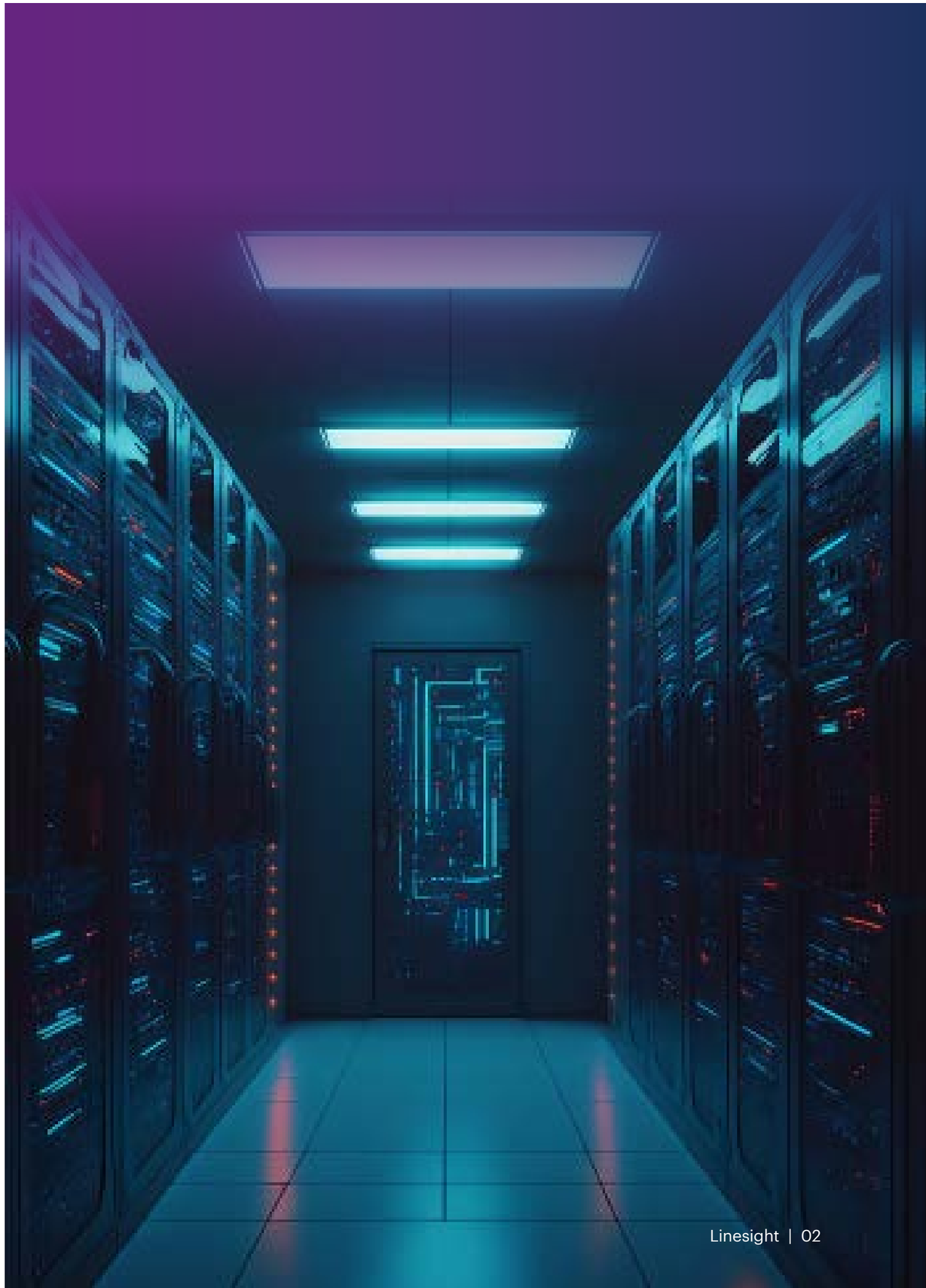
Linesight

Powering up data centres: Navigating energy challenges in Taiwan

June 2023

Contents

01 | Foreword



Data centres are the critical infrastructure of the 21st century. As the digital transformation of the global economy continues, demand for both data processing, and the energy required to support it, is set to grow.

