



Investment Opportunities and Risks in Taiwan Electricity Market

Liutong Zhang (Lucas), lzhang@waterrockenergy.com, +852 9365 8216
Director, WaterRock Energy Economics

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Executive summary: Tight supply and demand situation with focus on sustainability presents opportunities for investment

Market Characteristics

- Energy policy is formulated at the highest level of government, and the current government has ambitious RE targets
- The power market has been tight since 2015; and phasing out nuclear can potentially lead to resource adequacy issue
- Taipower will continue to dominate the electricity market even though market liberalization is being slowly rolled out since 2017
- Economic dispatch is used in Taiwan
- RE energy is subsidized, funded via a surcharge on non-RE power sale.

Investment Opportunities

- Opportunities are plenty and diverse in Taiwan, as it shifts its fuel mix towards RE and gas
 - To meet growing demand (400-800 MW each year) and replace about 12 GW of old nuclear and thermal capacity in 2018-2025, which presents strong financing needs for new capacity and gas infrastructure
 - To leverage on the relatively favorable RE policies for solar and offshore wind expansion to meet the ambitious RE targets [20 GW for solar and 6.9 GW for wind by 2025]; RE could become even more important if construction of new LNG terminal(s) face delays
 - To capture potential opportunities of new IPP projects if construction of Taipower capacity or new LNG terminal infrastructure is delayed.

Investment Risks

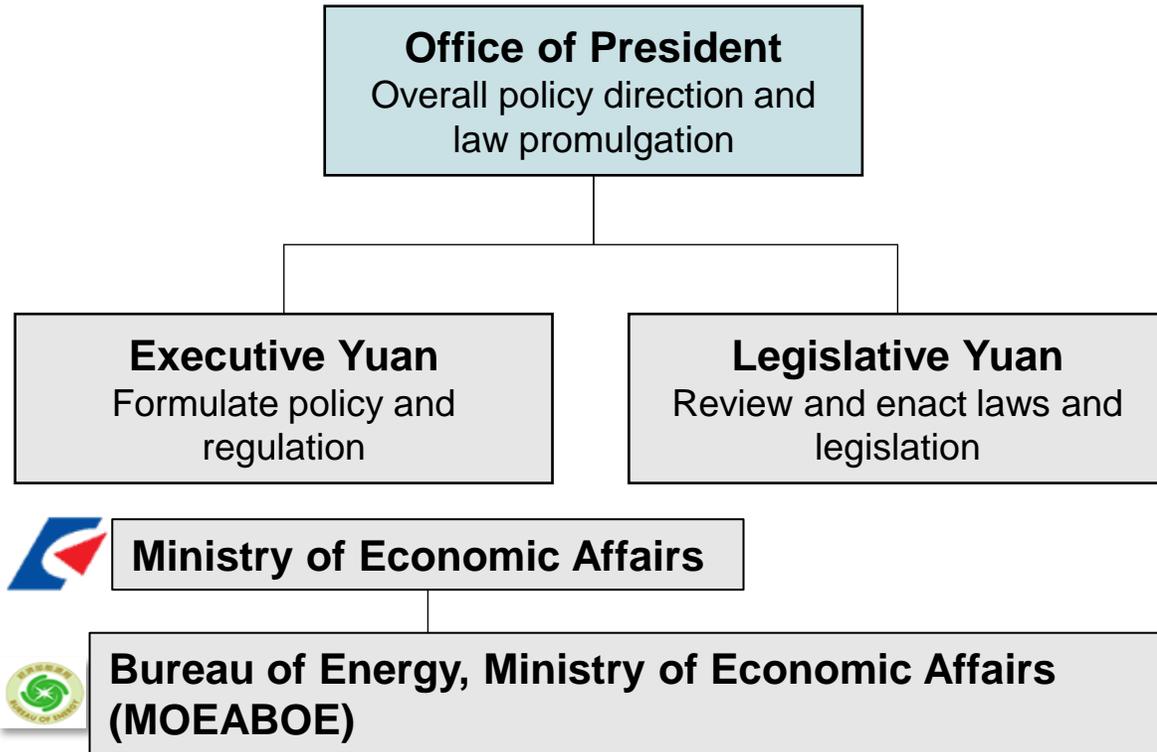
- It is unclear how Cost Competitiveness and Environmental Sustainability will be reconciled in Taiwan. Profitability of Taipower may be further squeezed and there is a risk that it may have to revise its legacy contracts with power developers
 - Taipower re-negotiated the original 25-year PPAs with the IPPs in 2013 to lower the cost of power purchase, partly due to inability to pass-on cost to customers
- There are several other potential risks, including credit-risk of off-takers after market liberalization, curtailment risk, construction and exchange rate risk etc

Outline

- 1 Market Characteristics of Taiwan Electricity Sector**
- 2 Investment Opportunities in Taiwan Electricity Sector
- 3 Investment Risks in Taiwan Electricity Sector
- 4 Appendix - Introduction to WaterRock Energy Economics

Energy policy is formulated at the highest level of government, and the current government has ambitious RE and nuclear-free targets

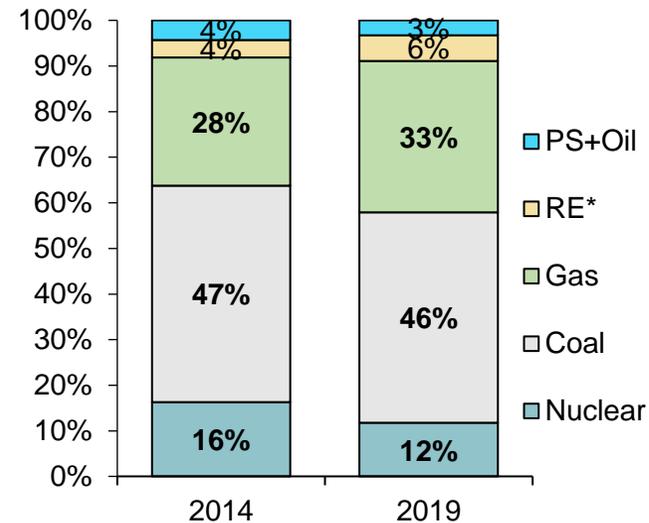
Key Government Agencies in Taiwan Energy Sector



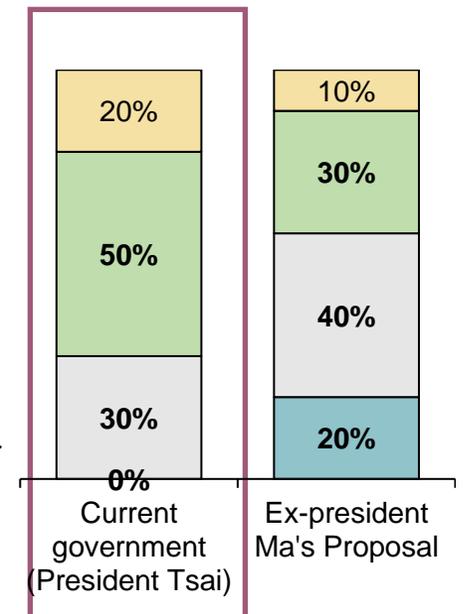
MOEABOE is responsible for implementing energy-related policy and regulation, and collating market data and providing Power Development Plans

- The Office of President provides input on key energy policies such as market reform, renewable policies and time-line to phase out nuclear power.
- The current government, Democratic Progressive Party (DPP), targets **30% coal, 50% gas and 20% renewables** and **0% nuclear** in 2025.

