



UC San Diego

SCHOOL OF GLOBAL POLICY AND STRATEGY

CENTER FOR EXCELLENCE IN DISASTER MANAGEMENT & HUMANITARIAN ASSISTANCE
ROBERTSON FOUNDATION FOR GOVERNMENT FELLOW
UNIVERSITY OF CALIFORNIA SAN DIEGO SCHOOL OF GLOBAL POLICY AND STRATEGY

The Resilience of Taiwan's Energy and Food Systems to Blockade

August 2023

By: Jackson Rice

The Resilience of Taiwan's Energy and Food Systems to Blockade

August 2023

Robertson Foundation for Government Fellow

United States Indo-Pacific Command (USINDOPACOM) Student Volunteer Internship Program (SVIP)

University of California San Diego

Client Organization:

Department of Defense, Center for Excellence in Disaster Management & Humanitarian Assistance (CFE-DM)

By: Jackson Rice

Cover Photo: Shizhao, Zhuqi Township, Chiayi County, Taiwan by Eric BARBEAU on Unsplash.com.

<https://unsplash.com/photos/dnVmJGGuFdo>

Disclaimer

This report was prepared by graduate and post-graduate research fellow(s) participating in the ARIS Academic Partnership Program. The report has been prepared in good faith based on resources available at the time of publication. Information was gathered from the public domain, from local and government sources, as well as from subject matter experts. While making every attempt to ensure the information is relevant and accurate, the Center for Excellence in Disaster Management and Humanitarian Assistance (CFE-DM) does not guarantee or warrant the accuracy, reliability, completeness, or currency of the information in this publication. We hope that you find this report informative, relevant, and reliable. Please visit our website to download copies of this publication and other products (<https://www.cfe-dmha.org>).

Table of Contents

Executive Summary.....	1
Background.....	3
Energy	3
Supply - Fossil Fuels Foundational	3
Electricity Mix - The Future is LNG	4
Strengthening the Grid through Decentralization	4
Electricity Consumption by Sector	5
Petroleum Consumption by Sector	5
Oil - Shaky Suppliers, Stable Stockpile	6
Stockpile	6
Import Origin	6
Coal - Can't Kick the Habit.....	7
Stockpile	7
Import Origin	7
Natural Gas - Not Enough Storage	8
Stockpile	8
Storage	9
Import Origin	9
Nuclear Power - Abandoned Overachiever	10
Renewables - Currently Insufficient, but Long-term Potential	11
Food Security	12
Consumption Habits	13
Stockpiles.....	14
How to Build Resilience to Blockade - All About Staples	15
Proteins	15
Cold Chain Investments Will Reduce Waste.....	16
Distribution of Energy and Food During Crisis	16
Conclusion	17
References	30

Executive Summary

This paper examines the current vulnerabilities of Taiwan's critical infrastructure to a blockade. It details energy and food security and identifies the Taiwanese government's efforts to address vulnerabilities. Finally, it provides recommendations to supplement ongoing Taiwanese efforts and address remaining deficiencies.

Taiwan imports 97.3% of its energy.

- The energy system's resilience will depend on expanding storage capacity for the stockpiling of oil, coal, and natural gas as well as effective planning for the rationing and redirection of energy to critical sectors quickly.

The island relies on agricultural imports for more than 70% of the calories it consumes.

- The food system's resilience will depend on expanding storage capacity for the stockpiling of wheat, corn and soy as well as effective planning for rationing and food substitution.

Vulnerabilities

- Taiwan's grid is isolated and centralized, with choke points that make wide swaths of the system susceptible to blackout.
- Over half of crude oil imports come from Saudi Arabia and Kuwait, both of whom could be coerced into cutting exports to Taiwan out of reluctance to losing access to the Chinese market.
- Coal-fired power would need to be ramped-up during a blockade, current capacity to do so remains unclear.
- An 11-day stockpile of Liquefied Natural Gas (LNG) is extremely vulnerable to a blockade, which is especially concerning given the government's intention to expand LNG to make up 50% of the electricity mix by 2025.
- Decades of dietary changes enabled by globalization have resulted in wheat noodles and dumpling skins becoming staple foods. Taiwan imports 99.93% of its wheat.
- Pork, poultry, and aquaculture operations are supported by animal feed constituted almost entirely from imported corn and soy.
- Food waste is rampant. In 2018, 40% of fruits and vegetables, 38% of fish, 21% of meat, and 19% of wheat products were wasted before arrival to retailers.

Ongoing Efforts by Taiwan Authorities

- In September 2022, Taipower, the state-owned electricity provider, released its Grid Resilience Strengthening Construction Plan which seeks to reduce choke points by deploying microgrids.
- The Ministry of Economic Affairs (MOEA) maintains oil stockpiles surpassing 100 days.
- Taipower is investigating potential sites to store enough coal to generate up to 50 days of electricity. MOEA has reported that coal inventories will increase in the coming years.
- CPC Corporation (CPC), Taiwan's state-owned petroleum and natural gas company, has plans to install additional storage tanks at each of Taiwan's 3 LNG Terminals to achieve a 24-day storage capacity by 2027.

- The Ministry of Agriculture (MOA) has acknowledged its preparations for a blockade have involved increasing the food supply and creating plans for food substitution.
- In January 2022, The Executive Yuan announced a US\$453 million investment to improve Taiwan's cold-chain infrastructure. This will reduce food waste by allowing food products to be stored at proper temperatures for a greater duration of the distribution process.

Recommendations

- The US Department of Energy (DOE) could build on existing Memorandum of Understandings (MOUs) that it supports between American Institute in Taiwan (AIT) and the Taipei Economic and Cultural Representative Office in the United States (TECRO) to facilitate the information sharing of its extensive institutional knowledge of natural gas storage best practices.
- Taiwan authorities have been publicly cryptic about coal storage ambitions. It would be worthwhile for DOE officials to have exploratory conversations with Taiwanese counterparts to identify areas of opportunity where assistance could be provided.
- Restarting Taiwan's two decommissioned nuclear reactors and resuming paused construction on a third would yield an amount of energy equivalent to almost 20% of Taiwan's peak demand. DOE officials should meet with Taiwanese counterparts to assess plans for these reactors during a blockade.
- Energy officials from the US and Canada could engage with Taiwanese counterparts in discreet talks or publicly through a Global Cooperation and Training Framework (GCTF) energy working group to establish a contingency plan for how North American oil would be supplied in the event of an oil embargo from Gulf states.
- U.S. Department of Agriculture (USDA) officials at AIT should meet with MOA officials to gather the most up-to-date information on food stocks. Wheat, corn, and soy stockpiles could be enhanced by adding more grain silos at the ports of Keelung and Kaohsiung.
- To increase the longevity of the corn and soybean stocks during a blockade, distribution to aquaculture operations should be prioritized. It takes one pound of feed to produce one pound of farmed fish, two pounds of feed to produce one pound of chicken, and three pounds of feed for one pound of pork. The protein content per pound is roughly equivalent for each source.
- Rehearsal of the distribution of energy and food stockpiles ought to be implemented into annual exercises. The computer simulation and tabletop phases of the annual Han Kuang exercise are particularly suitable for integrating distribution simulations. Officials from DOE and AIT should be present at these simulations and discuss key takeaways with Taiwanese counterparts.

Methods

This paper synthesizes research and commentary on Taiwanese energy and food security with a detailing of Taiwanese government initiatives to provide a succinct overview of the two sectors' resilience to a blockade. The objective is to uncover areas where the U.S. government can provide resources to fill gaps in current preparedness.

Background

China's brinkmanship in the Taiwan strait have led some analysts to conclude that, by utilizing grey-zone tactics to steadily erode norms, China is positioning itself to launch a surprise invasion in the next decade. In an invasion scenario, regardless of its outcome, the costs incurred by China would be incredibly high. A recent, open-source wargame has indicated that, if the U.S. intervenes, the likelihood for a successful invasion is extremely low.¹ Therefore, Beijing might opt for a blockade strategy with the intention to coerce Taiwan into making sovereignty concessions. A blockade would also create political challenges for Taiwan and the United States by making it difficult to respond with conventional force without risking being perceived as the first to escalate.² Therefore, it is conceivable that the Chinese Communist Party (CCP) might view a blockade as the most pragmatic path for asserting sovereignty while minimizing risks. A key point from the June 2023 Council on Foreign Relations Task Force Report on preparing for a Taiwan conflict is that if the PRC blockades Taiwan, Taiwan will be unlikely to function and remain cohesive for the length of time it would take for the United States to intervene.³ Enhancing the resilience of critical infrastructure not only increases Taiwan's ability to withstand coercion, but can also support the deterrence of a blockade in the first place.