Due to continuing efficiency improvements, data centre power consumption has grown at a slower pace than the activity they support. Nevertheless, the availability, reliability and cost of electricity remain key factors in location decisions, not only for operators but for host countries as well.

Taiwan is a high-tech hub and one of the world's largest producers of semiconductors. To retain its manufacturing dominance, and to support future development, the Taiwanese government has embarked on a number of initiatives to increase the overall electricity supply, shore up resilience, and shift to less carbon-intensive sources of energy, with a target to generate 20% from renewables by 2026.

There are also demand-side solutions that data centre operators can use to reduce their reliance on national grids, both in the way facilities are designed and managed. This includes optimising energy efficiency, supporting investment in renewables through corporate power purchase agreements, expanding in-campus generation, as well as taking advantage of continuing innovation in cooling and monitoring technologies.

Overall, these initiatives are a cause for optimism for a more sustainable and resilient energy supply in Taiwan.

Garvan Barry
Director - North East Asia
garvan.barry@linesight.com

02 | The impact of the energy crisis on data centres

Energy markets have been under pressure due to a range of factors including widening demand-supply gap, ageing infrastructure and rising energy costs.

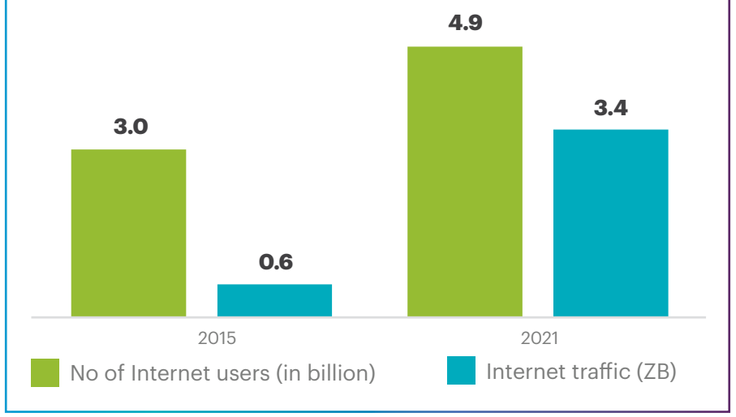
Globally, energy markets are under pressure and the Russia-Ukraine conflict has exacerbated the situation. Natural gas, oil, and electricity prices have risen to unprecedented levels, affecting all sectors of the economy. Energy prices have been highly volatile over the last two years. The World Bank's Energy Price Index increased by 126% between January 2021 and September 2022. Despite a drop in the last three quarters, prices are still 27% higher than they were in January 2020.

Inflation in energy prices has hugely impacted the data centre industry, due to the significant energy consumption required for these facilities.

Internet users increased by 60% between 2015 and 2021, and internet traffic increased by 440%. Data centre electricity consumption (excluding crypto usage) increased from 200 TWH to 220-320 TWH in 2021. However, data centres still account for 0.9-1.3% of global electricity demand. In many large economies, its consumption is equal to or greater than domestic energy consumption of few countries, making the sector particularly vulnerable to price fluctuations. [1]

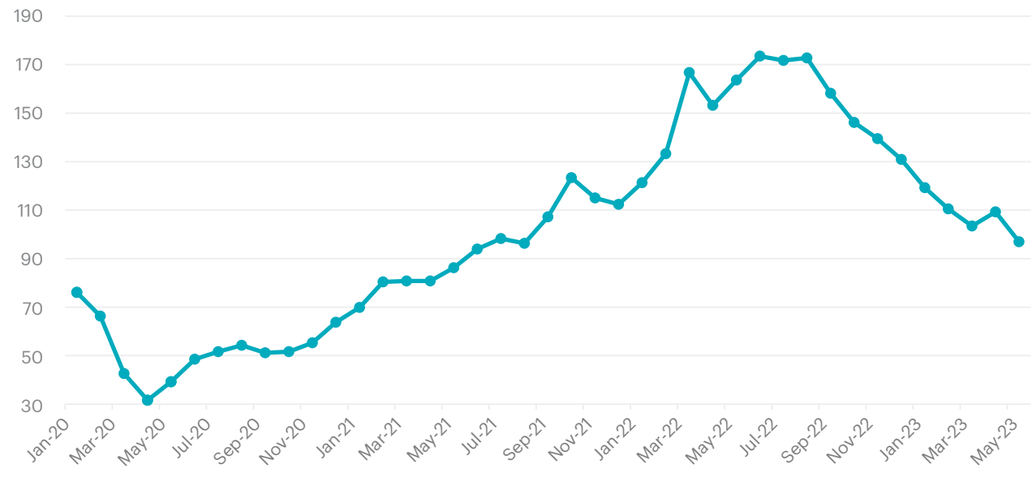
In key data centre hubs, when compared to global averages, the percentage of data centre energy usage to the total consumption is high.