Fuel Mix in 2014 and 2019



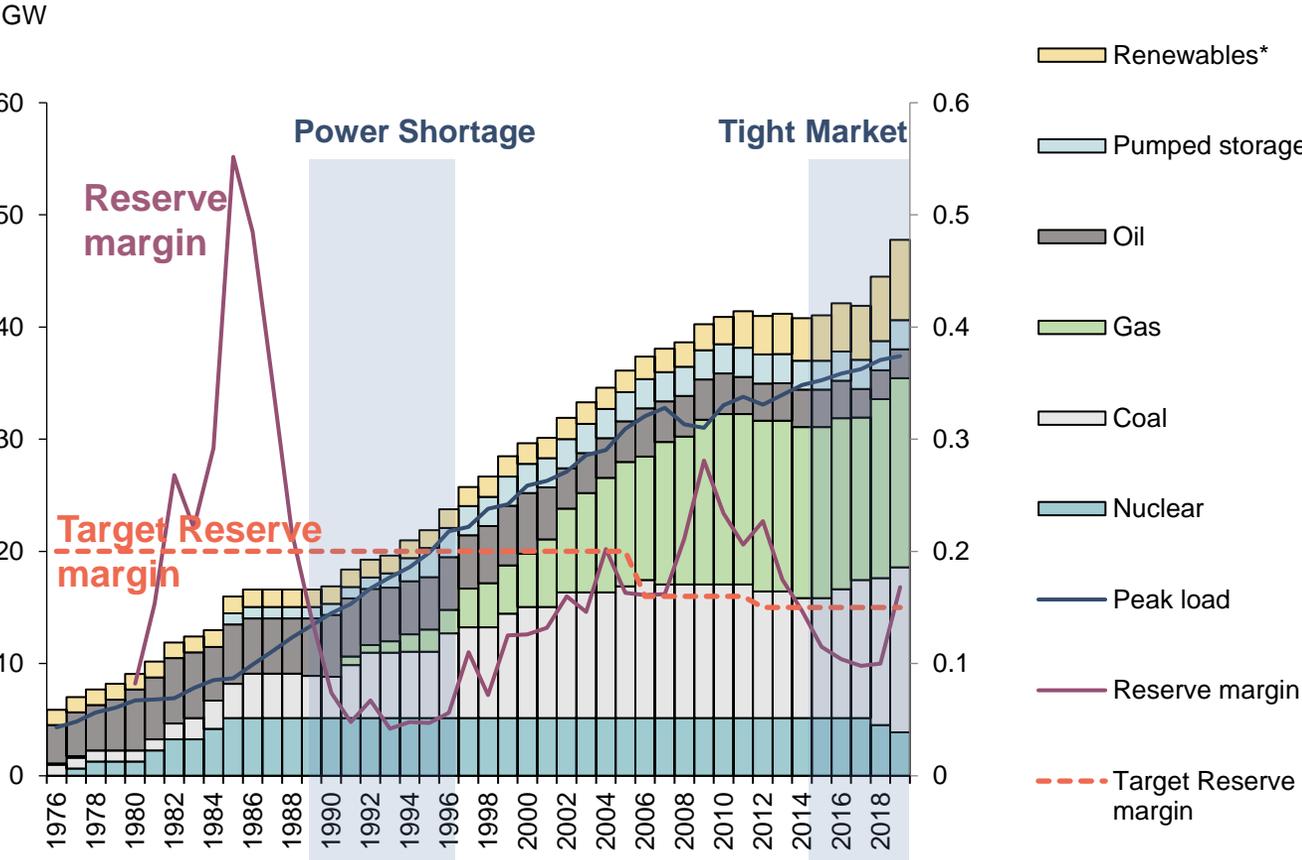
2025 Generation Targets



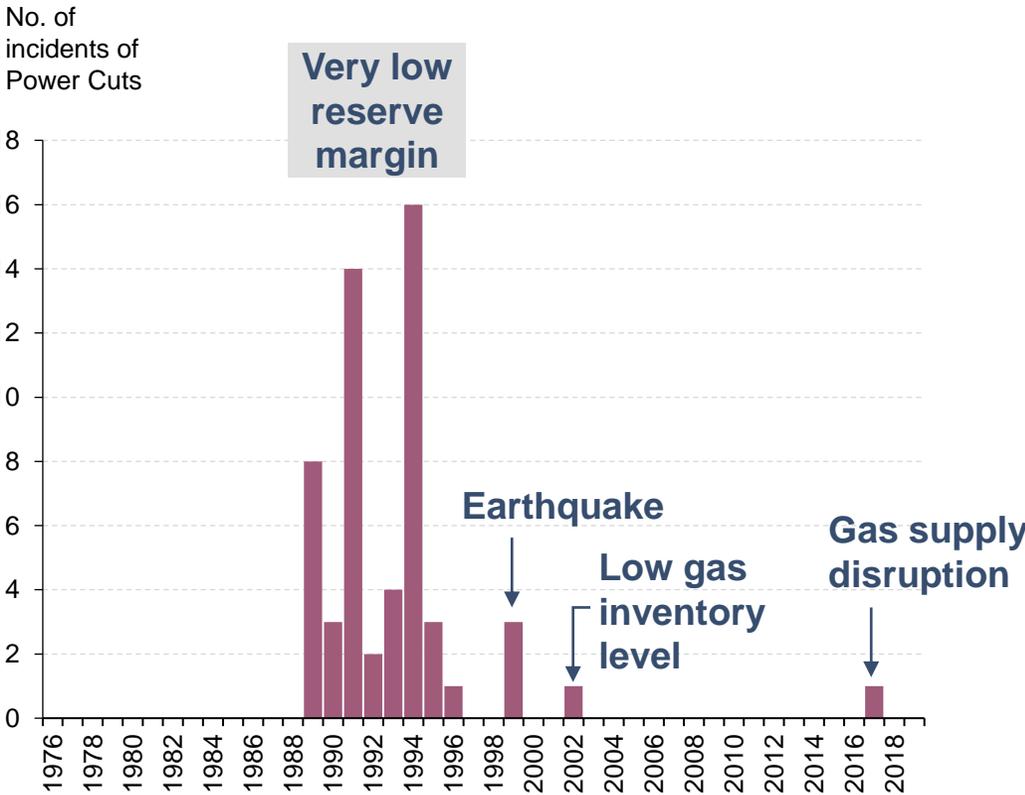
Note: * In Taiwan, RE includes conventional hydro, wind, solar, biomass and waste.

The power market has been tight since 2015; and phasing out nuclear quickly can potentially lead to resource adequacy issue

Supply and Demand Fundamental in Taiwan (Taipower System)



No. of Incidents of Power Cuts

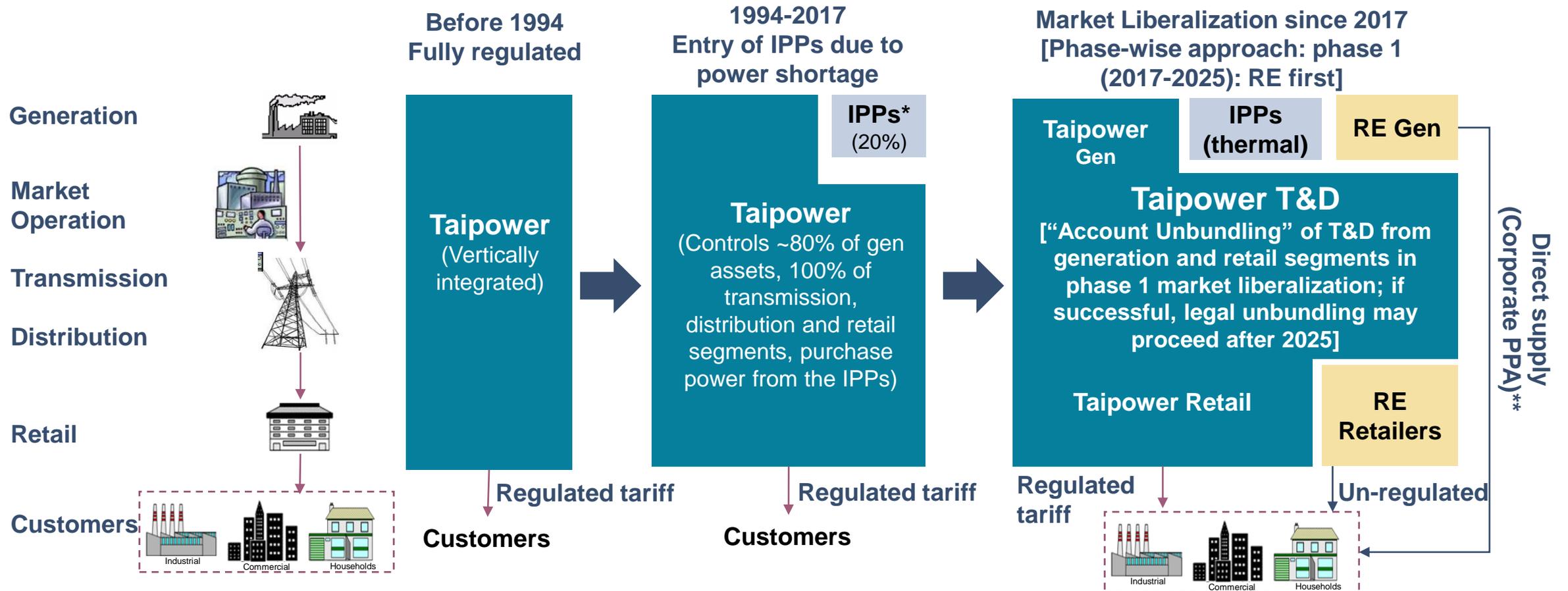


*Note: Renewables include conventional hydro, wind and solar under MOEABOE's definition. The installed capacity does not include co-gens.