Energy

Supply - Fossil Fuels Foundational

In 2022, Taiwan was dependent on imports for 97.3% of its energy supply. The most significant inputs were oil (43.6%), coal (29.7%), and natural gas (19.1%) (Figure 1). Nuclear power (4.9%) is currently being phased out by the anti-nuclear Democratic Progressive Party (DPP), with the planned cutoff coming in 2025.⁴ Over the long term, renewables may play more of a role in enhancing resilience. However, government projections still estimate a 27% dependence on fossil fuels by 2050.⁵ Barring any revolution in

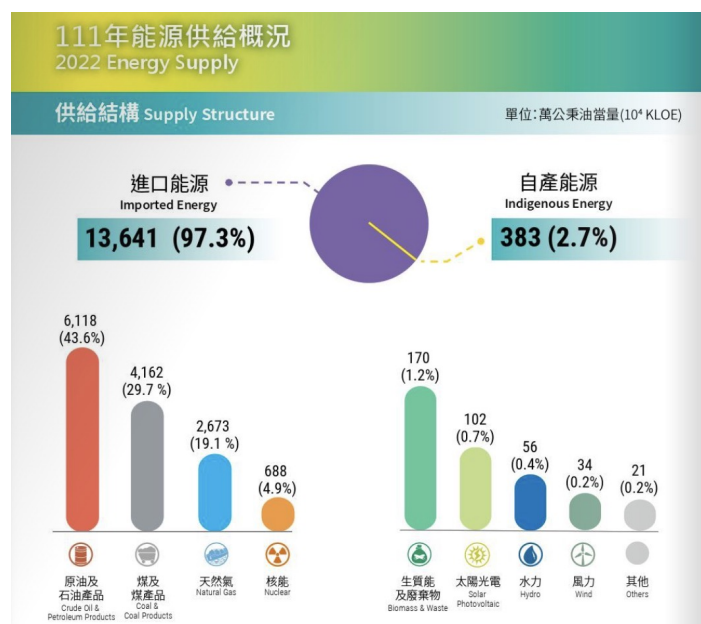


Figure 1: Taiwan's Energy Supply in 2022, Bureau of Energy, Ministry of Economic Affairs (MOEA)

1 Cancian, Mark F., Matthew Cancian, and Eric Heginbotham. "The First Battle of the Next War: Wargaming a Chinese Invasion of Taiwan." CSIS. Accessed July 12, 2023. <https://www.csis.org/analysis/first-battle-next-war-wargaming-chinese-invasion-taiwan>.

2 Martin, Bradley, Kristen Gunness, Paul DeLuca, and Melissa Shostak, Implications of a Coercive Quarantine of Taiwan by the People's Republic of China. Santa Monica, CA: RAND Corporation, 2022. https://www.rand.org/pubs/research_reports/RRA1279-1.html. Also available in print form.

3 U.S.-Taiwan Relations in a New Era: Responding to a More Assertive China." Council on Foreign Relations <https://www.cfr.org/task-force-report/us-taiwan-relations-in-a-new-era/recommendations>.

4 "Tsai Confident Taiwan Will Phase Out Nuclear Power by 2025," Focus Taiwan, March 11, 2017 <https://focustaiwan.tw/politics/201703110022>

5 Wang, C. (2022, March 29). Taiwan Vows \$32 Billion Clean Energy Spree as It Lags on Targets. Bloomberg.com. <https://www.bloomberg.com/news/articles/2022-03-30/taiwan-vows-32-billion-clean-energy-spree-as-it-lags-on-targets>

green technology, resilience will continue to be predicated on the longevity of fossil fuel stockpiles for at least the next couple decades.

Electricity Mix - The Future is LNG

In 2016, the government set a target for the 2025 electricity mix to come from 50% gas-fired power, 30% coal-fired power, and 20% renewable sources.⁶ However, in June 2022, the Ministry of Economic Affairs reduced the expected contributions from renewables down to only 15.1% by 2025.⁷ As renewables come up to speed and coal use decreases, LNG will persist as the backbone of the grid.

It is important to note that these electricity mix targets are constantly referenced incorrectly in the press and academic studies as ‘energy’ targets. This creates the false impression that Taiwan is striving to transition its entire energy mix to LNG, coal, and renewables when in actuality these targets are just for inputs to electricity generation. The vast majority of remaining energy consumption comes from imported petroleum used by the transportation and industrial sectors (Figure 4).

Taiwan’s electricity generation, by source (In percent)

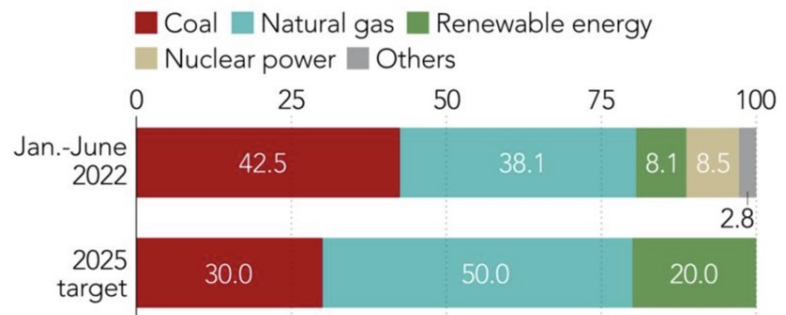


Figure 2: Electricity Generation by Energy Form, Bureau of Energy, MOEA

Strengthening the Grid through Decentralization

Taiwan’s grid is isolated and centralized, with heavy reliance on larger plants to serve as workhorses that power the island. The biggest source of grid fragility is the north’s dependence on electricity transmitted from plants in the south.⁸ This centralization has led to vulnerable choke points that make wide swaths of the system susceptible to blackouts when things go wrong. There were 22 power outages impacting 1,000 households or more in the summer of 2022 alone. The most frequent causes were malfunctions of feedlines, power transformers and high-voltage cables.⁹

Taipower announced the Grid Resilience Strengthening Construction Plan in September 2022, which seeks to decentralize and compartmentalize Taiwan’s grid by deploying microgrids, rather than relying on major grids for electricity supply. This Taipower decentralization initiative pairs with broader efforts to reduce coal-dependence and eliminate nuclear power, in favor of the distributed generation provided by wind and solar power.¹⁰

6 Ming-Zhi Gao, Anton, Tsung Kuang Yeh, and Jong-Shun Chen. “An Unjust and Failed Energy Transition Strategy? Taiwan’s Goal of Becoming Nuclear-Free by 2025.” *Energy Strategy Reviews* 44 (2022): 100991. <https://doi.org/10.1016/j.esr.2022.100991>.

7 台北時報. (2022, July 24). Renewables to fall short of 2025 target, report says. Taipei Times. <https://www.taipeitimes.com/News/biz/archives/2022/07/25/2003782352>

8 Oung, Angelica. “Fixing Taiwan’s Grid Issues Requires Redistribution.” Taiwan Business TOPICS, May 9, 2022. <https://topics.amcham.com.tw/2022/05/fixing-taiwans-grid-issues-requires-redistribution/>.

9 Li, Lauly, and Ting-Fang Cheng. “Taiwan’s Frequent Blackouts Expose Vulnerability of Tech Economy.” *Nikkei Asia*, August 30, 2022. <https://asia.nikkei.com/Business/Technology/Taiwan-s-frequent-blackouts-expose-vulnerability-of-tech-economy>.

10 McGillis, Jordan. “Taiwan’s Electrical Grid and the Need for Greater System Resilience.” Global Taiwan Institute, June 14, 2023. <https://globaltaiwan.org/2023/06/taiwans-electrical-grid-and-the-need-for-greater-system-resilience/>.

Electricity Consumption by Sector

56.1% of electricity is used in the industrial sector, 18.2% in the residential sector, 17.1% in the services sector, and 6.1% in the energy sector (Figure 3). In 2020, Taiwan Semiconductor Manufacturing Company (TSMC) accounted for 6% of Taiwan's overall energy consumption. This is expected to rise to 12.5% by 2025 due to developments in manufacturing processes that require more electricity.¹¹

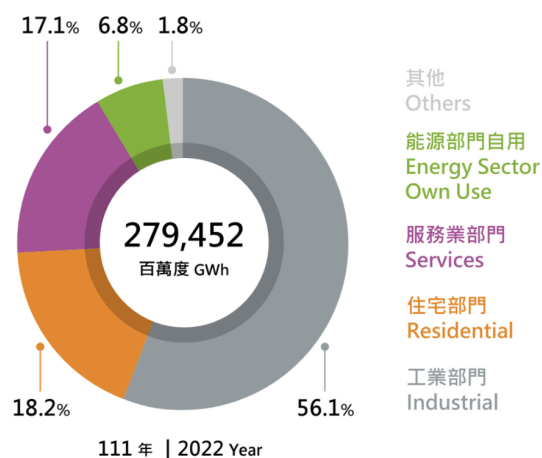


Figure 3: Electricity Consumption by Sector in 2022, Bureau of Energy, MOEA

Petroleum Consumption by Sector

Petroleum products make up 49.5% of total energy consumption, of which 53% is used in the industrial sector and 30.5% in transportation. Taiwan remains entirely dependent on imported oil for its industrial and transportation sectors (Figure 4). Implementing a plan for how to divert oil set aside for industrial production to transportation during a blockade would extend the length of time oil stockpiles could sustain transportation on the island.