Global Digital Growth



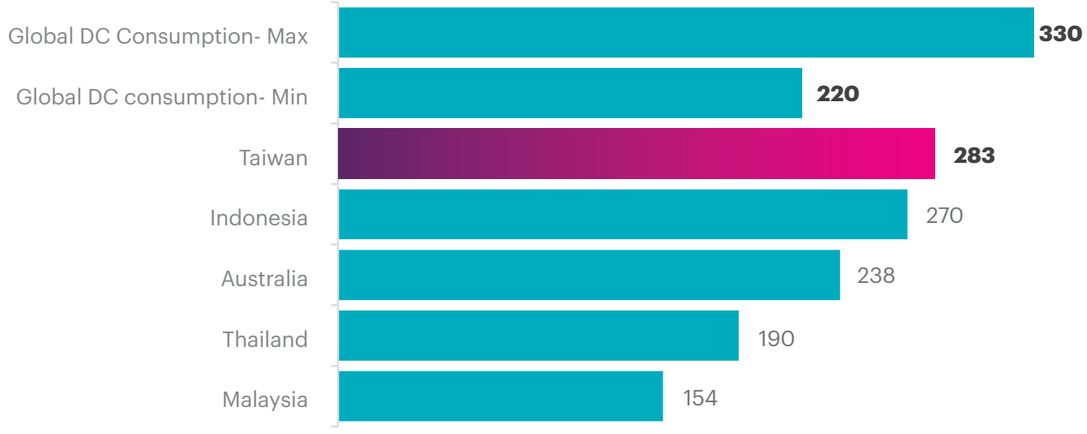
Source: Data Centres and Data Transmission Networks, IEA. License: CC BY 4.0

Global Energy Price Index (monthly)



Source: World Bank Commodity Price Data (The Pink Sheet) – monthly indices based on nominal US dollars

Annual electricity consumption of APAC countries vs Global DC electricity consumption in 2021 (in TWh)



Source: Data Centres and Data Transmission Networks, IEA (iea.org), License: CC BY 4.0, Electricity consumption 2021- Enerdata World Energy & Climate Statistics Year book 2022

For instance, in Ireland and Singapore, it is close to 14% and 7%, respectively.[2,3] Power resilience is also critical for the operation of data centres and any power disruption can result in data loss, hardware failure and downtime, which can be extremely costly. reliability and cost of power are therefore critically important consideration in site selection. Usually, Data Centre players negotiate for a power contract on a fixed-year basis for 2-3 years, however with the current volatility in the market, securing a long-term contract becomes challenging, adding to further uncertainties on the cost of operations.

Energy sourcing has also become a key challenge for data centres. Obtaining power for a new project or expanding existing ones has always been difficult, especially in areas where the local grids have already been overburdened. In fact, data centre electricity consumption has increased significantly in some established markets, leading to the imposition of moratoriums in these areas. As data centres are such high energy consumers, they can have significant impact on local power grids. This has resulted in many countries introducing policy changes which is impacting data centre investment plans.

Examples of development restrictions for data centres

Irish transmission operator EirGrid, refused connections for projects in Dublin that did not meet the defined requirements. Data centres accounted for close to 14% of Ireland's energy consumption in 2021. EirGrid has predicted that if all the contracted capacity to data centres in Ireland would be utilised, then data centres would make up between 25% to 33% of Ireland's electricity demand by 2030.[3]

In Singapore, a three-year moratorium on data centre construction came to an end last year, and new proposals must now fulfil the energy efficiency and sustainability criteria such as a power usage effectiveness ratio (PUE) of at least 1.3, a Platinum rating under its Green Mark scheme etc.[2]

However, because data centres are an essential component of any country's digital economy, efforts are being made to achieve sustainable solutions to meet the energy demand.