Source: MOEABOE, Taipower WaterRock Energy Research and Analysis

Taipower will continue to dominate the electricity market even though market liberalization is being slowly rolled out since 2017

Electricity Market Structure in Taiwan

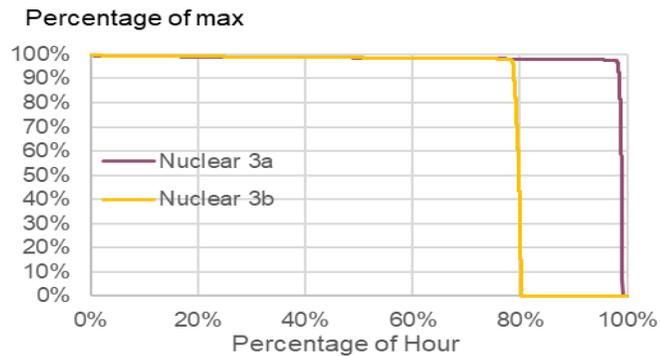


Note: *Thermal IPPs supply power to Taipower on 25-year power purchase agreements with capacity and energy payment. ** It is reported that Google signed a long-term corporate PPA with a 10 MW solar project in Tainan early 2019. The successful implementation of T&D tariff setting and third-party access for T&D lines are critical to enable RE gen/retailer to directly sell to customers. There is also a discussion to set up a power exchange to facilitate the contractual negotiation between RE generators/retailers and customers, and may be used as a platform for trading in ancillary service and imbalance in energy market

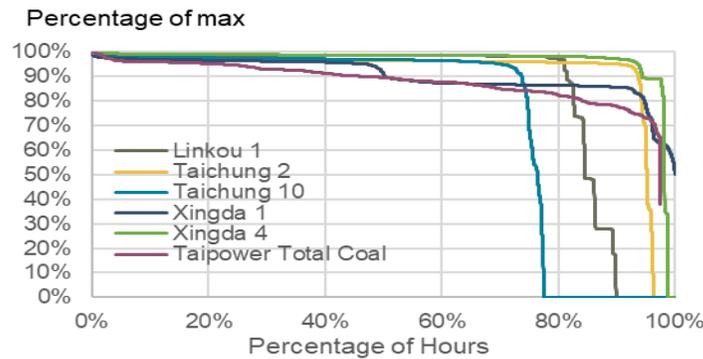
Economic dispatch is adopted, with nuclear and coal as base-load, gas as mid-merit and pumped storage/oil as peaking

Generation Unit Dispatch-duration Curve (Taipower system)

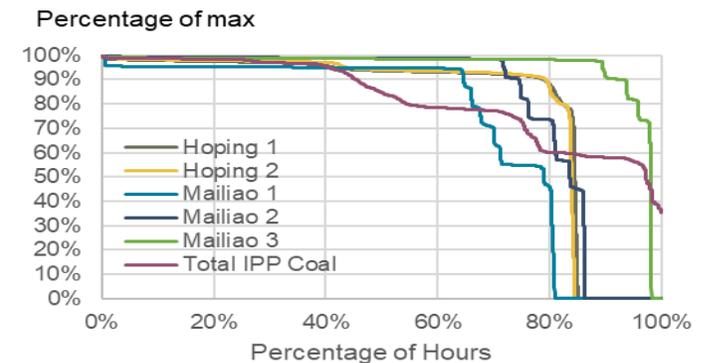
Nuclear (Base-load)



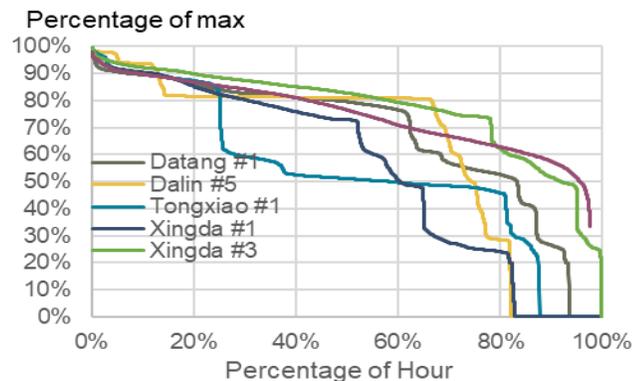
Taipower Coal (Base-load)



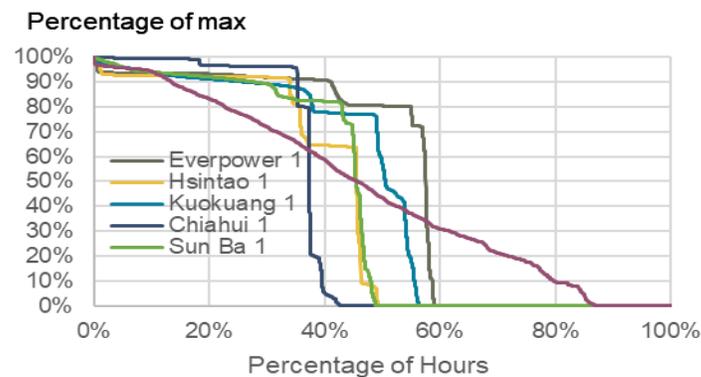
IPP Coal (Base-load)



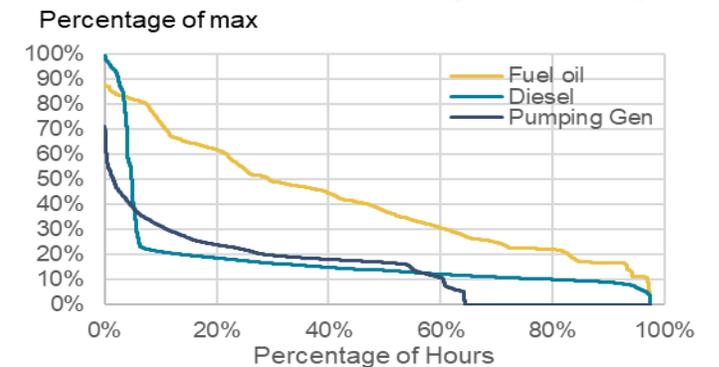
Taipower LNG (Mid-merit)



IPP LNG (Mid-merit)



Oil and pumped storage (peaking)

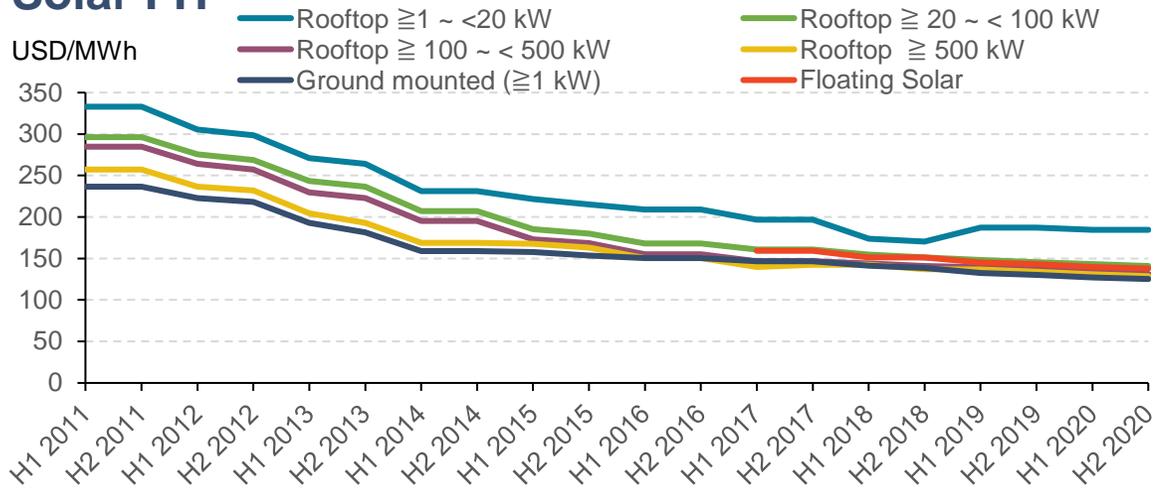


Note: Unit commitment is currently based on manual rough scheduling, and Taipower uses Siemens' Energy Management System (EMS) to do Economic Dispatch (ED), which can automatically send up/down commands according to the cost of power generation. Sometimes, coal plant generation needs to be reduced to meet environmental and water constraints. Taipower plans to introduce Market Management System (MMS) to do Security Constrained Economic Dispatch (SCED) in 2023.

