle lies in their latest 7nm chips wherein China faces severe IP restrictions. The amount of money being poured into R&D from China's end comes nowhere near other countries such as the USA, but there is hope in the fact that they have a very long way to catch up. Most estimates claim that China is 5-10 years away from producing the top end, and by that time newer technology will prevail leaving them even behind.

To understand this hierarchy better, some crucial players need elaboration- ASML, TSMC, SMIC, and Huawei:

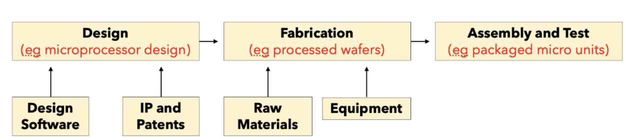

FIG. 4. Semiconductor Supply Chain

- To understand the role of each better, the value chain stems from TSMC which is a fabricator, or a manufacturer, of chips for other brands such as Apple and NVIDIA.
- ASML is a world leader based out of the Netherlands in producing lithography machines. Lithography is the process of projecting patterns on silicon wafers; a crucial and complex step in making advanced semiconductors. ASML also enjoys an unequivocal monopoly in the market- capturing about 90% of the share.

SMIC is the chinese counter-part to TSMC, and has been able to reproduce less advanced semi-conductors that can be used in low-tech applications such as watches, cars but not phones, laptops and AI. So far, the US and EU have worked out geopolitical measures to hinder China's progress. ASML is restricted from exporting the more advanced lithography machines to China which would allow it to make smaller and more efficient chips. Huawei and China have been in the process of duplicating the advanced lithography techniques but haven't yet made any considerable progress, however, the concern of them catching up is very valid. There are two risks we foresee:

1. Worsening relations between the USA and EU (specifically the Netherlands) owing to the sensitive situation in Ukraine could convince the Netherlands to remove the barriers to exporting to China.
2. If and when China does catch up with ASML and TSMC, the entire value chain of an incredibly sensitive industry will be at the cusp of a controversial political player.

However, the one thing we can be certain about is ASML's moat. It relies on the collaboration of more than 5,100 companies and requires 16,000 patents to make one machine that can cost hundreds of millions of dollars. Such an intricate collaboration is based on trust and transparency amongst a myriad of players in the EU that cannot be replicated in China.

Although the US and EU continue to mandate the restriction of the most advanced lithography machines to China, this can and will be called into question after worsening ties that ensue from Trump's tariffs and reaction to Ukraine. It's imperative that they continue to hold such a policy as it remains one of the main impediments to China's competitiveness in the semiconductor space. Although China can catch up, in theory to TSMC's most advanced chips, to make it economically viable and competitive is where TSMCs specialty lies. The moat is in the margin, and the worry is the margin might shrink after an ill-thought-out policy that imposes tariffs even on Taiwan. We would highly recommend against any tariffs on semiconductors from Taiwan so they can hold to their moat (i.e.; cost-effectiveness) for as long as they can.

VI. CONCLUSION AND POLICY RECOMMENDATION

Taiwan's semiconductor industry is both its greatest economic asset and a major source of vulnerability, given its energy-intensive nature and the island's heavy dependence on imported fossil fuels. The nation's phase-out of nuclear power has exacerbated its reliance on coal and liquefied natural gas (LNG), making it highly susceptible to global price fluctuations, supply chain disruptions, and geopolitical risks—especially given China's increasing strategic interest in disrupting Taiwan's energy security. Taiwan's ongoing energy crisis, marked by frequent blackouts and declining reserve margins, poses a direct threat to the stability of semiconductor production, which could trigger cascading global supply chain disruptions.

Ensuring energy resilience is not just an economic necessity for Taiwan—it is a global priority. The stability of the worldwide electronics supply chain hinges on Taiwan's ability to sustain semiconductor production without disruption. By implementing a pragmatic and forward-looking energy strategy, Taiwan can fortify its Silicon Shield, maintain its technological leadership, and contribute to a more secure and sustainable global semiconductor ecosystem.

Addressing the next steps for Taiwan, our policy recommendation focuses on both a short-term measure to increase household energy independence, as well as a long-term policy to revive the nuclear energy sector with global support.