These solutions need to be tailored and aligned with the climate of the region. Each geographical location presents unique environmental factors that should be considered when implementing sustainability measures for data centres.

Sustainability related regulatory landscape for data centres

Singapore introduced new standards to enhance energy efficiency in data centres located in tropical climate countries. The Infocomm Media Development Authority (IMDA) has announced guidelines that enable data centres to operate at higher temperature settings while optimising energy consumption. This standard facilitates the transition toward gradually increasing data centre operating temperatures to 26°C and above. By implementing these guidelines, data centres can achieve cooling energy savings of 2% to 5% for every 1°C increase in operating temperature.[4]

The European Union's energy efficiency research centre has published an Assessment Framework for data centres. It is aimed at helping evaluate data centres' energy efficiency and compliance with the European Taxonomy for Sustainability. This framework will be the basis for mandatory reporting under the upcoming Corporate Sustainability Reporting Directive (CSRD).[8]

03 Taiwan's energy situation and the challenges for data centres

Taiwan's increasing energy consumption primarily driven economic growth, and dependence on imported fuel, necessitate the utilisation of renewable energy sources

Strategically located in Asia, Taiwan is a developed economy manufacturing 65% of the world's semi-conductors and almost 90% of the advanced chips.[6] It is also one of the major connectivity hubs and a fast-emerging data centre market in APAC, with an evolved technology ecosystem. Adoption of 5G & AI/ML, demand for cloud services, growth in procurement of big data and IoT solutions are the key factors driving the growth of the industry in the country. The Taiwan data centre industry is expected to grow at a CAGR of 18.4% between 2022-2027.[7]

Whilst the market is rapidly expanding, the industry faces several key challenges, including limited land availability, a lack of skilled labour, contractors at capacity, and the country's challenging energy situation. Taiwan has a high population density and a strong industrial base, putting significant strain on the country's energy infrastructure. With the current volatility in the global energy market, pressure on the energy sector is exacerbated. As the demand for data centres grows, so will the demand for energy to power these facilities. Recently Taiwan experienced widespread power outages, which affect the data centre industry. However, there are several initiatives being made by the public and private sectors to address the issue, and DC operators have been looking into energy-efficient solutions to overcome these challenges.

Energy consumption and supply dashboard of Taiwan- 2021

Domestic energy consumption by sector

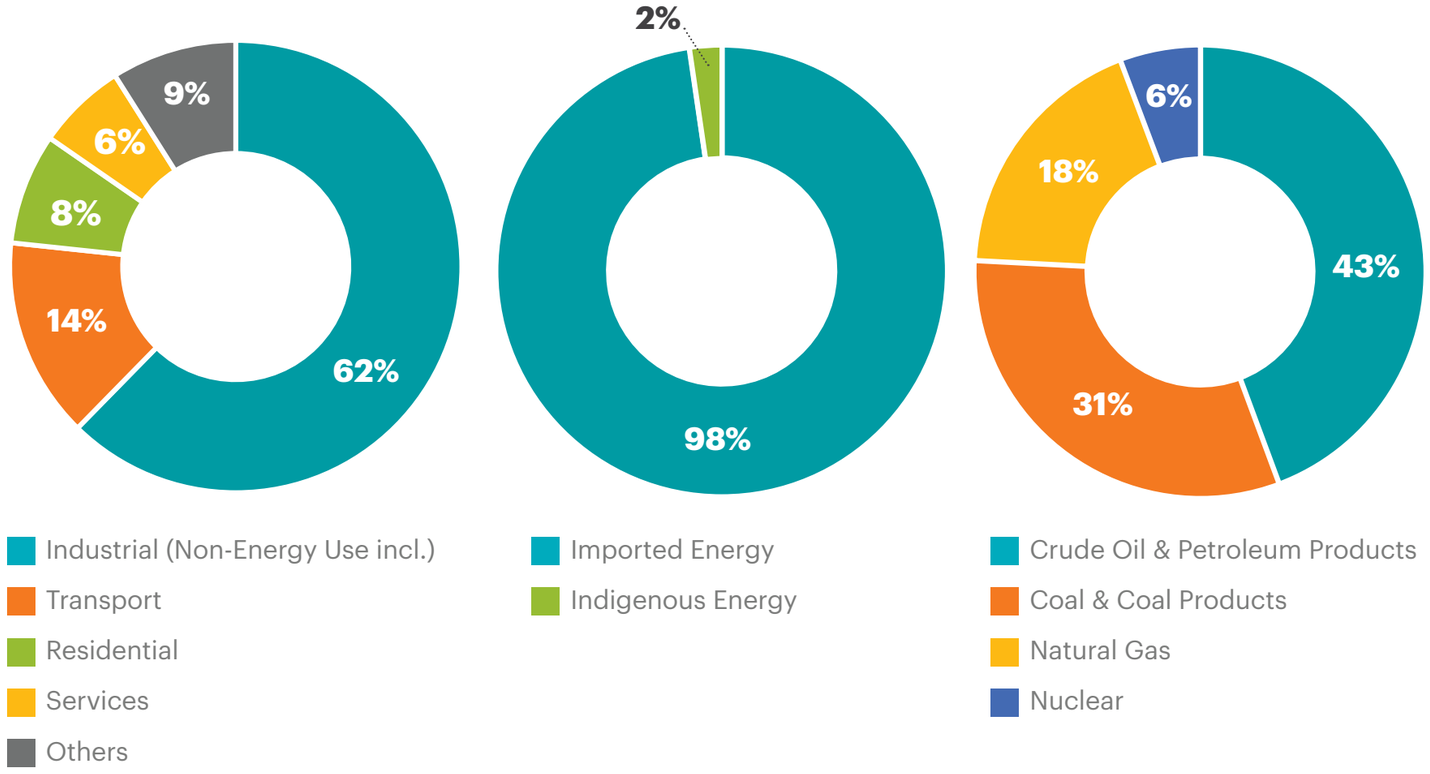
Total = 8,936 (10^4 KLOE)