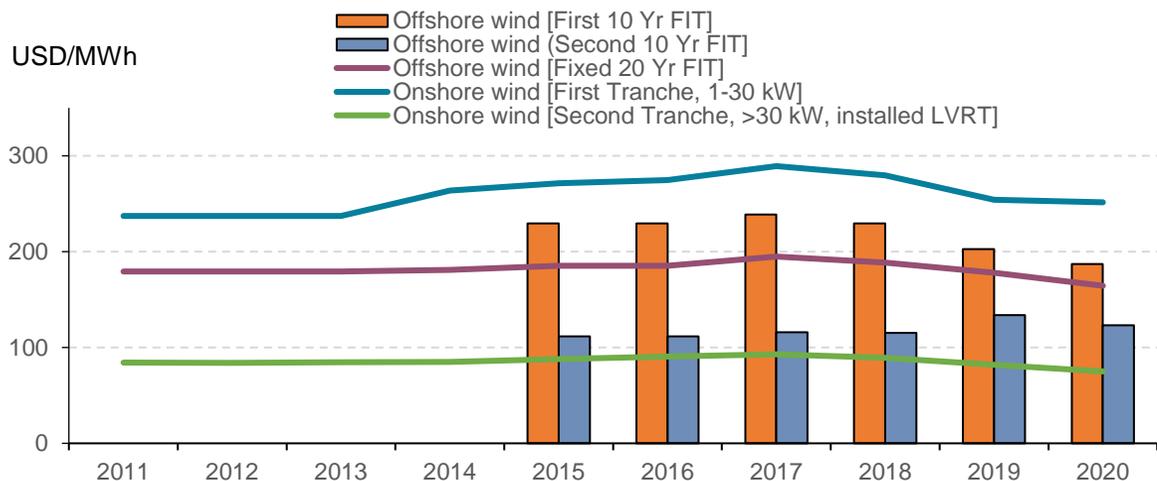
Source: MOEABOE, Taipower, WaterRock Energy Research and Analysis

Based on the Renewable Energy Development Act, RE energy is subsidized, funded via a surcharge on non-RE power sale

Solar FIT



Wind FIT



Subsidies and Funding

- FIT is reset annually for new projects
- Solar resources can obtain a fixed feed-in tariff set based on their commissioning date by entering a 20 years PPA with Taipower
- Competitive auction is used for round 2 offshore wind projects; rules and regulation are being drafted for round 3.
- Funding of feed-in tariff is from a surcharge on non-RE power sale (which is annually adjusted).

Transmission connection

- RE investors can apply for the construction of new grid infrastructure
- Cost of bolstering the power grid in addition to the existing networks may be shared by RE investor and Taipower. The cost-sharing mechanism shall be provided by Taipower and shall be submitted to the Taiwanese government for approval. The government may invite relevant government agencies, scholars and experts, and organizations to form a committee to review the cost-sharing mechanism.

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Opportunities are plenty and diverse in Taiwan, as it shifts its fuel mix towards renewables and natural gas

Opportunities

a

To meet growing demand and displace old technology

Market Context

- Historical demand growth in about 2 percent in the past decade; and future demand growth is expected to be 1-2 percent each year. **Incremental capacity to meet growing demand is expected to 400-800 MW**
- The current Taiwan government plans to **completely phase out nuclear capacity (totaled 5.1 GW)** by 2025; replacement is from new gas, solar and wind projects
- **Nearly 6 GW of oil, gas and coal capacity will reach their economic life in 2020-2025**, and they would need to be replaced with more efficient gas capacity or renewable capacity
- Taipower may call for another round of IPP projects if it faces power shortage in the coming years.

b

To leverage on RE policy for RE investment

- The current Taiwan government has ambitious RE target, to increase its generation mix from 5% in 2018 to 20% in 2025 with **solar target set at 20 GW and wind target set at 6.9 GW by 2025**
- Relatively favorable policies are adopted to incentivize RE capacity expansion
- Investors for solar and offshore projects could be interested to sell equity stake in their projects to diversify their risk.

c

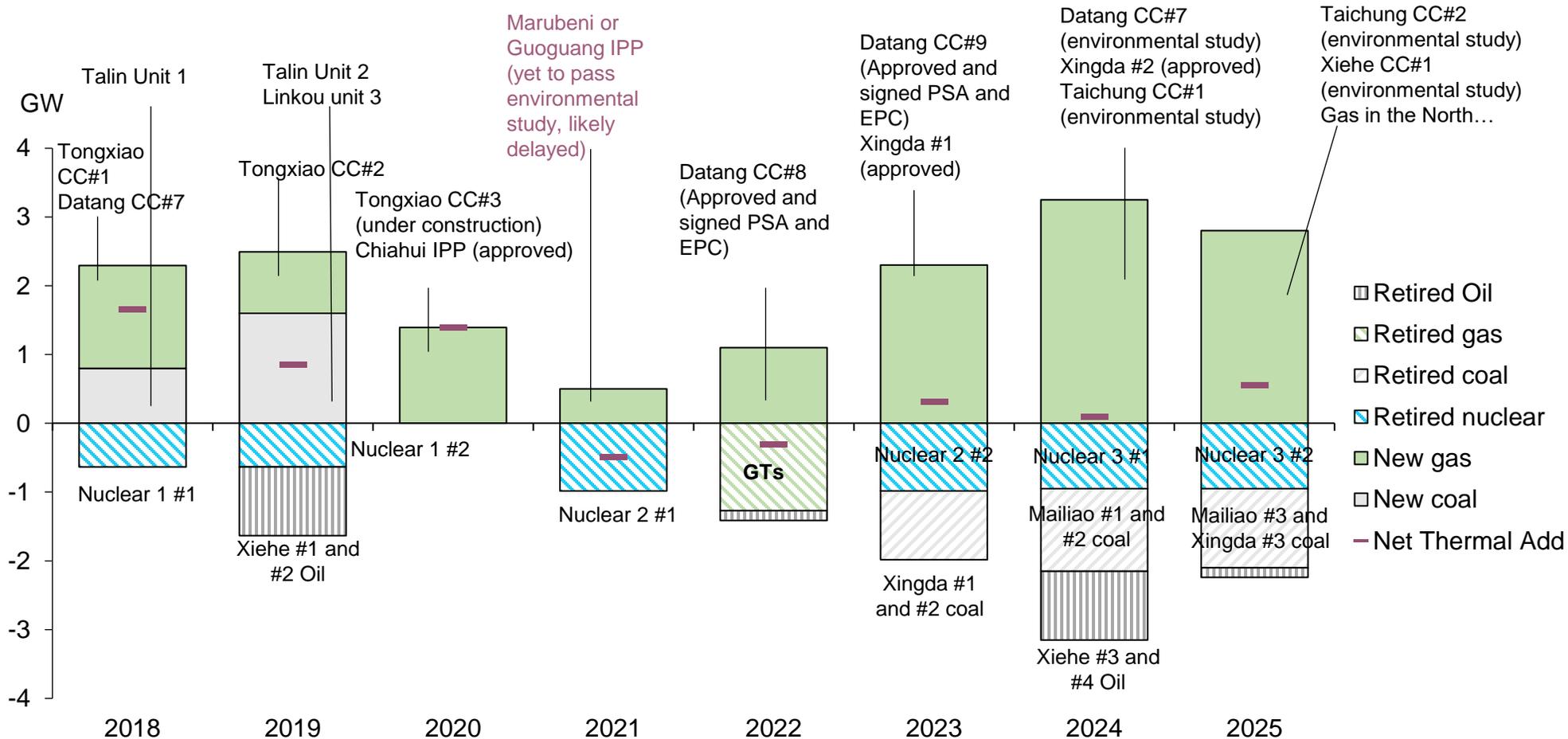
Special projects

- Cost of renewable technologies (such as battery energy storage) continues to fall, and thus they are likely to be economical for more applications in the power sector.

a

To meet growing demand and replace old capacity New capacity and gas infrastructure needs to be financed/built soon, or the Taiwan power market could experience power shortage after 2022