石油產品消費 (按部門別)

Petroleum Products Consumption (by Sector)

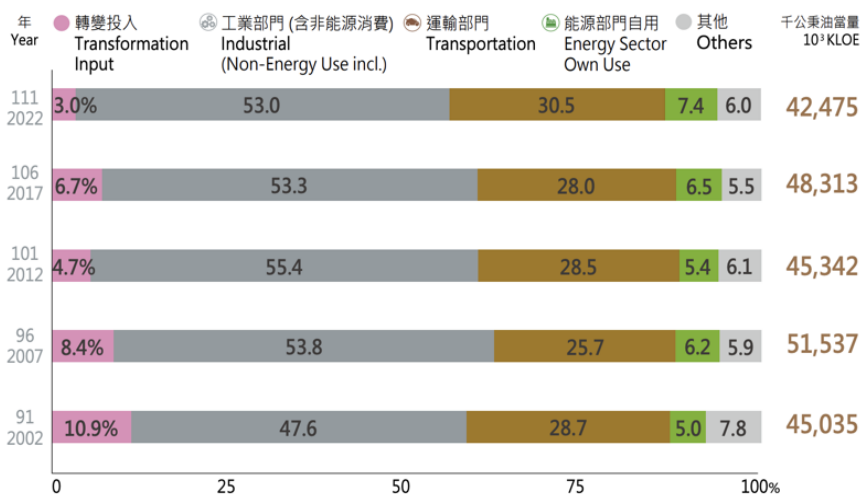


Figure 4: Petroleum Consumption by Sector, Bureau of Energy, MOEA

11 Hou, B., & Stapczynski, S. (2022, August 25). Chipmaking's Next Big Thing Guzzles as Much Power as Entire Countries. Bloomberg.com. <https://www.bloomberg.com/news/articles/2022-08-25/energy-efficient-computer-chips-need-lots-of-power-to-make>

Oil - Shaky Suppliers, Stable Stockpile

Stockpile

Under Article 24 of Taiwan's Petroleum Administration Act, oil refinery operators and importers are required to maintain stockpiles of no less than 60 days and the government itself is required to maintain a 30-day security stockpile. Each of these are calculated based on the average domestic sales and private consumption of the previous twelve months.¹²

In August 2022, the Ministry of Economic Affairs (MOEA) reported that Taiwan had crude oil reserves equivalent to 146 days of consumption.¹³ The estimate was only partially corroborated in October 2022 by Tseng Wen-Sheng, Deputy Minister at MOEA and acting Taipower chairman, who stated that crude inventories would be maintained at a level exceeding 100 days.¹⁴

Import Origin

Imports from the Middle East made up 73.5% of all crude oil imports to Taiwan in 2022 (Figure 5). As the world's largest oil importer, China naturally plays a crucial role in the economies of Middle Eastern countries. In 2022, exports to China accounted for 8% of Saudi Arabia's GDP, 15% of Kuwait's, 9% of the United Arab Emirates', and 33% of Oman's.¹⁵

Even while oil stockpiles are relatively secure at somewhere between 100 and 146 days, it is still prudent to plan for a scenario where Gulf countries are pressured by the PRC to stop supplying oil to Taiwan. If the PRC succeeds in pressuring Gulf exporters to halt shipments, the U.S. and Canada have the capacity to step in and supply Taiwan's refineries.¹⁶

Energy officials from the US and Canada could engage with Taiwanese counterparts either in discreet talks or publicly through a Global Cooperation and Training Framework (GCTF) energy working group to establish a contingency plan for how North American oil would be supplied in the event of an oil embargo from Gulf states.

The GCTF was developed jointly by Taiwan and the U.S. to provide a platform for Taiwan to engage

原油進口地區分布 (111年)
Origin of Imported Crude Oil (2022)

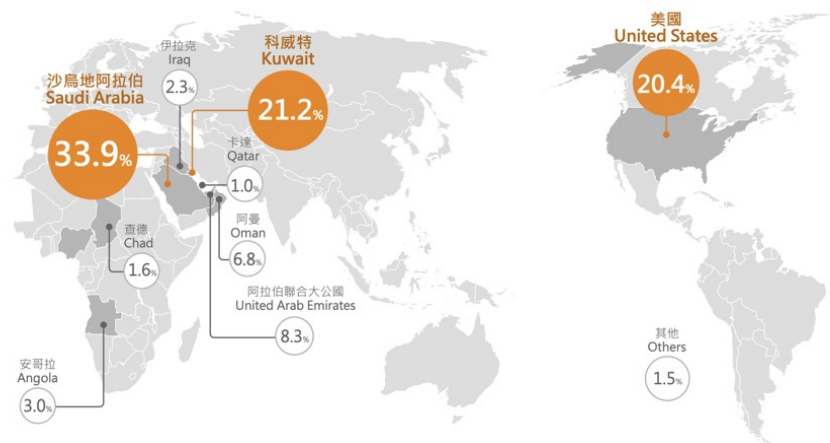


Figure 5: Origin of Imported Crude Oil (2022), Bureau of Energy, MOEA

¹² Management of Oil Security Stockpile. 經濟部能源局(Bureau of Energy, Ministry of Economic Affairs, R.O.C.)全球資訊網. (2023, February 21). https://www.moeaboe.gov.tw/ECW/english/content/Content.aspx?menu_id=8675

¹³ Wang, L. (2022, August 3). Energy supplies sufficient, ministry says. Taipei Times. <https://www.taipeitimes.com/News/biz/archives/2022/08/04/2003782917>

¹⁴ Kao, Jeanny, and Yimou Lee. "Nation to Boost Energy Inventories, Official Says." Taipei Times, October 24, 2022. <https://www.taipeitimes.com/News/biz/archives/2022/10/25/2003787649>.

¹⁵ Webster, J. (2023, July 7). Does Taiwan's massive reliance on energy imports put its security at risk? Atlantic Council. <https://www.atlanticcouncil.org/blogs/new-atlanticist/does-taiwans-massive-reliance-on-energy-imports-put-its-security-at-risk/>

¹⁶ Ibid.

with multinational partners in global problem solving. The full partners (currently Taiwan, the United States, Japan, and Australia) annually hold GCTF Joint Committee meetings to decide on prospective areas of cooperation for the coming year.¹⁷

Coal - Can't Kick the Habit

Stockpile

Government regulations require Taipower to store 30 days of coal, however Taipower generally maintains a reserve of 40 to 42 days. After the PLA exercises following U.S. House of Representatives Speaker Nancy Pelosi's visit, it was reported that Taipower was looking into potential sites to store enough coal to generate up to 50 days of electricity in the event of a blockade or war.¹⁸ In August 2022, Deputy Minister of Economic Affairs Tseng Wen-sheng stated that coal inventories would be increased in the coming years, however he declined to provide details citing security concerns.¹⁹

Import Origin

Taiwan's relationships with its two largest coal importers, Australia and Indonesia, are relatively secure. Though Russia accounted for 11.1% of total coal imports in 2022 (Figure 6), Russian coal as a percentage of total imports has been on the decline.²⁰ In March 2023, CPC Corporation announced it would not renew LNG contracts with Russian companies, signaling a similar split with Russian coal could be coming.²¹

Australia has ample supply to replace lost Russian coal imports and is unlikely to be coerced by China, demonstrated particularly by Beijing rescinding its own unofficial, two-year ban on Australian coal imports in March, 2023.²²

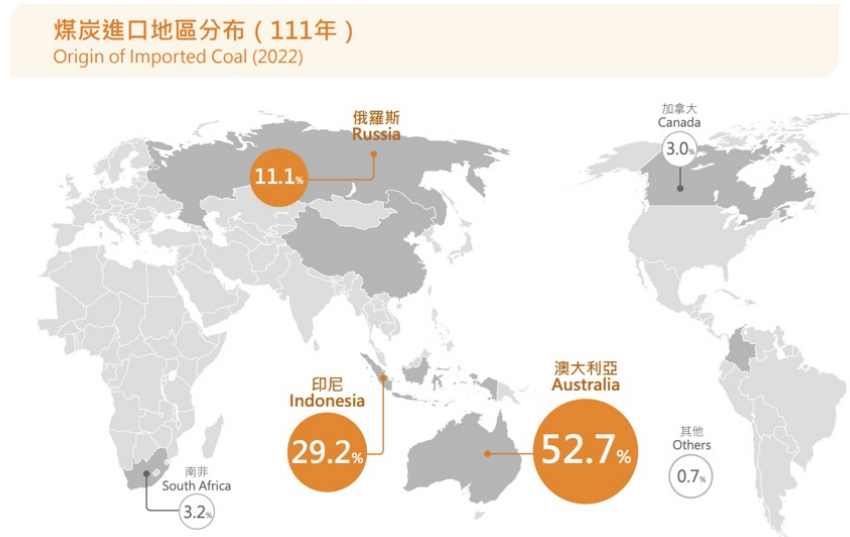


Figure 6: Origin of Imported Coal (2022), Bureau of Energy, MOEA

17 Global Cooperation and Training Framework (GCTF) <https://www.gctf.tw/en/IdeaPurpose.htm>

18 Lin, Ching-hua, and William Hetherington. "Taipower Aims to Increase Coal Storage." Taipei Times, January 22, 2023. <https://www.taipaitimes.com/News/front/archives/2023/01/23/2003793032>.

19 Kao, Jeanny, and Yimou Lee. "Nation to Boost Energy Inventories, Official Says." Taipei Times, October 24, 2022. <https://www.taipaitimes.com/News/biz/archives/2022/10/25/2003787649>.

20 Bureau of Energy, Ministry of Economic Affairs (2022, March 30). Energy Statistics Handbook- Sources of Imported Coal. 經濟部能源局(Bureau of Energy, Ministry of Economic Affairs, R.O.C.)全球資訊網. https://www.moeaboe.gov.tw/ECW_WEBPAGE/FlipBook/2021EnergyStaHandBook/index.html#p=135

21 Waksman, I. (2023, March 2). Russian gas contracts won't be renewed: Fuel Provider - RTI. RTI Radio Taiwan International. <https://en.rti.org.tw/news/view/id/2009088>

22 Webster, J. (2023, July 7). Does Taiwan's massive reliance on energy imports put its security at risk? Atlantic Council. <https://www.atlanticcouncil.org/blogs/new-atlanticist/does-taiwans-massive-reliance-on-energy-imports-put-its-security-at-risk/>

Until the renewable energy sector is more developed, coal will continue to play an integral role in the energy mix. Coal is particularly suited to enhancing resilience during a blockade due to its high energy density, ability to be stored either on- or off-site, and capacity to be dispatched as needed.²³ While the Taiwanese government has been publicly cryptic about its coal storage ambitions for both political and strategic reasons, it would be worthwhile for U.S. energy officials to have exploratory conversations with Taiwanese counterparts to identify areas of opportunity where assistance could be provided.