Energy supply structure

Total =14,397(10^4 KLOE)

Breakup of imported energy

Total = 14,070 (10^4 KLOE)

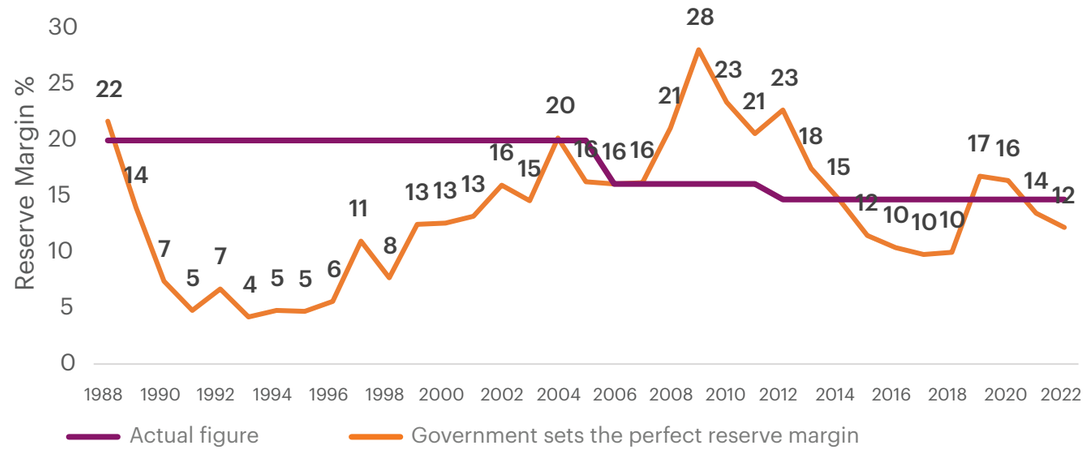


Source: Energy Statistics Handbook 2021, Bureau of Energy, MOEA

Overview of Taiwan's energy landscape

Taiwan's energy consumption has been steadily increasing over the past decade, primarily driven by the economic growth and industrial development. The total energy consumption in Taiwan increased from 65.89 million KLOE in 2001 to 89.36 million KLOE in 2021.[8] Its electricity consumption per capita is three times higher than the average for Asia, with more than 60% of the electricity is consumed by the industrial sector. The increase in energy consumption is putting significant pressure on country's power infrastructure.[8,9] Following are some of the key challenges that the island is facing in regards to energy sector.