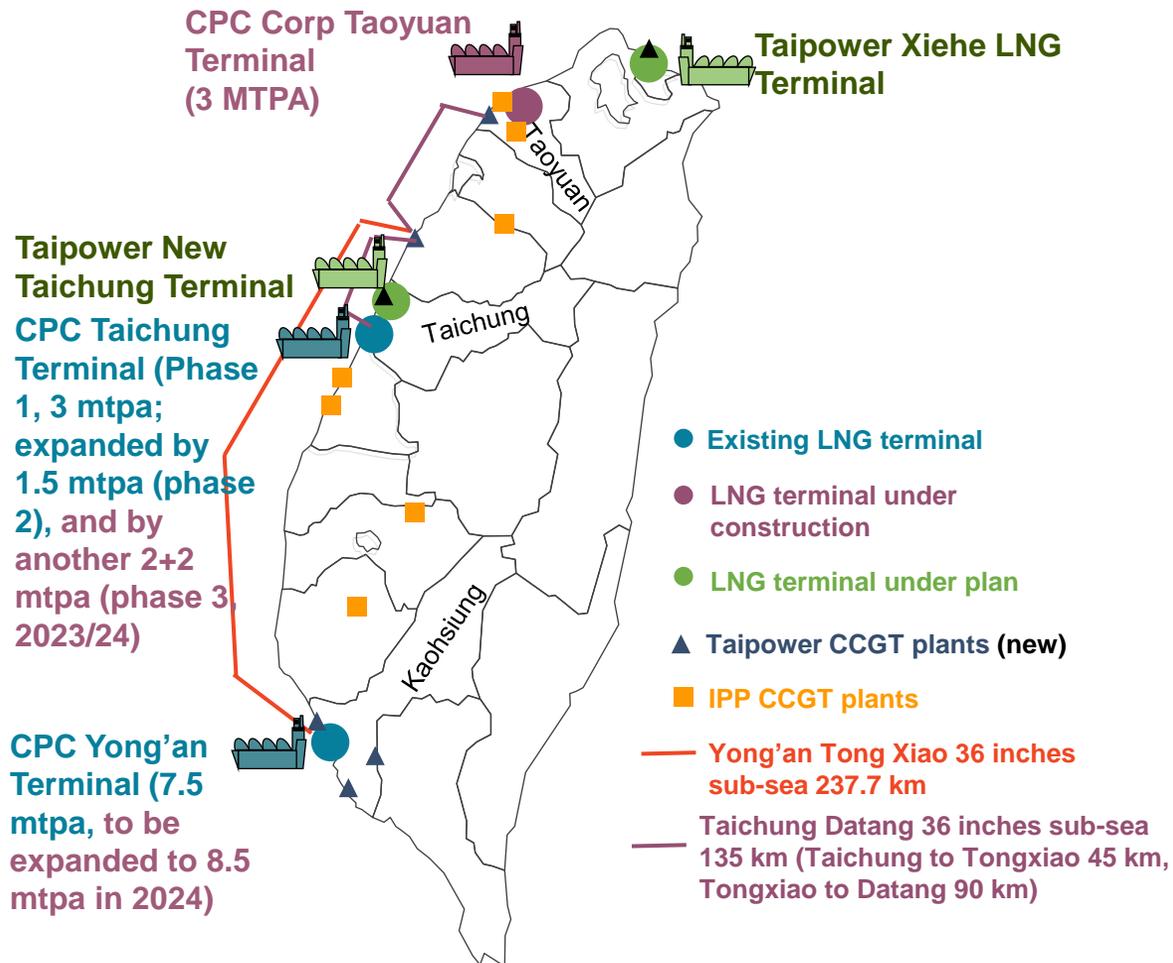
Capacity Addition and Retirement Schedule For Conventional Generation Plants (2018 Power Development Plan (PDP))



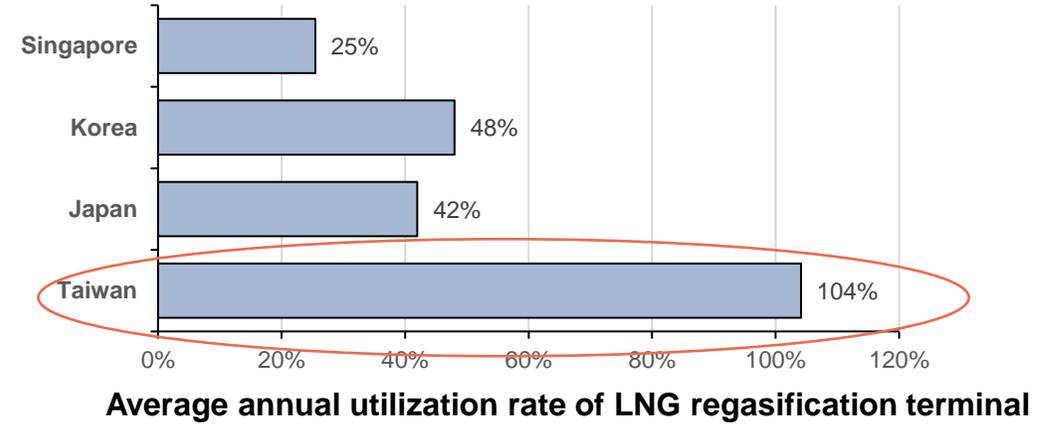
- In 2018-2025, Taiwan schedules to retire 5.1 GW of nuclear and 6.9 GW thermal capacity
- 2.4 GW of new coal is commissioned in 2018-19; it also aims to build 13.7 GW new CCGT capacity in 2018-25, and two more new LNG terminals.

a To meet growing demand and replace old capacity
Slow LNG terminal infrastructure built-up can become a material risk for gas supply to meet higher gas consumption in the power sector

Key Gas Infrastructure and CCGT Plants



Gas Infrastructure Bottleneck in Taiwan



- Taiwan LNG demand is 15.6 mtpa in 2019, of which about 80 percent is from the power sector. Nominal terminal capacity is about 15 mtpa. The LNG terminals have been operating full or slightly exceed its nominal capacity for most of the months since 2015
- Obtaining approval for environmental impact studies to expand existing and build new terminals usually face delays because of strong environmental lobby in Taiwan
- Risk of insufficient terminal capacity to meet LNG importation requirement is real as gas generation is expected to be increased by 60% in 2025 from 2019 level.

**a To meet growing demand and replace old capacity
Most of the IPP contracts will expire in 2024-2030, and their extension will depend on the progress of new projects**

Taiwan Thermal IPP

	NAME	Owners	Fuel Type	CAP	START YR	Expiry year
1st phase of IPP (1995)	Mailiao	Formosa Group	Coal	1,800	1999	2024
	Hoping	Taiwan Cement Corp (59.5%), CLP	Coal	1,297	2002	2027
	Everpower	Singapore Power (25%), Marubeni (40%) and other IPPs	LNG	900	2000	2025
	Chiahui	Far Eastern Group, Asia Cement Corp, J-Power	LNG	670	2003	2028
2nd phase (1996)	Hsintao	Marubeni (83.2%)	LNG	600	2002	2027
3rd phase (1999)	Kuokuang	CPC (65%), Taiwan Cogen Corp (35%)	LNG	480	2003	2028
	Star Energy	Taiwan Cogen Corp	LNG	490	2004	2029
	Starbuck	Taiwan Cogen Corp	LNG	490	2009	2034
	Sun Ba	Taiwan Cogen Corp	LNG	980	2004	2029
2017-2019*	Chiahui IPP#2	Asia Cement Corp, Far Eastern Group, J-Power	LNG	500	2020 (expected)	Every 10 Yr
	500 MW IPP	Failed round in 2018/19 (likely Marubeni Hsintao #2 or Kuokuang #2)	LNG	500	2021 (delayed)	Every 10 Yr

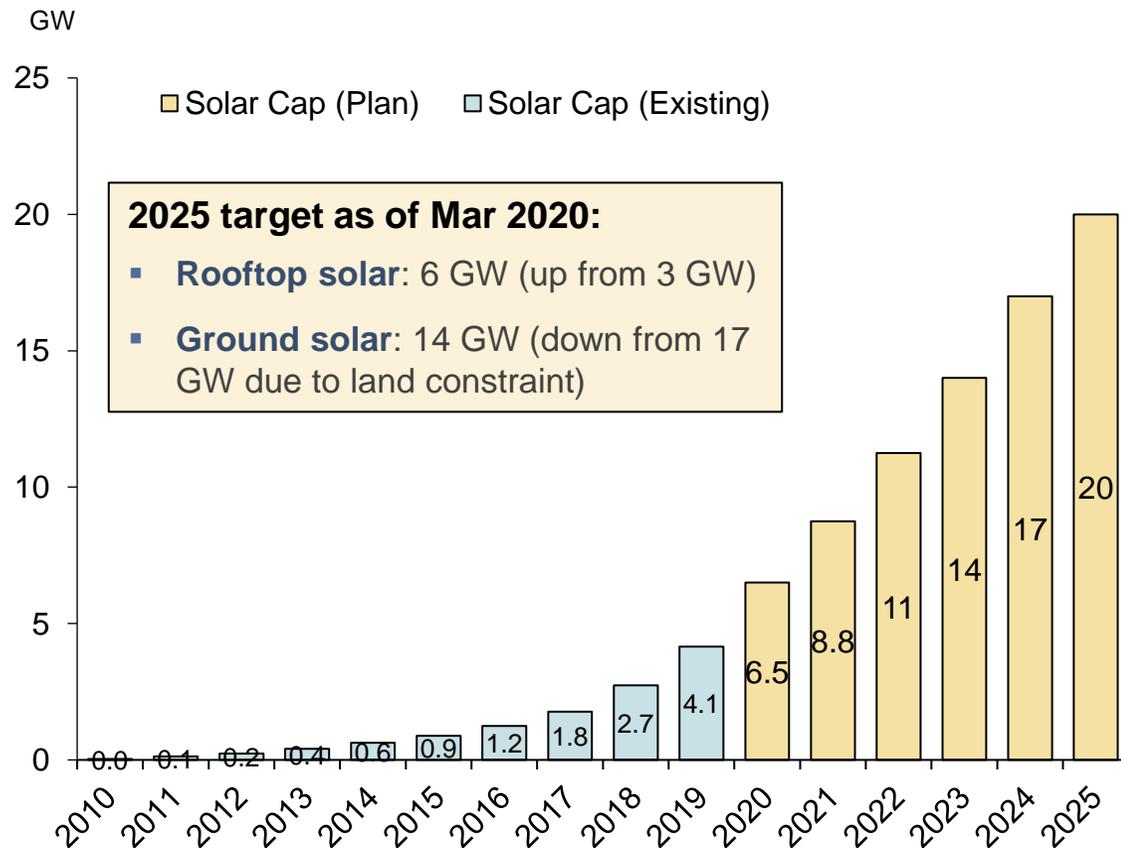
- Existing PPAs of the IPP thermal projects are mostly expiring in 2024-2030
- After the change in the Electricity Act (EA) in 2017, the MOEABOE only determines the required reserve margin and Taipower can determine whether to source power from IPPs; **the new PPAs will be renewed every 10 years**
- For the 2nd 500 MW IPP capacity to be commissioned in 2021, the tendering has failed three times because expansion capacity could not obtain the approval on their Environmental Feasibility Study.