Natural Gas - Not Enough Storage

Annual Consumption - 17 mtpa (million megatons per year). ²⁴		
Terminal	Current Capacity	Projected Capacity
Yung-An LNG Terminal, Kaohsiung	10.5 mtpa	12.3 mtpa by 2027. ²⁵
Taichung LNG Terminal, Taichung	5 mtpa	10 mtpa by 2026, 13 mtpa by 2029. ²⁶
Guantang LNG Terminal, Taoyuan	Under construction, expected completion mid-2025	3 mtpa by 2025, 6 mtpa by 2027. ²⁷
Proposed Keelung Terminal	Construction is yet to be approved and is facing an uphill battle. ²⁸	Capacity would be 1.8 mtpa

Table 1. Annual Natural Gas Consumption and Storage Capacity

Stockpile

As of April 2023, Taiwan reported it had 11 days of liquified natural gas reserves, expeditiously meeting the 2025 target set by MOEA (Figure 7).²⁹ This is particularly short compared to the longevity of oil and coal stockpiles, especially considering the plans to transition the electricity grid to 50% dependency on natural gas by 2025.

Security Stockpile Required				
Year	2019	2022	2025	2027
Security Stockpile Required (in terms of daily gas supply)	7	8	11	14
Storage Capacity Required	15	16	20	24

Figure 7: Natural gas stockpiles and storage capacity, Bureau of Energy

23 McGillis, Jordan. "Taiwan's Energy Security and the Threat of a PRC Blockade." Global Taiwan Institute, September 8, 2022. <https://globaltaiwan.org/2021/12/taiwans-energy-security-and-the-threat-of-a-prc-blockade/>.

24 Yep, Eric, Christel Goh, and Ivy Yin. "Taiwan's CPC Seeks 14 LNG Cargoes for One Year amid Worsening Drought." S&P Global Commodity Insights, March 13, 2023.

25 "GIIGNL 2022 Annual Report." International Group of Liquefied Natural Gas Importers , October 5, 2022. <https://giignl.org/document/giignl-2022-annual-report/>.

26 Smith, Christopher E. "CPC Begins Taichung Phase III LNG Terminal Expansion." Oil & Gas Journal, July 18, 2022. <https://www.ogj.com/pipelines-transportation/lng/article/14279843/cpc-begins-taichung-phase-iii-lng-terminal-expansion>.

27 "GIIGNL 2022 Annual Report." International Group of Liquefied Natural Gas Importers , October 5, 2022. <https://giignl.org/document/giignl-2022-annual-report/>.

28 Global Energy Monitor. "Hsieh-HO FSRU." Global Energy Monitor, February 21, 2023. https://www.gem.wiki/Hsieh-Ho_FSRU.

29 Kuo , Chien-shen, and Evelyn Kao. "Taiwan's Fuel Inventory Adequate during China's Military Drills: Minister ." Focus Taiwan - CNA English News, April 10, 2023. <https://focustaiwan.tw/business/202304100012>.

Storage

In 2022, Taiwan imported a total of 19.96 million/mt all via LNG carrier ships. Taiwan currently has two LNG terminals along Taiwan's western and southwestern coasts at Taichung and Yung-an (Kaohsiung) respectively. They have a combined import capacity of 16.5 million mt/year. Both have been operating above capacity due to growing demand. Expansions for both terminals are being planned. A third terminal, Guantang, is under construction in Taoyuan, about 40 miles west of Taipei, and will have a capacity of 3 million mt/year.³⁰ The project is expected to be finished by May 2025 and operational by the end of that year.³¹

To achieve the government's target of a 24-day storage capacity and 14-day stockpile by 2027 (Figure 7), CPC has plans to install additional storage tanks at each of Taiwan's 3 LNG Terminals.³²

Taipower has had plans since 2018 to build a fourth LNG terminal in Keelung, Taiwan's second largest port 18 miles north of Taipei, by converting the oil-fired Hsieh-ho Power Plant into a gas-fired facility. However, its environmental impact assessment has dragged on for more than four-and-a-half years without being approved and local groups in Keelung have started gathering signatures for a referendum to stop the project.³³ If completed, the project would generate 1.8 million/mt of additional storage capacity.³⁴

Import Origin

In July 2021, CPC signed a 15-year agreement with Qatar to purchase 1.25 million tons of LNG per year, about 7.4% of Taiwan's LNG consumption.³⁵ In December 2022, China and Qatar signed a 27-year deal for 4 million tons per year through 2050.³⁶ If Taiwan was abruptly cut off from Qatari imports, U.S., Australian, and Canadian LNG could make up the difference.³⁷ The 25-year contract between CPC and U.S.-based

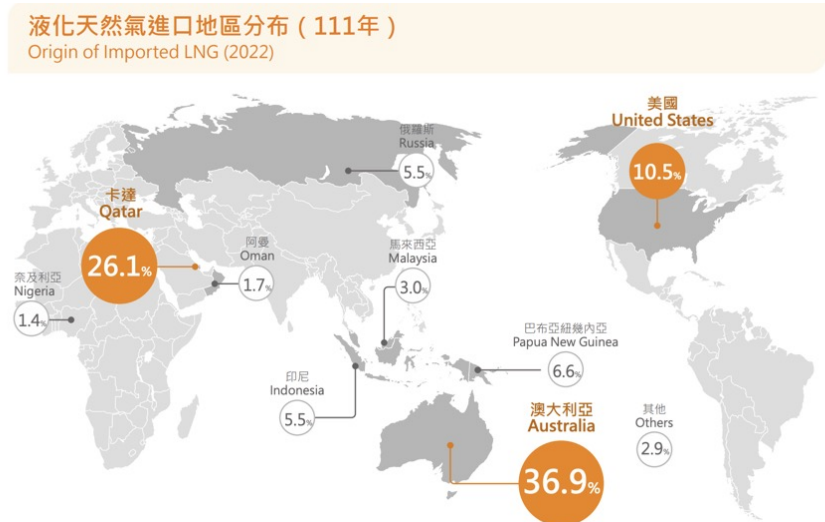


Figure 8: Origin of Imported LNG (2022), Bureau of Energy, MOEA

30 Yep, Eric, Christel Goh, and Ivy Yin. "Taiwan's CPC Seeks 14 LNG Cargoes for One Year amid Worsening Drought." S&P Global Commodity Insights, March 13, 2023. <https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/energy-transition/031323-taiwans-cpc-seeks-14-lng-cargoes-for-one-year-amid-worsening-drought>.

31 Tsuge, Mamoru. "Japan's JFE Engineering Wins \$230M Order for Taiwan LNG Terminal." Nikkei Asia, March 27, 2023. <https://asia.nikkei.com/Business/Engineering-Construction/Japan-s-JFE-Engineering-wins-230m-order-for-Taiwan-LNG-terminal>.

32 Lin, Ching-hua, and William Hetherington. "Taipower Aims to Increase Coal Storage." Taipei Times, January 22, 2023. <https://www.taipeitimes.com/News/front/archives/2023/01/23/2003793032>.

33 Kung, Johnson. "A Better Approach to LNG Projects." Taipei Times, February 21, 2023. <https://www.taipeitimes.com/News/editorials/archives/2023/02/22/2003794810>.

34 Global Energy Monitor. "Hsieh-HO FSRU." Global Energy Monitor, February 21, 2023. https://www.gem.wiki/Hsieh-HO_FSRU.

35 Oung, Angelica. "CPC Inks 15-Year Deal with Qatar to Purchase LNG." Taipei Times, July 7, 2021. <https://www.taipeitimes.com/News/biz/archives/2021/07/08/2003760466>.

36 Dargin, Justin. "What's at Stake in the Massive China-Qatar Gas Deal." Carnegie Endowment for International Peace, December 29, 2022. <https://carnegieendowment.org/2022/12/29/what-s-at-stake-in-massive-china-qatar-gas-deal-pub-88696>.

37 Webster, J. (2023, July 7). Does Taiwan's massive reliance on energy imports put its security at risk? Atlantic Council. <https://www.atlanticcouncil.org/blogs/new-atlanticist/does-taiwans-massive-reliance-on-energy-imports-put-its-security-at-risk/>

Cheniere Energy for 2 million tons annually exemplifies that potential.³⁸

A stockpile of only 11 days makes LNG extremely vulnerable to a blockade. This is especially concerning given the government's intentions to expand LNG to make up 50% of the electricity mix by 2025. Although the government is working to expand storage capacity to 14 days --the goal for 2027 -- is still a remarkably short amount of time.

Six terminals would be required for the amount of natural gas Taiwan aspires to burn and a one-month supply to be kept in reserve. The fourth and fifth receiving terminals have not yet emerged from the Environmental Impact Assessment planning stage, and the location of the sixth remains a question mark.³⁹

The US Department of Energy could assist Taiwan with its extensive institutional knowledge of natural gas storage best practices. In addition to new storage solutions, the speed with which the U.S. could supply LNG to the island in a supply shock is crucial. As it stands, it would take at least 30 days for additional LNG shipments originating from the U.S. to make it to Taiwan.⁴⁰

The Alaska LNG project approved by the Department of Energy in April 2023 could ship LNG to Taiwan within 10 days upon its estimated completion in 2030, however it appears the project may never come to fruition as Japanese and Korean buyers have refused to fund it, citing a lack of confidence in its timeline.⁴¹

Nuclear Power - Abandoned Overachiever

In 2022, nuclear power still made up 2.9% of the total energy mix (Figure 1) and 8.5% of the electricity mix (Figure 2). In July 2023, President Tsai reiterated her administration's goal to make Taiwan nuclear free by 2025.⁴² Taiwan has 4 nuclear reactors: two that have been decommissioned (Jinshan and Kuosheng), one whose construction has been halted (Lungmen, northern coast), and one still currently operational (Maanshan, southern coast).