Percent Reserve Margin for Power System in Taiwan



Source: Taipower 2022

High reliance on imports with limited domestic energy reserves

Approximately 98% of the energy supply in Taiwan is through imported energy which is primarily derived from fossil fuels including coal and oil, which leaves the island's energy supply vulnerable to external disruption. The value of energy imports in 2021 stood at US$ 47.56 billion, which was approximately 62% more than that in previous year.[8] Taiwan's oil imports increased by 75.6% to US$11.9 billion in the first five months of 2022 compared to the same period last year as crude oil prices started to rise in 2022. **In order to reduce the dependency of imported energy the Ministry of Economic Affairs' Bureau of Energy has been actively promoting energy research at several universities since the 1990s.** [10]

Low power reserve margins

Looking at a global benchmark, Taiwan's power reserves are around 15% of its installed capacity, below the average of 20% in many other countries and well below Singapore's 27%.[11,12] One of the key drivers in the quest for increased stability in the electricity supply lies in Taiwan's rapidly expanding semiconductor chip manufacturing sector, and the need to ensure adequate supply is fundamental for the island's economy in this regard. Taiwan needs to raise its energy reserves to support its booming manufacturing sector. **To stabilise the power supply, in addition to the development of renewable energy, Taipower is also actively building new gas-fired units.**

Isolated grid system

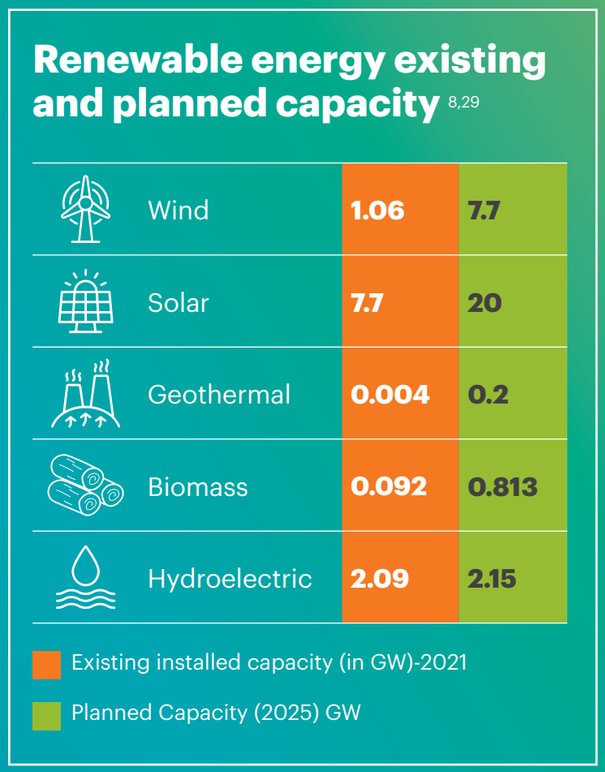
Another challenge is the isolated grid system of Taiwan's grid which could make it susceptible to power shortages in the event of a sudden supply shock.[13] It is highly reliant on Hinsta power plant in the south and location of the substation is such that the power flows only one way-south to north.[14] **However, Taipower has declared plans for grid resilience and sustainability, but this will require a large infrastructure overhaul that will take a long time to complete.**[13] **Given the situation, DCs can consider Taipower dual power lines fed into data centre with different feeders to improve power system reliability.**

Leveraging renewable energy potential

Taiwan has been actively promoting the development of renewable energy in recent years, with a goal of generating 20% of its electricity from renewable sources by 2025, up from 4.8% in 2016. [8] Though there is very minimal increase in the share of renewable energy the past decade, and as per a recent report by Ministry of Economic affairs, the percentage of renewable energy is expected to reach to 15% as against planned target of 20% in 2026. [15] However consistent efforts are being made, as a result share of renewable energy reached new high of 8% in first 10 months of 2022. [16]