*Note: Another possible IPP capacity is the repowering of the existing Mailiao coal plant (3x600 MW) to gas-fired power plant (2x900 MW) in 2025, Formosa has signed MOU with Yunlin government.
Source: MOEABOE, Taipower

b Opportunities to Invest in Solar Projects

There are more opportunities for solar investment with relatively high FIT and ambitious plan to expand capacity from 4 GW in 2019 to 20 GW in 2025

Installed Capacity of Solar Projects

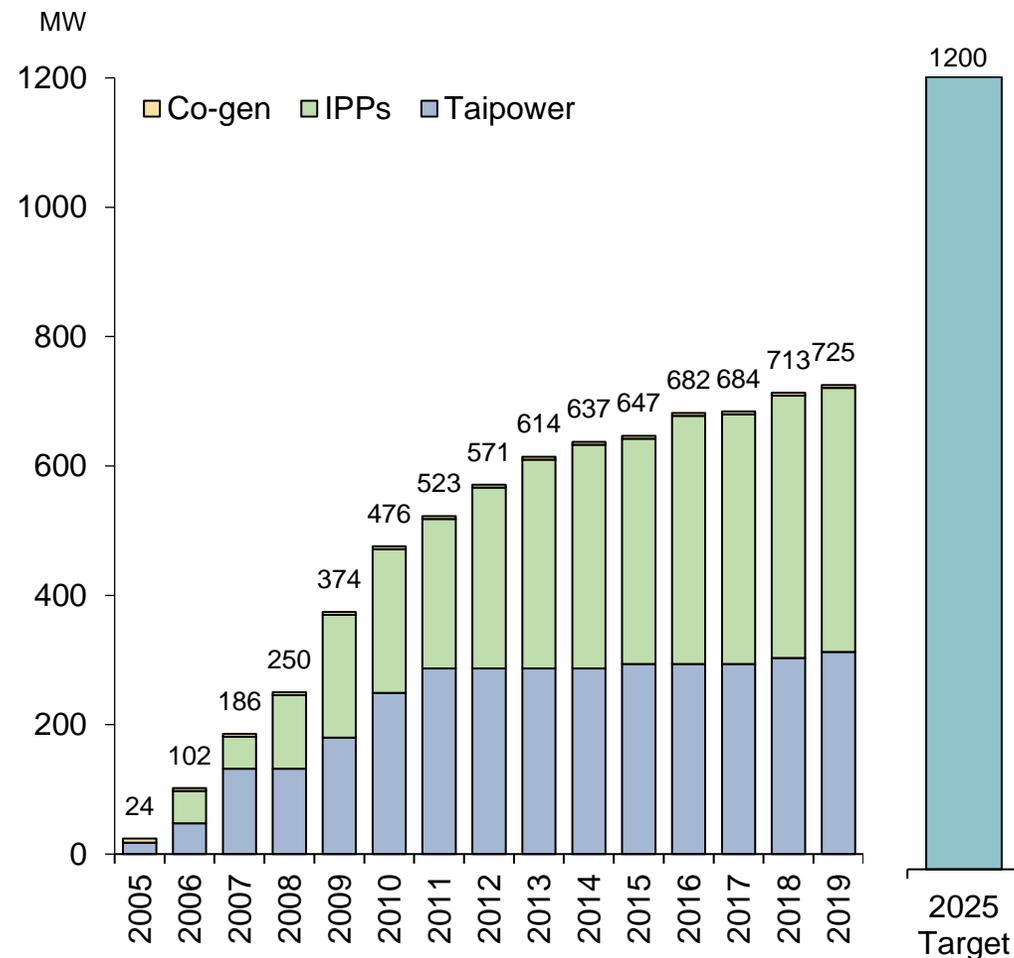


- Solar expansion in Taiwan has been largely on track with the government's plan, thanks to relatively generous feed-in-tariff with 20-year contracts
 - FIT is still more than 12 US cents/kWh for plants to be commissioned in H2 2020, and only down by 20-30 percent from the level in 2014*
- Land is a key hurdle for developing solar in Taiwan
 - Negotiation with multiple land owners is often required, which materially complicated the process
- Foreign investors are relatively active in investing in solar
 - Vena Energy (formerly Equis) has invested in multiple projects, one of which is a 70 MW solar farm in Chiayi
 - I Squared Capital developed over 500 MW solar capacity with local partners, and it sold its equity share (270 MW solar) to Marubeni on Feb 27, 2020. One of the flagship projects is a 180 MW floating solar farm in Zhangbin industrial park.

*Note: The high feed-in tariff is partly because of relatively low expected generation hour of solar in Taiwan (about 1250 in South Taiwan and 900 in North Taiwan) and small project size due to availability of land.

b Opportunities to Invest in Onshore Wind Projects
 Developing onshore wind projects in Taiwan is challenging due to difficulty of obtaining environmental approval and availability of suitable sites

Installed Capacity of Onshore Wind Plants



- Feed-in tariff for 20 years is provided, which is set at 0.75 RMB/kWh for >30 kW plants commissioned in 2020
- Installed capacity is about 725 MW in 2019 and the target is 1.2 GW by 2025
- **Key challenges** of the **onshore** wind projects are:
 - **Stringent environmental requirements** lead to a complicated and prolonged application and approval process
 - ❖ Migrating birds & ocean mammals and
 - ❖ Local fishery, navigation and harbor development
 - **Bankability.** Projects located on government-owned land are given a nine-year lease, which may be renewed provided certain requirements are satisfied. This likely constrains limited or non-recourse financing to a period less than the lease term.

b Opportunities to Invest in Offshore Wind Projects

Taiwan government has a 3-phase strategy to develop the offshore wind industry

1

Demonstration Program (2016-2020)

Only one project is built

- In 2013, the government awarded three demonstration projects
 - **128 MW** project in Miaoli by Formosa Wind Power Corp [a consortium of Macquarie Capital (50%), Orsted (35%) and Swancor (15%)]. Phase I (2*4 MW) was commissioned in May 2017 and phase II (120 MW) was commissioned in end 2019
 - 108 MW project in Changhua by Fuhai Wind Farm Corp, a subsidiary of Taiwan Generation Company. It could not obtain approval for its environmental impact study as the site is near to a dolphin habitat and protected reefs and there are also local issues with fishery community. It is reported that it re-started its application to obtain environmental approval in Mar 2019.
 - 108-110 MW (22 turbines) project in Changhua by Taipower, **Project stalled due to fisheries compensation issues.**

2

Zones of Potential (2019-2025)

5.5 GW capacity is auctioned

- It has identified 36 Zones of Potential with a total area of 3,084 km²
- 18 projects obtained clearance for Environmental Impact Assessment (EIA) and has completed competitive auction for 5.5 GW offshore wind projects; it also targets to commission those projects by 2025, although project delay is likely.