The reactors are supplied by imported nuclear fuel. While open-source information on the origin of Taiwan's nuclear imports is not available, Kazakhstan accounted for 43 percent of the world's uranium production from mining in 2022 and Russia is deeply embedded in nuclear energy supply chains.⁴³ It is plausible that Taiwan could be cuff off. Fortunately, stockpiles of nuclear fuel are stable for hundreds of years, inexpensive to store, and highly robust against natural disasters.⁴⁴ It would make sense for Taiwan to build up these stockpiles while it still can to maintain flexibility if nuclear policy preferences change in

38 Duncan DeAeth, "Taiwan's CPC Corp. Signs US\$25 Billion LNG Deal With US Firm Cheniere Energy," Taiwan News, August 18, 2018, <https://www.taiwannews.com.tw/en/news/3509642>.

39 Oung, Angelica. "How Can Taiwan Avoid an Energy Crisis?" AmCham Taiwan, May 9, 2022. <https://topics.amcham.com.tw/2022/05/how-can-taiwan-avoid-an-energy-crisis/>.

40 Chausovsky, Eugene. "Energy Is Taiwan's Achilles' Heel." Foreign Policy, July 31, 2023. https://foreignpolicy.com/2023/07/31/energy-taiwan-semiconductor-chips-china-tsmc/?utm_source=Sailthru&utm_medium=email&utm_campaign=Editors+Picks+-+08012023&utm_term=editors_picks.

41 Davis, River, and Sylvan Lebrun. "U.S. Allies in Asia Snub Natural Gas from Alaska Project." The Wall Street Journal, July 25, 2023. <https://www.wsj.com/articles/u-s-allies-in-asia-snob-natural-gas-from-alaska-project-e54f754a>.

42 Wang, Flor, and Kuei-hsiang Wen. "Tsai Reiterates 2025 Nuclear-Free Goal," Focus Taiwan - CNA English News, June 7, 2023. <https://focustaiwan.tw/politics/202306060021>.

43 Webster, J. (2023, July 7). Does Taiwan's massive reliance on energy imports put its security at risk? Atlantic Council. <https://www.atlanticcouncil.org/blogs/new-atlanticist/does-taiwans-massive-reliance-on-energy-imports-put-its-security-at-risk/>

44 Kemp, R. S. (n.d.). Strategic fuel reserves - MIT: Laboratory for nuclear security and policy. Laboratory for Nuclear Security and Policy. <http://lnsp.mit.edu/strategic-fuel-reserves>

the future.

While nuclear power has fallen out of favor in Taiwan after the accident at Japan's Fukushima power plant, as a result of the March 11, 2011 earthquake and tsunami, it could still play a role in a future blockade scenario. Current Vice President and Democratic People's Party (DPP) nominee for the January 2024 presidential election, Lai Ching-te, stated that Taiwan's nuclear reactors might be reactivated in an emergency involving a war or blockade.⁴⁵ Lai, the front runner in most presidential polls as of mid-August, has also stated that the government is studying the feasibility of maintaining shut reactors so they could be restarted for emergency use.⁴⁶

Restarting the two decommissioned reactors and resuming construction on Lungmen could yield nearly 8 gigawatts of total dispatchable nuclear capacity, equivalent to almost 20 percent of Taiwan's peak demand.⁴⁷ Normally, once reactors are decommissioned, they are quite difficult to restart. In Taiwan's case however, because it never found a suitable permanent site to store nuclear waste, it used the 'decommissioned' reactors as storage sites. This prevented the reactors from being fully shut down. Yeh Tsung-kuang, professor at National Tsing Hua University's Department of Engineering and System Science, has estimated that it would take less than a year to bring the ones in "stasis" back into service, and two to five years for Lungmen's completion.⁴⁸

Renewables - Currently Insufficient, but Long-term Potential

In May 2023, deputy director-general of Taiwan's Bureau of Energy Lee Chun-l stated that offshore wind is crucial to strengthening energy security and is expected to generate USD\$32.6 billion in investments by 2025.⁴⁹ A nine hundred-megawatt wind farm off Taiwan's west coast first produced electricity in early 2022; once fully complete, the installation could power approximately one million homes.⁵⁰

Distributed solar installations, when equipped with microgrids, can be deployed on various rooftops and are resistant to disruptions from both cyber and kinetic attacks. However, these installations often experience low utilization rates and incur higher costs due to customized installations. On the other hand, utility-scale solar systems are more efficient and cost-effective, but their higher concentration of panels may render them more vulnerable to cyberattacks. More broadly, Taiwan's solar potential is limited by factors such as frequent cloudy conditions and the scarcity of available land.⁵¹

Accomplishing the goal of making up 20% of the electricity mix by 2025 would have required solar

45 Ibid.

46 Yeh, Su-ping, Hing-kao Wang, Evelyn Kao, and Shih Hsiu-chuan. "Nuclear an Option to Meet Energy Needs: KMT Presidential Candidate." Focus Taiwan - CNA English News, May 31, 2023. <https://focustaiwan.tw/politics/202305300014>.

47 McGillis, Jordan. "Taiwan's Electrical Grid and the Need for Greater System Resilience." Global Taiwan Institute, June 14, 2023. <https://globaltaiwan.org/2023/06/taiwans-electrical-grid-and-the-need-for-greater-system-resilience/>.

48 McGillis, Jordan, and Angelica Oung. "Taiwan's Nuclear Option." The Breakthrough Institute, December 19, 2022. <https://thebreakthrough.org/journal/no-18-fall-2022/taiwans-nuclear-option>.

49 Wu, S. (2023, May 10). Focus: Taiwan's wind industry braves cross-strait risks in clean energy boom. Reuters. <https://www.reuters.com/business/energy/taiwans-wind-industry-braves-cross-strait-risks-clean-energy-boom-2023-05-10/>

50 Webster, J. (2023, July 7). Does Taiwan's massive reliance on energy imports put its security at risk? Atlantic Council. <https://www.atlanticcouncil.org/blogs/new-atlanticist/does-taiwans-massive-reliance-on-energy-imports-put-its-security-at-risk/>

51 Ibid.

capacity increasing from 6.5 gigawatts in 2020 to 20 gigawatts by 2025 (8 from distributed, 12 from utility-scale), and wind capacity increasing from 1.3 gigawatts to 5.5 gigawatts.⁵²

Currently, renewable energy is not capable of playing a significant role during a blockade. Nevertheless, as technology advances and Taiwan continues attracting investment to its renewables sector, a significant portion of the energy mix will undoubtedly come to be bolstered by renewables. A March 2022 report from the Taiwan government's National Development Council calls for 60% to 70% of Taiwan's power to come from renewable sources by 2050.⁵³

Food Security

Taiwan relies heavily on agricultural imports to sustain its population. In 2021, the country's indigenous agricultural production contributed to only 31.3% of the total annual caloric intake, with imports constituting the remaining 68.7% of consumed calories (Figure 9).⁵⁴ This ratio is slightly misleading, as indigenous agricultural production is bolstered by animal products that depend on imported corn and soybean (Figure 10).

Food Self-Sufficiency Rate (% of calories consumed attributable to domestic production)

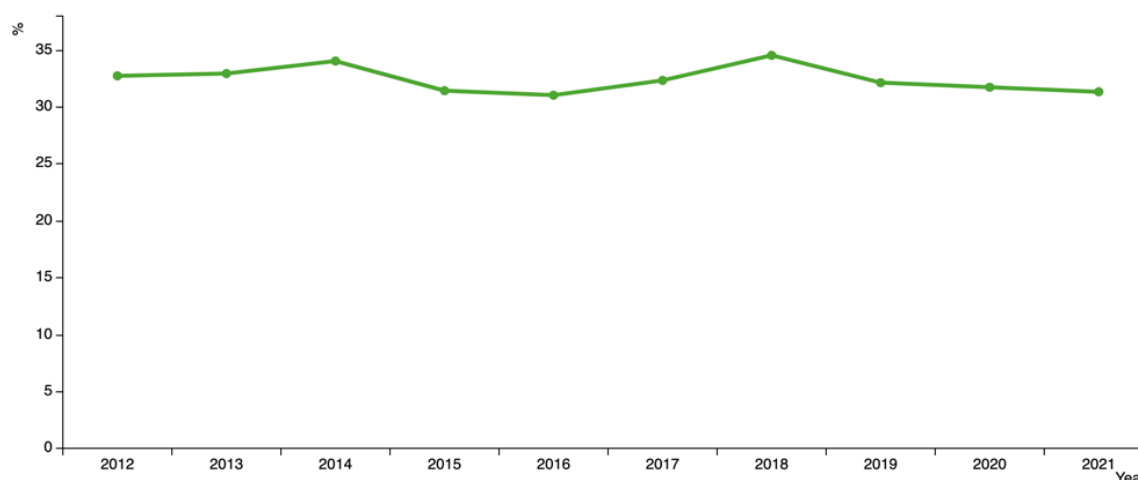


Figure 9: Food self-sufficiency rate, Taiwan Ministry of Agriculture (MOA)

The food self-sufficiency rate has remained stagnant despite long-standing government initiatives to increase it. In 2011, Lee Wu-chung, a professor of agricultural economics at National Taiwan University, concluded that government efforts to increase self-sufficiency by encouraging farmers to plant more mixed grains and the public to eat more rice to improve domestic grain stores were the correct moves. However, his prediction that they would only have short-term effects was proven correct.⁵⁵

52 Spector, J. (2023, April 6). Taiwan's rapid renewables push has created a bustling battery market. Canary Media. <https://www.canarymedia.com/articles/energy-storage/taiwans-rapid-renewables-push-has-created-a-bustling-battery-market>

53 Wang, C. (2022, March 29). Taiwan Vows \$32 Billion Clean Energy Spree as It Lags on Targets. Bloomberg.com. <https://www.bloomberg.com/news/articles/2022-03-30/taiwan-vows-32-billion-clean-energy-spree-as-it-lags-on-targets>

54 Ministry of Agriculture, E. Y. (n.d.). Comprehensive Self-Sufficiency Ratio- Measured by Calorie. Ministry of Agriculture, Executive Yuan, R.O.C.(Taiwan). <https://eng.moa.gov.tw/ws.php?id=2505449>

55 Lee, W. (2011, March 3). Promoting self-sufficiency in food. Taipei Times. <https://www.taipeitimes.com/News/editorials/archives/2011/03/04/2003497297>

A 2013 study quantified the extent to which water and land constraints limited countries' capacities to produce on their own territories. It found that a significant number of countries were unable to achieve food self-sufficiency because their endowments of available land, water, and fertile soil could not support sufficient agricultural production.⁵⁶ While Taiwan was not included in the study, the government's failure to increase self-sufficiency over the past decade indicates that Taiwan too is limited by these geographical constraints.