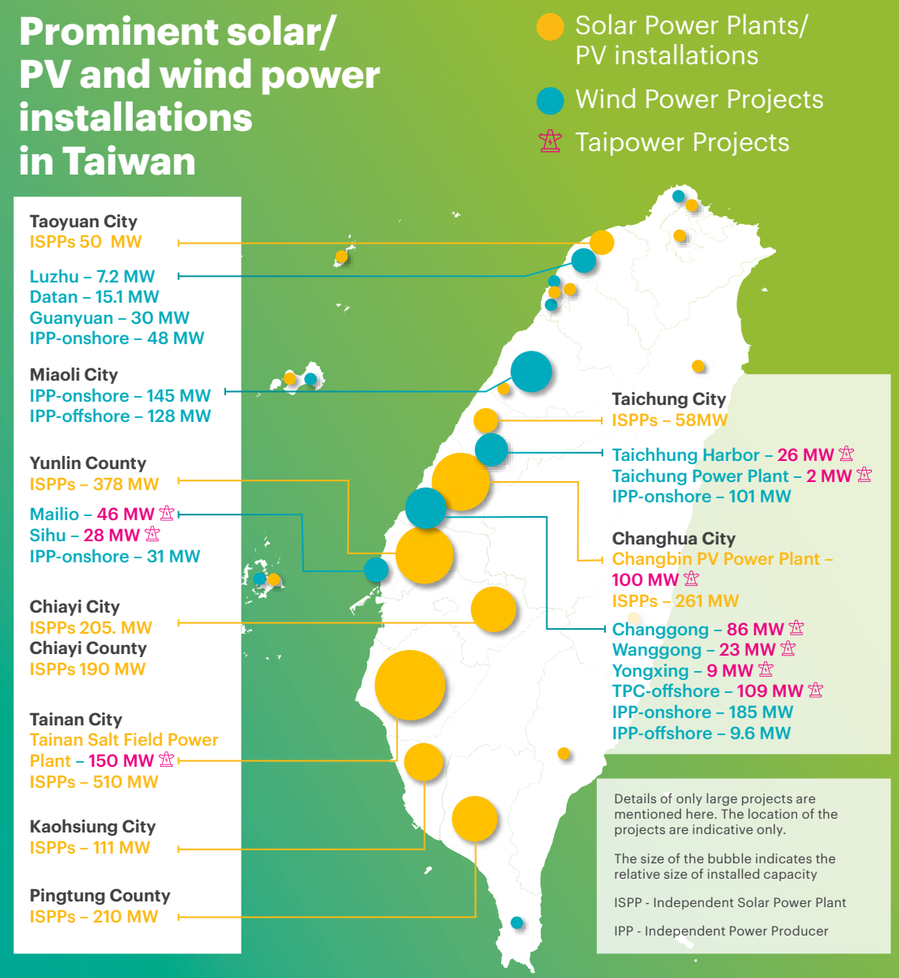
Wind and solar energy are the largest contributors to the overall renewable energy sector. Many domestic companies are also now beginning to work on the development of solar energy, and efforts are being made to achieve the target of 20 GW of solar power capacity by 2026.

Renewable energy existing and planned capacity [8,29]



The planned capacity corresponds to the renewable energy target for 2025, which was set in 2019 and has now been extended to 2026.

Prominent solar/ PV and wind power installations in Taiwan



Source: Taipower - Overview of the Development of Renewable energy (updated on 25.5.2023)

Renewable Electricity Dashboard of Taiwan

Parameters	2016	2021
Renewable energy generation (in 10^2 GWh)	**127**	**174**
Share of renewable energy in the total energy generation	**4.8%**	**6.0%**
Share of installed capacity	**9.5%**	**19.5%**
Renewable energy installed capacity (GW)	**4.7**	**11.6**

Source: Energy statistics Handbook 2021, Bureau of Energy MOEA

Key Upcoming Wind Power Projects in Taiwan

Project Name	Stage	Value (US$ Million)	Construction Start	Project Completion
Miaoli Formosa 4 Offshore Wind Farm 4400MW	Planning	**21,000**	**2026 Q4**	**2032 Q1**
Iberdrola – Offshore Wind Farms Development Program 6000 MW	Planning	**16,000**	**2026 Q1**	**2031 Q2**
Orsted-Greater Changhua Offshore Wind Farm 2420MW	Execution	**12,990**	**2019 Q4**	**2030 Q4**
EnBW/ Green Invt Group -Haiding Formosa 3 Offshore Wind Farm 2GW	Planning	**10,000**	**2026 Q1**	**2031 Q4**
Taiya Energy - Huan Ya Floating Offshore Wind Farm 1434MW	Planning	**7,696**	**2026 Q4**	**2032 Q1**

Source: GlobalData

04 | Strategies to navigate

The energy crisis facing the data centre industry requires a multi-pronged approach that addresses energy sourcing, consumption, carbon emissions, and sustainability.