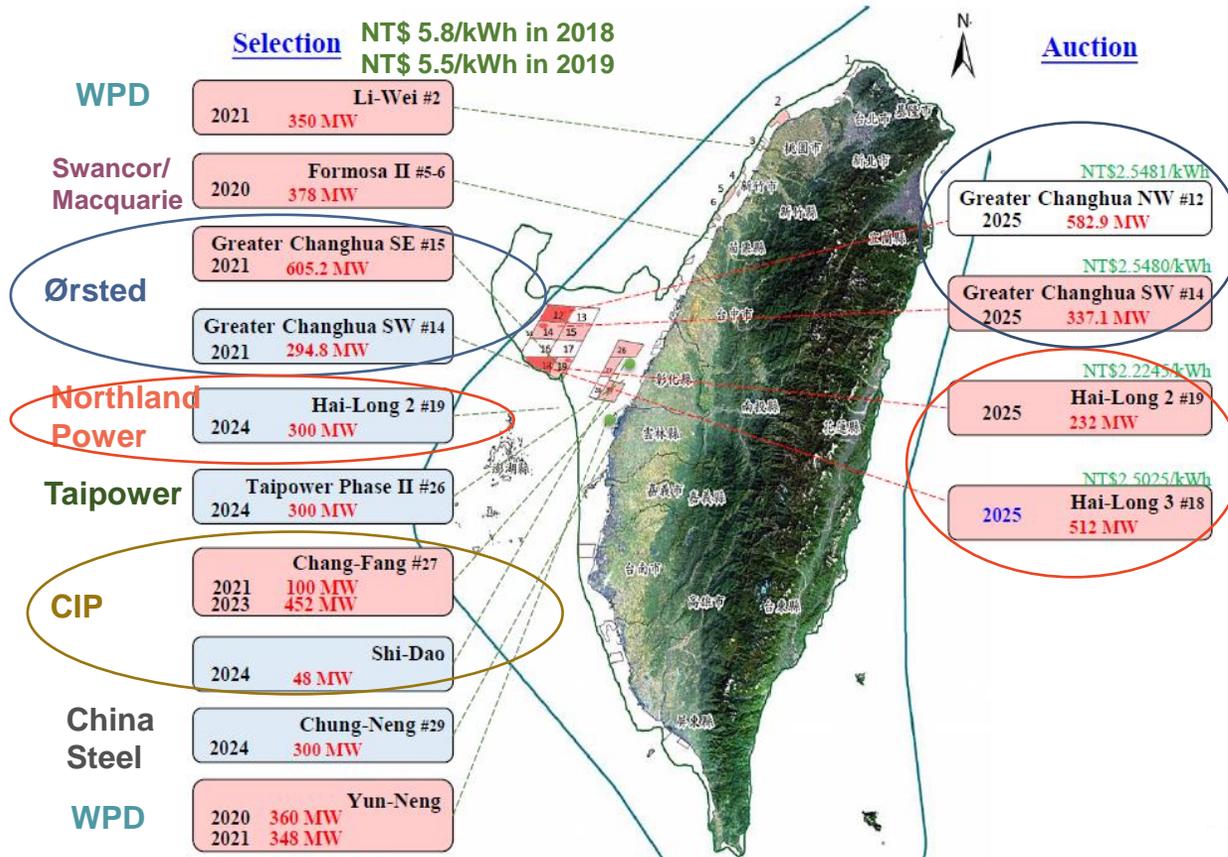
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Offshore Zonal Development (Post 2025)

- Cost reduction and push for commercialization of equipment manufacturing
- Establish offshore wind local supply chain and seek opportunity to enter other markets in Asia.

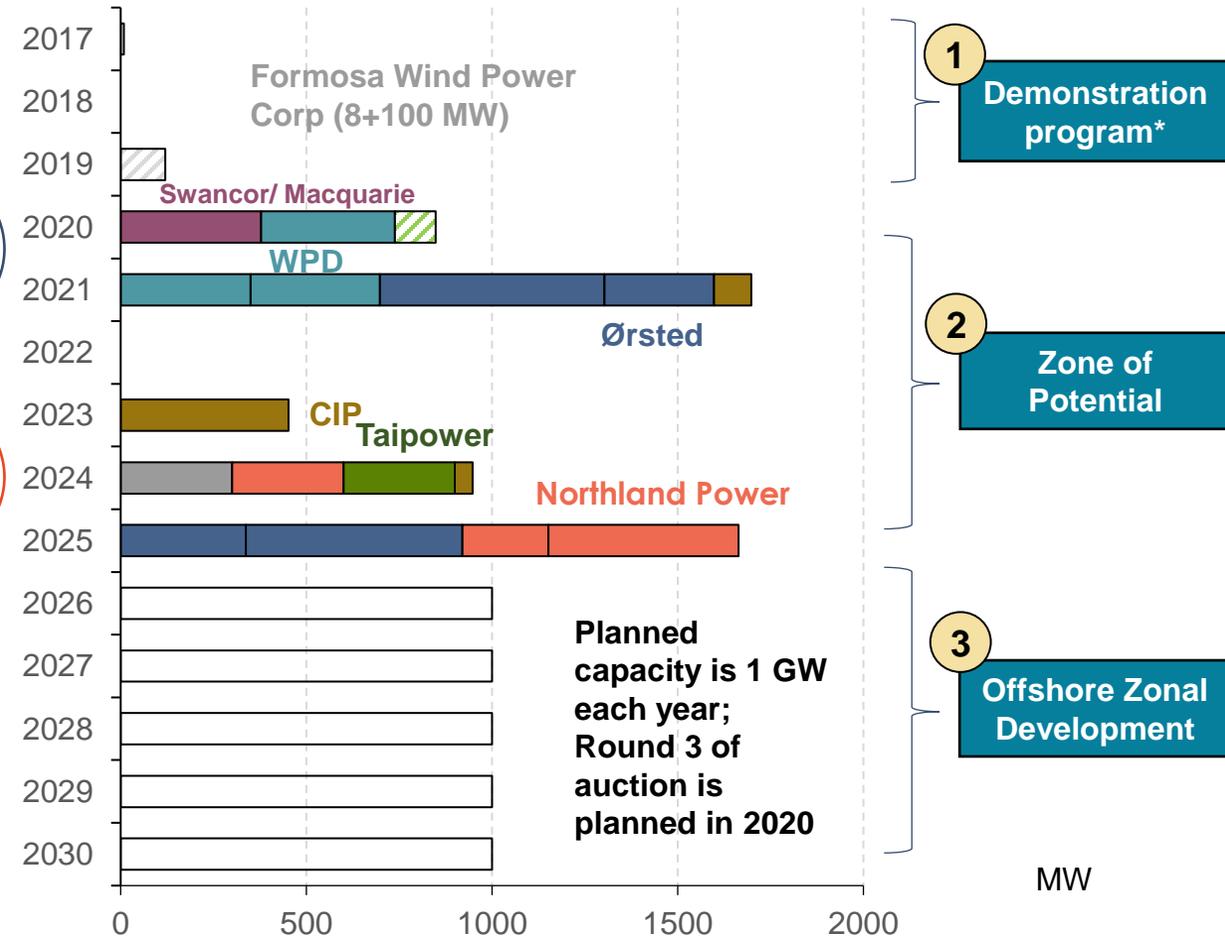
b Opportunities to Invest in Offshore Wind Projects
 There are still opportunities to buy stakes in the existing approved wind projects or build new ones in the new rounds of competitive auctions

Phase 2 of Offshore Wind Projects (Zonal of Potential)



Active Participation of foreign investors

Offshore Offshore Wind Capacity Over the Year



Note: The planned commissioning date of the projects maybe be delayed.
 Source: MOEABOE, WaterRock Energy Research and Analysis