A. Revamping Taiwan's Energy Ecosystem

The first main concern impacted by the energy crisis is ensuring households and residents aren't severely affected. Since the stakeholders of the energy crisis are also households that are affected by blackouts and greyouts, we've laid out a policy recommendation to make them more self-reliant and resistant to volatile energy production. This also aligns with Taiwan's plan to go net zero by 2050. Some considerations in the path to net zero and a greater share of renewable energy:

1. Renewable energy works differently than conventional energy. Coal and other fossil fuels have the ability to perfectly match the demand for energy since their production is more elastic and divisible. Renewable energy (such as wind and solar) have periods of excess supply (such as during the day for solar) and periods of excess demand (during the night when solar is rendered useless). Hence energy storage helps solve such a mismatch.
2. Solar and wind are not efficient enough for energy-heavy sectors such as semiconductors. They take

up too much space for too little yield, and as mentioned above are not a constant source of energy. Fossil fuels, unfortunately, do a brilliant job in catering to the needs of the industry- efficient, high-yielding, demand-elastic, and consistent.

One way to ensure households are not affected by power insufficiency is to come up with alternate energy sources for households and focus on fossil fuels for industry for the short term, till nuclear catches up. The policy in question has two-fold benefits:

1. Renewable energy requires a revamped distribution network (the grid) which this aims to solve.

2. Households are more independent from fluctuations in fossil fuel imports.

We would recommend the Taiwanese government, and in particular Taipower, to install solar panels and energy storage- in particular lithium-ion batteries in all households. This forms an integrated network of connected energy storage and production across all households. The government can overcome the space constraint as it delegates production and storage to households, and at the same time, households move from a consumer model to a prosumer model. Electricity generated during periods of excess supply can be stored in a massive integrated battery network that can be used during periods of excess demand or even traded amongst households. Below is an illustration of the same:

FIG. 5. Producer & Consumer and Prosumer Models

The illustration on the left shows the current grid which draws most of the electricity from coal and energy of the state. Here, they're fully dependent on electricity produced by the grid. We advocate a shift to a model to the right- here households are empowered by having solar panels in their own homes. Capex considerations are solved by funding from the government which charges a subscription for electricity consumption. It also updates the grid which now has an integrated and connected network, with energy storage facilities during times of crises and power cuts.

B. Revamping Taiwan's Energy Ecosystem

Given Taiwan's current situation, with a severe lack of any sources of renewable energy, the country is on the precipice of a deep crisis. While our near-term outlook focuses on making households energy-independent, by using solar to power homes and keeping the usage of fossil fuels solely for industrial applications, Taiwan's future energy security is still a matter of concern. Under such circumstances, reintegrating nuclear power plants into Taiwan's energy portfolio appears increasingly logical. This shift in energy generation would require overcoming significant political and public opinion barriers.

The distrust of nuclear energy in Taiwan stems from its association with the island's authoritarian past, where early reactors were built with little transparency or public input. Many citizens still link nuclear projects to centralized power and potential weapons development, reinforced by the DPP's pledge for a "nuclear-free homeland" by 2025. However, modern reactors offer advanced safety features, and nuclear energy remains a viable, low-carbon alternative. To shift public perception, the government should launch an inclusive awareness campaign, engaging local leaders, academics, and industry experts in open discussions, using clear visuals and transparent data to highlight safety improvements and international standards. Reforms to foreign direct investment (FDI) restrictions will help in developing these plants. At present, Taiwan's cap on public-private investment stands at 50 percent, but raising this limit to 80 or 90 percent could attract substantial financing from foreign nuclear specialists. Taiwan Power Corporation (Taipower), which struggles with high fuel costs and limited capacity to transfer those costs to consumers, would then face less financial pressure. In turn, international companies—such as Constellation Energy, Westinghouse Electric Company (United States), Korea Electric Power Corporation (South Korea), and Électricité de France (France)—would gain a tangible incentive to expedite reactor construction and adhere to high safety and operational standards. These firms could also bring the latest reactor technology suited for high-density, earthquake-prone regions like Taiwan, comforting the public about the concerns about seismic risks.

Global collaboration on Taiwan's nuclear infrastructure supports technology supply-chain stability, as industries worldwide rely on its semiconductor exports. A nuclear-backed energy portfolio would also reduce fossil fuel dependence and align with international clean energy goals. Taiwan's long-term energy security requires self-sufficient, low-carbon solutions, achieved through public engagement, higher FDI thresholds, and partnerships with global nuclear experts to sustain its economy and semiconductor dominance. If these steps are accompanied by proactive engagement with communities and careful adherence to international safety norms, nuclear power can evolve into a broadly accepted cornerstone of Taiwan's energy future, thereby maintaining its Silicon Shield.

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