Consumption Habits

Based on findings from the Nutrition and Health Survey in Taiwan, 2017–2020, Taiwanese on average consume:

Product	Average Consumption Per Day
Carbohydrate-rich foods daily	12.5 servings (equivalent to 3.1 bowls of rice) - Either from rice or wheat products, mainly noodles or dumpling skins
Protein-rich foods	7.7 servings
Pork and Poultry	4.1 servings
Fish/Seafood	1.3 servings
Soy (soymilk, tofu, fresh soybean, etc.)	1.1 servings
Eggs	0.8 servings
Dairy	0.5 servings
Cooking Oils	4.8 servings
Vegetables	2.4 servings
Fruits	1.5 servings
Seeds / Nuts	0.5 servings

Table 2. Average Daily Food Consumption

In summary, the major staple foods are steamed white rice, wheat noodles, and dumplings. For lunch and dinner, pork, chicken, sea foods, tofu, and egg, in that order, are major sources of protein. Vegetables are mainly stir fried with non-tropical plant oil.⁵⁷

Commodity	Domestically Produced	Imported
Wheat	0.07%	99.93%
Soybeans	0.15%	99.85%
Corn	3.13%	96.87%
Beef	4.82%	95.18%
Starchy Roots	15.72%	84.28%
Milk	65.76%	34.24%
Fish and Seafood	68.19%	31.81%
Poultry	79.84%	20.16%
Fruits	81.56%	18.44%
Vegetables	83.15%	16.85%
Pork	90.09%	9.91%
Rice	90.66%	9.34%

Grains	Animal Feed	Animal Products	Produce
--------	-------------	-----------------	---------

Figure 10: Domestic/Import ratios by commodity calculated from 2021 Food Balance Sheet, Taiwan Ministry of Agriculture (MOA) (<https://eng.moa.gov.tw/ws.php?id=2505709>)

⁵⁶ Fader, M., Gerten, D., Krause, M., Lucht, W. L., & Cramer, W. (2013, March 26). Spatial decoupling of agricultural production and consumption: quantifying dependences of countries on food imports due to domestic land and water constraints. IOP Science. <https://iopscience.iop.org/article/10.1088/1748-9326/8/1/014046>

⁵⁷ Pan, W. H., Wu, S. Y., Yeh, N. H., & Hung, S. Y. (2022). Healthy Taiwanese Eating Approach (TEA) toward Total Wellbeing and Healthy Longevity. *Nutrients*, 14(13), 2774. <https://doi.org/10.3390/nu14132774>

Taiwan has a diverse group of suppliers for its agricultural products (Figure 11), with 95% of these products arriving via ocean carriers at four major ports. Among ports processing agricultural imports in 2019, Keelung accounted for 43.31% of total dollar value, followed by Kaohsiung with 33.97%, Taichung with 17.38%, and Taipei with 5.35%.⁵⁸ Each of these ports is equipped with the requisite infrastructure to handle and store the products, such as port cranes for containers, grain silos, and cold storage for fresh fruits and vegetables.⁵⁹

Top 10 Import Origin	
USA	23.04%
New Zealand	9.84%
Japan	8.50%
UK	6.55%
Australia	5.19%
France	5.18%
Thailand	4.62%
China	4.19%
The Netherlands	3.78%
South Korea	3.55%

Figure 11: Top 10 Importers of agricultural products, USDA Taiwan Exporter Guide

Stockpiles

The Ministry of Agriculture (MOA), renamed from Council of Agriculture (COA) in May 2023, is responsible for maintaining stocks of key food staples to provide enough supply in the event of a disruption in world trade.⁶⁰ In response to concerns about food security at the start of the Covid-19 pandemic, COA reviewed stocks and near-term production levels and determined that Taiwan had enough food on island to last 6 months.⁶¹

Commodity	Stockpile Supply
Rice	9 months
Wheat	6 months
Sweet Potato Seedlings	Sufficient supply can be scaled up if needed
Vegetables	6 months
Fruits	6 months
Livestock Products	6 months
Fishery Products	6 months
Fertilizers	6 months
Soybeans, Corn (livestock and fishery feed)	Up to 6 months

Table 3. Supply Timelines for Commodities⁶²

If these assessments are credible, there is reason to be optimistic about the food system's resilience to a blockade. This assessment was released in April 2020, mere months after the pandemic began. Since then, there has been enhanced focus from Taiwanese authorities on preparing the island. In September 2022, COA Deputy Minister Chen Junne-jih acknowledged that Taiwan had already begun preparing for a scenario where its food imports were blocked by increasing the food supply and creating plans for food substitution.⁶³

58 Ferreira, G. F., & Critelli, J. A. (2023, May 19). Taiwan's Food Resiliency—or Not—in a Conflict with China . United States Army War College Press. <https://press.armywarcollege.edu/cgi/viewcontent.cgi?article=3222&context=parameters>

59 Ibid.

60 "Taiwan: Taiwan Confident in Food Stocks as COVID-19 Disrupts International Trade," Attaché Report(GAIN), Foreign Agricultural Service/U.S. Department of Agriculture (website), April 14, 2020 <https://www.fas.usda.gov/data/taiwan-taiwan-confident-food-stocks-covid-19-disrupts-international-trade>

61 Lai, T., & Blaustein, L. (2020, April 13). Taiwan Confident in Food Stocks as COVID-19 Disrupts International Trade. USDA Foreign Agricultural Service. <https://www.fas.usda.gov/data/taiwan-taiwan-confident-food-stocks-covid-19-disrupts-international-trade>

62 Ibid.

63 Smith, M. (2022, September 4). Taiwan open to buying Australian exports banned in China. Australian Financial Review. <https://www.afr.com/world/asia/taiwan-open-to-buying-australian-exports-banned-in-china-20220904-p5bf8u>

The stockpiles have undoubtedly been fortified and expanded since the report's release in 2020. If they have not done so already, it would be worthwhile for representatives from AIT to meet with officials at MOA to gather the most up-to-date information on the stockpiles. The two sides can identify what additional resources or support could be provided.

How to Build Resilience to Blockade - All About Staples

Rice stocks would likely be depleted at a faster rate than currently projected, as the dearth of wheat imports would shift carbohydrate consumption toward domestically produced rice. Taiwan's dependence on imported wheat has increased for decades due to the development of a robust baking sector that produces popular goods such as wheat noodles and buns. The calories lost from wheat would have to be replaced through a combination of rice and sweet potato.⁶⁴ The COA report references its sweet potato seedlings stockpile as capable of being scaled up if needed.⁶⁵ This process should be initiated.

As stockpiles are depleted, Taiwan will only be able to consume what it can produce domestically. Given that Taiwan does not have enough arable land to expand food production, successfully sustaining the population with domestic products will require increases in output that can only be achieved from higher yields.⁶⁶

To achieve these higher yields, Taiwan will rely on the distribution of its fertilizer stockpile. While COA reported the fertilizer stockpile to be at 6 months, amidst the intensified cultivation of rice and sweet potatoes that would occur under blockade, it is likely the stockpile would be depleted at a faster rate.

Fortunately, Taiwan's largest fertilizer producer Taiwan Fertilizer Company domestically produces ammonium sulfate and potassium chloride,⁶⁷ the most suitable fertilizers for rice and sweet potatoes respectively.⁶⁸ The government could work in tandem with Taiwan Fertilizer Company to build up stockpiles for these two specific fertilizers and leverage the company's existing relationship with farmers to develop planning for rapid distribution to rice and sweet potato producers.

Proteins

Taiwan's main sources of protein (pork, poultry, and fish) are entirely reliant on imported corn and soybean (Figure 10). Without effective planning, Taiwan could not maintain its current levels of animal protein consumption under a blockade because its livestock and aquaculture sectors would run out of feed grains. This highlights the importance of expanding corn and soybean stockpiles, a task that could be accomplished by adding more grain silos at the ports of Keelung and Kaohsiung.