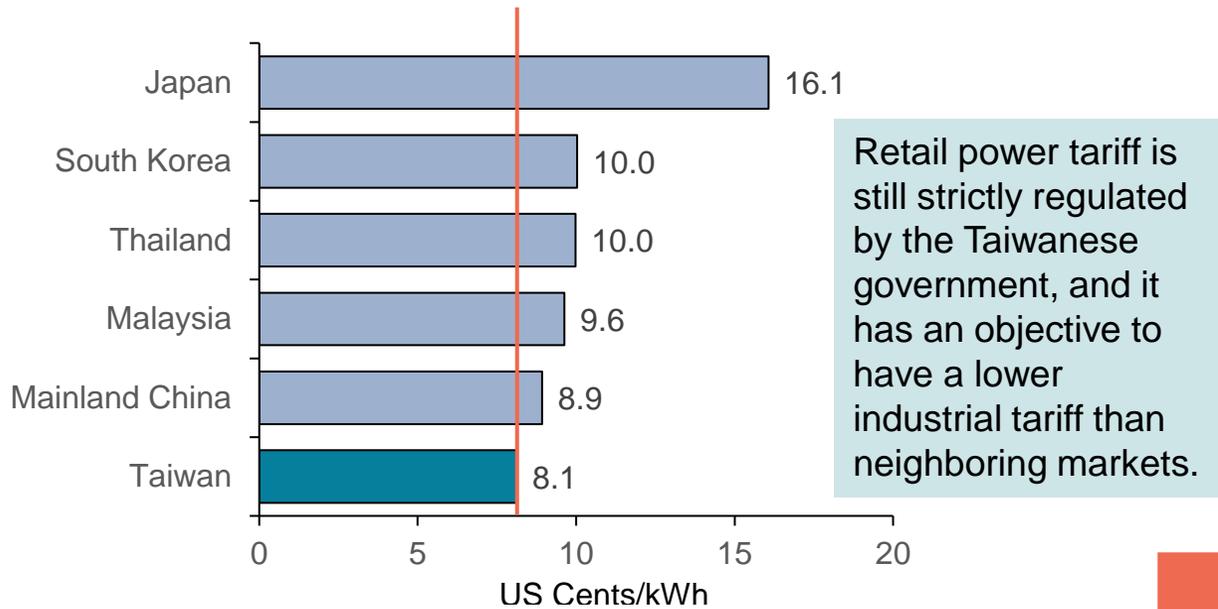
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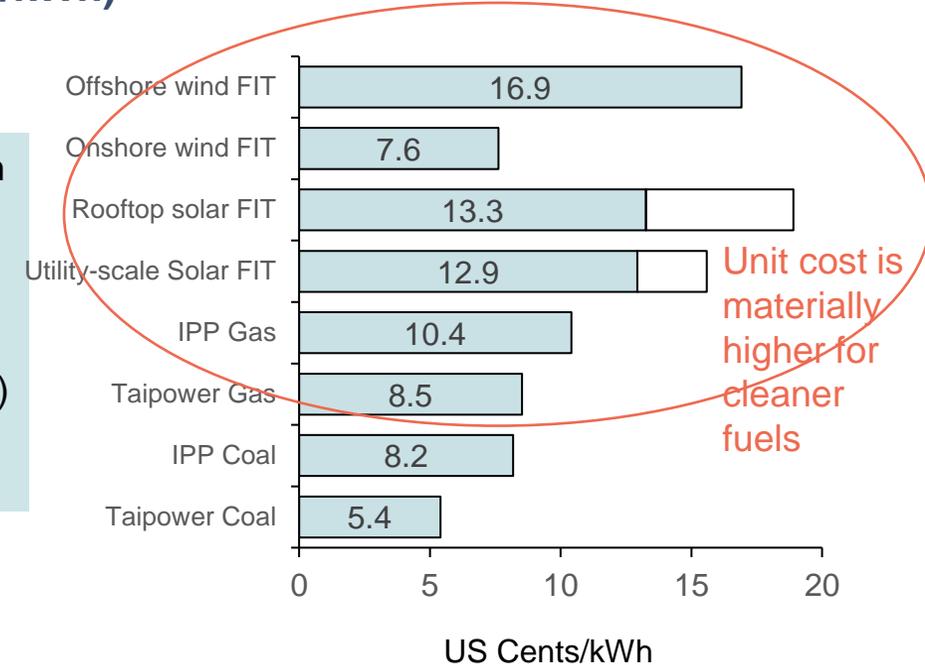
Investment Risk

It is unclear how Cost Competitiveness and Environmental Sustainability will be reconciled in Taiwan, giving rise to a future risk of contractual re-negotiation

Comparison of Average Industrial Tariff of Taiwan with Neighboring Markets in 2018, US Cents/kWh



Cost Comparison of Different Sources of Generation (2019, US Cents/kWh)



It is unclear how these two conflicting objectives can be reconciled in the medium- and long-term.

Profitability of Taipower may be further squeezed and **there is a risk that it may have to revise its legacy contracts with power developers**

Investment Risk

Taipower re-negotiated the 25-year PPAs with the IPPs in 2013 to lower power purchase cost, partly due to its inability to pass-on cost to customers

Contractual Re-negotiation of Taipower and Thermal IPPs

Time	Contractual Terms	Outcome
Sep 2008 – May 2012	Taipower wanted to adjust fixed interest cost (7-10%) determined in 1990s to floating interest cost to reflect latest debt financing cost	Delayed by the IPPs and no agreement was reached
May-Jun 2012	Based on Rule 60 of the Electricity Act, if the industry participants have profits higher than the reasonable benchmark, they need to return 60% of the “extra” profit to the consumers and only keep 40% of the “extra” profit. Taipower wants to apply this rule to the IPPs	Delayed by the IPPs and no agreement was reached
25 Jun – 10 Oct 2012, initiated by Ministry of Economic Affairs (MOEA) and negotiated for four times	In the third negotiation, Ministry of Economic Affairs (MOEA) led the re-negotiation, including suggesting to use floating interest rates to reflect financing cost and raising capacity factor	No agreement was reached
Oct 11, 2012 to Aug 2013	<ul style="list-style-type: none"> On Oct 11, 2012, Economic Council in Legislative Yuan intended to reduce the 2012 budget of Taipower for purchase electricity from IPPs. In order to avoid disruption to their normal operation, the IPPs would like to enter re-negotiation with Taipower Taipower and the IPPs completed the negotiation based on the terms pushed by MOEA in Jun 2012 [i.e. changing fixed interest rate to floating interest rate]. 	<p>Third phase IPP: Taipower and Kuokuang, Star Energy and Sun Ba completed contractual adjustment on Jan 28, 2013; Taipower and Starbuck completed contractual adjustment on Mar 6, 2013.</p> <p>Phase I & II IPPs [changing to floating interest rate]: Everpower (Mar 13, 2013), Hsintao (Jun 21, 2013), Chiahui (Jul 30, 2013), Mailiao (Aug 23, 2013), Hoping (Aug 28, 2013).</p>

The primary driver on the re-negotiation is due to the need to reduce Taipower’s heavy loss as it cannot fully pass through the high commodity cost to end-users

Investment Risk

There are several other potential risks, including credit-risk of off-takers after market liberalization, curtailment risk, construction and exchange rate risk etc

Credit Risk of Offtaker(s)

- There has been discussion to at least legally separate different segments of Taipower and even privatize Taipower.
 - Thus, there are uncertainties on the credit worthiness of the new succeeding offtaker.
-

Curtailment Risk of Renewables

- Rates are paid based on generation, and there is no guaranteed full dispatch on renewables from Taipower
 - If expansion of transmission lines is slower than expected, there could be curtailment risks.
-

Construction Risks

- Developers may face construction risks, including cost overrun and completion delay
 - Coordination issues as multiple contractors are involved, especially for offshore wind projects
 - Some local contracts may take longer than expected to build up experience and complete on time
 - Disruption of construction supply chain due to COVID-19.
-

Other Risks

- Feed-in tariff for solar is based on commissioning date, so the tariff could be less if solar projects are delayed
- Exchange rate risk: tariffs are in local currency.

Thanks and Contact

**WaterRock
Energy Economics**

www.waterrockenergy.com

**WaterRock Energy
Economics (HK)**

Unit 1001, 10/F, Wharf T&T
Centre, Harbour City,
7 Canton Road,
Tsim Sha Tsui, Hong Kong

Key contact numbers,
No. in HK: +852 9365 8216
China: +86 155 0757 1202
Wechat: zhangliutong83112

**For enquiries, contact
Liutong Zhang (Lucas)**

lzhang@waterrockenergy.com

Skype: liutongzhang



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Who is WaterRock Energy Economics

Background:

- A boutique market and economic consulting firm for provision of advisory services related to the power and gas markets in greater China and ASEAN regions
- Small, nimble and client-focused.
- Focus on the power and gas sector in Taiwan, the Philippines, Singapore, Hong Kong and mainland China
- Very analytical team
- Deep local knowledge and connection with local companies
- Flexibility to partner with other consulting firms for projects.

Services:

- **Transaction Support:** Offer due diligence studies on power and gas assets in ASEAN and greater China region. To date, the team have supported the successful completion of >20 GW of renewable and thermal capacity with a transaction value of more than US\$30 billion
- **Market Analysis:** Provide independent and detailed fundamental market analysis on the power, gas and oil sector since 1990s. Key focused topics are opportunities and risks of investing in RE sector, economics of power plants and gas infrastructure projects (like LNG terminals) etc
- **Regulatory Support:** Provide analysis and support on regulatory issues related to fuel mix, market design, market power mitigation and long-term resource adequacy in competitive electricity markets such as Singapore and the Philippines
- **Modelling Support:** Create and provide power dispatch and optimization modelling support for power companies and consultancies.

We focus on the power and gas sector in Greater China and ASEAN Regions

We also have an unique quantitative tool to model the Taiwan electricity market

Power Optimization Tool of WaterRock Energy

(to systematically understand cost competitiveness, dispatch and market price of existing and new power plants)