64 Ferreira, G. F., & Critelli, J. A. (2023, May 19). Taiwan's Food Resiliency—or Not—in a Conflict with China . United States Army War College Press. <https://press.armywarcollege.edu/cgi/viewcontent.cgi?article=3222&context=parameters>

65 Lai, T., & Blaustein, L. (2020, April 13). Taiwan Confident in Food Stocks as COVID-19 Disrupts International Trade. USDA Foreign Agricultural Service. <https://www.fas.usda.gov/data/taiwan-taiwan-confident-food-stocks-covid-19-disrupts-international-trade>

66 Ferreira, G. F., & Critelli, J. A. (2023, May 19). Taiwan's Food Resiliency—or Not—in a Conflict with China . United States Army War College Press. <https://press.armywarcollege.edu/cgi/viewcontent.cgi?article=3222&context=parameters>

67 Thomson Reuters. (n.d.). About Taiwan Fertilizer Co Ltd. Reuters. <https://www.reuters.com/markets/companies/1722.TW/>

68 Reddy, J. (2022, February 20). The Best Fertilizer for Rice Crop: Organic, NPK, and Schedule for Paddy. Agri Farming. <https://www.agrifarming.in/the-best-fertilizer-for-rice-crop-organic-npk-and-schedule-for-paddy;>

(2023, July 17) Sweet Potato Fertilizer Requirements and Recommendations: Management Practices for Optimal Yield

<https://www.agrifarming.in/sweet-potato-fertilizer-requirements-and-recommendations-management-practices-for-optimal-yield>

To increase the longevity of the corn and soybean stocks during a blockade, distribution to aquaculture operations should be prioritized. It takes one pound of feed to produce one pound of farmed fish, two pounds of feed to produce one pound of chicken, and three pounds of feed for one pound of pork.⁶⁹ The protein content per pound is roughly equivalent for each source.

MOA can also begin investing in converting farms that solely produce pork into integrated pig-fish operations. Integrated pig-fish culture has been practiced for many years in many parts of Asia.⁷⁰ This would prepare farms to switch entirely to aquaculture if need be, but allows for the continued production of pork.

Cold Chain Investments Will Reduce Waste

Food losses in Taiwan are so high because food starts being wasted even before the distribution process. In 2018, the rate of loss of Taiwan's vegetable and fruit production was 40% (Figure 12). The leading cause of food losses in Taiwan are attributed to slow sales and weak storage management capabilities related to temperature and packaging.

In January 2022, The Executive Yuan announced a US\$453 million investment to improve Taiwan's cold-chain infrastructure. A key feature of the initiative is the construction of flagship logistics centers and regional distribution centers so that food products will be stored at the proper temperatures for as much of the distribution process as possible.⁷¹ The goal is to enhance the country's ability to stockpile essential food products and handle temporary food shortages and price volatility.⁷²

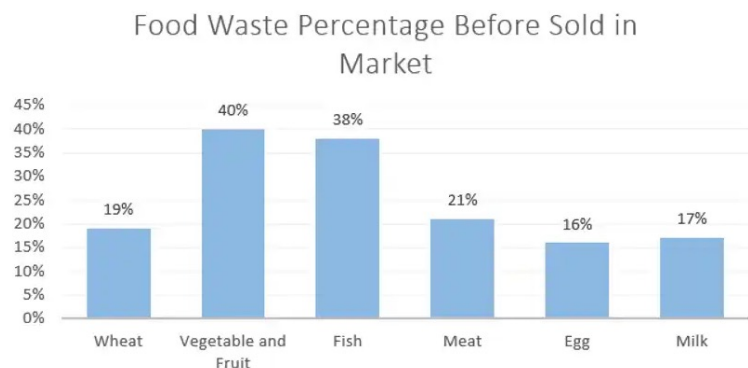


Figure 12: Food Waste Before Being Sold in 2018, Taiwan COA

Distribution of Energy and Food During Crisis

Under a blockade, the effectiveness of energy allocation and food distribution will play a pivotal role in overall resilience. According to the All-Out Defense Response Handbook released by the Ministry of National Defense (MND), in the case of war or national emergency, the Executive Yuan will announce the rationing of daily necessities. The Ministry of Economic Affairs is responsible for the national energy allocation and the Ministry of Agriculture is responsible for distribution policies for rice and edible oil,

69 Bourne, J. K. (n.d.). How to Farm a Better Fish. National Geographic. <https://www.nationalgeographic.com/foodfeatures/aquaculture/>

70 Fermin, F. V. (2001). Backyard integrated pig-fish culture in the Philippines. Integrated Agriculture-Aquaculture: A Primer. <https://www.fao.org/3/y1187e/y1187e17.htm>

71 Department of Information Services, Executive Yuan. (2022, January 27). Promoting a nationwide agricultural product cold chain Logistics System. Executive Yuan, R.O.C. (Taiwan). <https://english.ey.gov.tw/News3/9E5540D592A5FECD/6314bb5e-0b3a-4b44-9c9a-be9019d602b2>

72 Oscar Chung, "Kept in Reserve," Taiwan Today (website), May 1, 2021, <https://taiwantoday.tw/news.php?unit=8&post=200663&unitname=&postname=Kept-in-Reserve>.

salt, and liquified petroleum gas respectively.⁷³ Rehearsal of the distribution of energy and food stockpiles ought to be implemented into annual exercises.

The Ministry of National Defense currently conducts three annual exercises:

- Han Kuang - simulates the response of Taiwan's armed forces to an invasion with live fire drills and computerized war games
- Min-an - civil defense exercises that include rescue operations for building collapses, responses by firefighters and medical personnel
- Wan-an - Air defense drills that require pedestrians and motorists to clear the streets and move to designated shelters⁷⁴

The 2023 iteration of Han Kuang occurred in two phases. The computer simulation and tabletop phase was held from May 15-19 with live fire drills from July 24-28. Particular focus of this year's exercise was placed on the survival of critical command-and-control nodes as well as a greater emphasis on civil defense scenarios and training.⁷⁵ The computer simulation and tabletop phases are particularly suitable for integrating distribution plans into the exercise. It would be worthwhile for officials from the U.S. Department of Energy and AIT to be present at these simulations and discuss key takeaways with Taiwanese counterparts.

Conclusion

This report identifies expanding storage capacities for oil, coal, natural gas, and key food staples as a cornerstone for resilience against a blockade. Additionally, effective planning for the timely rationing and allocation of resources will be central to maintaining stability.

The Taiwanese government is taking proactive efforts to address these vulnerabilities. The recommendations put forth in this report offer a roadmap for the U.S. government to supplement existing Taiwanese initiatives. Information sharing, technological advancements, and military exercises that incorporate rehearsing the distribution of key resources can fortify Taiwan's energy and food systems against current vulnerabilities and ensure the sustained well-being of its citizens during a blockade.

73 All-Out Defense Mobilization Agency. (2022, April). All-Out Defense Handbook. Ministry of National Defense. https://aodm.mnd.gov.tw/UFile/down/81_2022081116095501_%E6%89%8B%E5%86%8A%E8%8B%B1%E8%AD%AF.pdf

74 Dotson, J. (2023, August 9). An Overview of Taiwan's 2023 Han Kuang Military Exercise. Global Taiwan Institute. <https://globaltaiwan.org/2023/08/an-overview-of-taiwans-2023-emhan-kuang-em-military-exercise/>

75 Ibid.

References

- About GCTF. Global Cooperation and Training Framework (GCTF). (n.d.). <https://www.gctf.tw/en/IdeaPurpose.htm>
- All-Out Defense Mobilization Agency. (2022, April). *All-Out Defense Handbook*. Ministry of National Defense. https://aodm.mnd.gov.tw/UFile/down/81_2022081116095501_%E6%89%8B%E5%86%8A%E8%8B%B1%E8%AD%AF.pdf
- Bourne, J. K. (n.d.). *How to Farm a Better Fish*. National Geographic. <https://www.nationalgeographic.com/foodfeatures/aquaculture/>
- Chausovsky, Eugene. “Energy Is Taiwan’s Achilles’ Heel.” *Foreign Policy*, July 31, 2023. https://foreignpolicy.com/2023/07/31/energy-taiwan-semiconductor-chips-china-tsmc/?utm_source=Sailthru&utm_medium=email&utm_campaign=Editors+Picks+-+08012023&utm_term=editors_picks.
- Chen , Cheng-hui. “Renewables to Fall Short of 2025 Target, Report Says.” *Taipei Times*, July 24, 2022. <https://www.taipeitimes.com/News/biz/archives/2022/07/25/2003782352>.
- Dargin, Justin. “What’s at Stake in the Massive China-Qatar Gas Deal.” *Carnegie Endowment for International Peace* , December 29, 2022. <https://carnegieendowment.org/2022/12/29/what-s-at-stake-in-massive-china-qatar-gas-deal-pub-88696>.
- Davis, River, and Sylvan Lebrun. “U.S. Allies in Asia Snub Natural Gas from Alaska Project.” *The Wall Street Journal*, July 25, 2023. <https://www.wsj.com/articles/u-s-allies-in-asia-snub-natural-gas-from-alaska-project-e54f754a>.
- Department of Information Services, Executive Yuan. (2022, January 27). *Promoting a nationwide agricultural product cold chain Logistics System*. Executive Yuan, R.O.C. (Taiwan). <https://english.ey.gov.tw/News3/9E5540D592A5FECD/6314bb5e-0b3a-4b44-9c9a-be9019d602b2>
- Dotson, J. (2023, August 9). *An Overview of Taiwan’s 2023 Han Kuang Military Exercise*. Global Taiwan Institute. <https://globaltaiwan.org/2023/08/an-overview-of-taiwans-2023-emhan-kuang-em-military-exercise/>
- Fader, M., Gerten, D., Krause, M., Lucht, W. L., & Cramer, W. (2013, March 26). *Spatial decoupling of agricultural production and consumption: quantifying dependences of countries on food imports due to domestic land and water constraints*. IOP Science. <https://iopscience.iop.org/article/10.1088/1748-9326/8/1/014046>
- Fermin, F. V. (2001). *Backyard integrated pig-fish culture in the Philippines*. Integrated Agriculture-Aquaculture: A Primer. <https://www.fao.org/3/y1187e/y1187e17.htm>
- Ferreira, G. F., & Critelli, J. A. (2023, May 19). *Taiwan’s Food Resiliency—or Not—in a Conflict with China*. United States Army War College Press. <https://press.armywarcollege.edu/cgi/viewcontent.cgi?article=3222&context=parameters>
- Gardner, Timothy. “Biden Admin Greenlights LNG Exports from Alaska Project.” *Reuters*, April 14, 2023. <https://www.reuters.com/business/energy/biden-admin-greenlights-lng-exports-alaska-project-document-2023-04-14/>.

- “GIIGNL 2022 Annual Report.” International Group of Liquefied Natural Gas Importers , October 5, 2022. <https://giignl.org/document/giignl-2022-annual-report/>.
- Global Energy Monitor. “Hsieh-HO FSRU.” Global Energy Monitor, February 21, 2023. https://www.gem.wiki/Hsieh-Ho_FSRU.
- Hou, B., & Stapczynski, S. (2022, August 25). Chipmaking’s Next Big Thing Guzzles as Much Power as Entire Countries. Bloomberg.com. <https://www.bloomberg.com/news/articles/2022-08-25/energy-efficient-computer-chips-need-lots-of-power-to-make>
- Kemp, R. S. (n.d.). Strategic fuel reserves - MIT: Laboratory for nuclear security and policy. Laboratory for Nuclear Security and Policy. <http://lnsp.mit.edu/strategic-fuel-reserves>
- Kao, Jeanny, and Yimou Lee. “Nation to Boost Energy Inventories, Official Says.” Taipei Times, October 24, 2022. <https://www.taipeitimes.com/News/biz/archives/2022/10/25/2003787649>.
- Kung, Johnson. “A Better Approach to LNG Projects.” Taipei Times, February 21, 2023. <https://www.taipeitimes.com/News/editorials/archives/2023/02/22/2003794810>.
- Kuo , Chien-shen, and Evelyn Kao. “Taiwan’s Fuel Inventory Adequate during China’s Military Drills: Minister .” Focus Taiwan - CNA English News, April 10, 2023. <https://focustaiwan.tw/business/202304100012>.
- Lai, T., & Blaustein, L. (2020, April 13). *Taiwan Confident in Food Stocks as COVID-19 Disrupts International Trade*. USDA Foreign Agricultural Service. <https://www.fas.usda.gov/data/taiwan-taiwan-confident-food-stocks-covid-19-disrupts-international-trade>
- Lee, W. (2011, March 3). *Promoting self-sufficiency in food*. Taipei Times. <https://www.taipeitimes.com/News/editorials/archives/2011/03/04/2003497297>
- Li, Lauly, and Ting-Fang Cheng. “Taiwan’s Frequent Blackouts Expose Vulnerability of Tech Economy.” Nikkei Asia, August 30, 2022. <https://asia.nikkei.com/Business/Technology/Taiwan-s-frequent-blackouts-expose-vulnerability-of-tech-economy>.
- Lin, Ching-hua, and William Hetherington. “Taipower Aims to Increase Coal Storage.” Taipei Times, January 22, 2023. <https://www.taipeitimes.com/News/front/archives/2023/01/23/2003793032>.
- Management of Oil Security Stockpile*. 經濟部能源局(Bureau of Energy, Ministry of Economic Affairs, R.O.C.)全球資訊網. (2023, February 21). https://www.moeaboe.gov.tw/ECW/english/content/Content.aspx?menu_id=8675
- McGillis, Jordan. “Taiwan’s Electrical Grid and the Need for Greater System Resilience.” Global Taiwan Institute, June 14, 2023. <https://globaltaiwan.org/2023/06/taiwans-electrical-grid-and-the-need-for-greater-system-resilience/>.
- McGillis, J., & Oung, A. (2022, December 19). Taiwan’s nuclear option. The Breakthrough Institute. <https://thebreakthrough.org/journal/no-18-fall-2022/taiwans-nuclear-option>
- Oung, Angelica. “CPC Inks 15-Year Deal with Qatar to Purchase LNG.” Taipei Times, July 7, 2021. <https://www.taipeitimes.com/News/biz/archives/2021/07/08/2003760466>.
- Oung, Angelica. “How Can Taiwan Avoid an Energy Crisis?” AmCham Taiwan, May 9, 2022. <https://topics.amcham.com.tw/2022/05/how-can-taiwan-avoid-an-energy-crisis/>.

- Oung, Angelica. “Fixing Taiwan’s Grid Issues Requires Redistribution.” Taiwan Business TOPICS, May 9, 2022. <https://topics.amcham.com.tw/2022/05/fixing-taiwans-grid-issues-requires-redistribution/>.
- Ministry of Agriculture, E. Y. (n.d.). *Comprehensive Self-Sufficiency Ratio- Measured by Calorie*. Ministry of Agriculture, Executive Yuan, R.O.C.(Taiwan). <https://eng.moa.gov.tw/ws.php?id=2505449>
- Ministry of Economic Affairs, B. of E. (2022, March 30). Energy Statistics Handbook- Sources of Imported Coal. 經濟部能源局(Bureau of Energy, Ministry of Economic Affairs, R.O.C.)全球資訊網. https://www.moeaboe.gov.tw/ECW_WEBPAGE/FlipBook/2021EnergyStaHandBook/index.html#p=135
- Reddy, J. (2022, February 20). *The best fertilizer for rice crop: Organic, NPK, and schedule for paddy*. Agri Farming. <https://www.agrifarming.in/the-best-fertilizer-for-rice-crop-organic-npk-and-schedule-for-paddy>
- Smith, Christopher E. “CPC Begins Taichung Phase III LNG Terminal Expansion.” Oil & Gas Journal, July 18, 2022. <https://www.ogj.com/pipelines-transportation/lng/article/14279843/cpc-begins-taichung-phase-iii-lng-terminal-expansion>.
- Smith, M. (2022, September 4). Taiwan open to buying Australian exports banned in China. Australian Financial Review. <https://www.afr.com/world/asia/taiwan-open-to-buying-australian-exports-banned-in-china-20220904-p5bf8u>
- Spector, J. (2023, April 6). *Taiwan’s rapid renewables push has created a bustling battery market*. Canary Media. <https://www.canarymedia.com/articles/energy-storage/taiwans-rapid-renewables-push-has-created-a-bustling-battery-market>
- Taipei Times. (2022, July 24). *Renewables to fall short of 2025 target, report says*. <https://www.taipeitimes.com/News/biz/archives/2022/07/25/2003782352>
- Taiwan News. (2021, May 14). *Government soothes fears, says Taiwan has 6 months of food supplies*. Taiwan News. <https://www.taiwannews.com.tw/en/news/4203406>
- Thomson Reuters. (n.d.). *About Taiwan Fertilizer Co Ltd*. Reuters. <https://www.reuters.com/markets/companies/1722.TW/>
- Tsuge , Mamoru. “Japan’s JFE Engineering Wins \$230M Order for Taiwan LNG Terminal.” Nikkei Asia, March 27, 2023. <https://asia.nikkei.com/Business/Engineering-Construction/Japan-s-JFE-Engineering-wins-230m-order-for-Taiwan-LNG-terminal>.
- Waksman, I. (2023, March 2). *Russian gas contracts won’t be renewed: Fuel Provider - RTI*. RTI Radio Taiwan International. <https://en.rti.org.tw/news/view/id/2009088>
- Wang, C. (2022, March 29). *Taiwan Vows \$32 Billion Clean Energy Spree as It Lags on Targets*. Bloomberg. com. <https://www.bloomberg.com/news/articles/2022-03-30/taiwan-vows-32-billion-clean-energy-spree-as-it-lags-on-targets>
- Wang, Flor, and Kuei-hsiang Wen. “Tsai Reiterates 2025 Nuclear-Free Goal.” Focus Taiwan - CNA English News, June 7, 2023. <https://focustaiwan.tw/politics/202306060021>.
- Wang, L. (2022, August 3). *Energy supplies sufficient, ministry says*. Taipei Times. <https://www.taipeitimes.com/News/biz/archives/2022/08/04/2003782917>

- Webster, J. (2023, July 7). *Does Taiwan's massive reliance on energy imports put its security at risk?* Atlantic Council. <https://www.atlanticcouncil.org/blogs/new-atlanticist/does-taiwans-massive-reliance-on-energy-imports-put-its-security-at-risk/>
- Wu, S. (2023, May 10). *Focus: Taiwan's wind industry braves cross-strait risks in clean energy boom.* Reuters. <https://www.reuters.com/business/energy/taiwans-wind-industry-braves-cross-strait-risks-clean-energy-boom-2023-05-10/>
- Yeh , Su-ping, Hing-kao Wang , Evelyn Kao, and Shih Hsiu-chuan. "Nuclear an Option to Meet Energy Needs: KMT Presidential Candidate ." Focus Taiwan - CNA English News, May 31, 2023. <https://focustaiwan.tw/politics/202305300014>.
- Yep, Eric, Christel Goh, and Ivy Yin. "Taiwan's CPC Seeks 14 LNG Cargoes for One Year amid Worsening Drought." S&P Global Commodity Insights, March 13, 2023. <https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/energy-transition/031323-taiwans-cpc-seeks-14-lng-cargoes-for-one-year-amid-worsening-drought>.
- "Yung-an LNG Terminal." Global Energy Monitor, February 22, 2023. https://www.gem.wiki/Yung-An_LNG_Terminal.



Center for Excellence in Disaster Management & Humanitarian Assistance
456 Hornet Avenue, Building 76, Joint Base Pearl Harbor - Hickam, Hawaii 96860-3503
Telephone: 808.472.0518 | DSN: 315.472.0518
<https://www.cfe-dmha.org>

  @cfedmha