Below are potential strategies that data centre players can explore in Taiwan to navigate energy challenges.

4.1 Diversifying energy sourcing

Though Taiwan is heavily reliant on fossil fuels for power, recent efforts by the government and various private players have increased renewable energy adoption by data centre operators.

Procuring renewable energy through CPPA

Obtaining a direct renewable power source for data centres or on-site generation facilities is not always feasible. Yet, there are other options for obtaining renewable energy. One of the procurement methods gaining traction in Taiwan is corporate power purchase agreements for renewable energy.

Data centres are energy intensive assets. Hence large Colo players have been entering into CPPA primarily for reducing energy costs and hedging against energy price fluctuations, and a long-term price certainty. However, meeting the sustainability goals has also become a key driver. There are many types of CPPA and pricing structures a buyer can enter, which largely depends on regulatory aspects of the electricity market, the buyer's sustainability and energy procurement strategy and the capability of the seller.

Examples of corporate renewable PPAs in APAC[17]

Buyer	Energy Company	Size of PPA	Type
AWS	Mitsubishi	**22 MW**	Solar
NTT	Clean Energy Connect	**70 MW**	Solar
AWS	Vibrant Energy, a subsidiary of Macquarie Group's Green Investment Group (GIG)	**300 MW**	Wind+Solar
Sify Technologies Limited	Vibrant Energy, a subsidiary of Macquarie Group's Green Investment Group (GIG)	**231 MW**	Wind+Solar
Meta	Sunseap Group	**100 MW**	Solar*
Telstra	Ark Energy Corporation	**350GWh per year**	Wind
Digital Reality	Origin Energy	**400 MW**	Wind
AWS	Perusahaan Listrik Negara	**210 MW**	Solar
Supernap Thailand	WHA Utilities & Power	-	Solar

*solar panels on rooftop of public housing

Definition

Corporate Power Purchase Agreement (CPPA) is an agreement for renewable energy producer (such as wind or solar farm) and the buyer to purchase electricity at a pre-agreed price, for an agreed time period.

Key CPPAs in Taiwan			
Purchaser	**Type of agreement**	**Year**	**Developer/ Seller/ Generator**
Google[23]	CPPA- 10 MW solar power	Q1 2019	New Green Power
Taiwan's semi conductor industry[24]	CPPA- 1 GW of wind capacity	Q4 2021	wpd AG
TSMC[25]	CPPA- 920 MW wind energy	Q3 2020	Ørsted
E-Link[18]	Virtual CPPA	2018	Penghu University of Science and Technology

In 2017, Taiwan's electricity act was amended to allow the sale of renewable power to end users through direct supply or wheeling, and the renewable energy development act (REDA) was revised in 2019.[18,26] Since then, the CPPA market has witnessed significant growth. Taiwan is one of the leaders in CPPAs. About 1,300 MW of CPPAs have been signed by end of 2020. This largely includes PV, on-shore wind and off-shore wind farms.[18]

Investing directly in an on-site or near site renewable power asset

On-site and near-site renewable energy generation is a common method used by data centre players all over the world to obtain a dependable and cost-effective power supply, while reducing their carbon footprint. PV solar panels are the most popular one-site renewable energy option because they are simple to install and provide a faster payback. This can be installed both in new buildings and used as a retrofit solution.

Wind energy is another option which is largely used in the form of near-site generation, as it requires large land and special site conditions. Other forms of on-site and near site renewable energy options are Geothermal, Biomass and Hydro-electric energy.

During grid outages, on-site power generation can serve as an emergency backup, improving energy density and lowering transmission line and conversion losses. However, data centres can face several challenges in procuring on-site or near-site renewable energy, including upfront investment, high maintenance cost, on-site generation space requirements, and the availability of renewable resources. Often, on-site generation facilities require backup power when renewable energy is unavailable, such as on a cloudy day. As a result, energy storage has become a critical factor in this case. Following are some of the on-site and near site renewable power generation examples adopted by data centres in APAC:

On-site / near-site renewable power generation examples adopted by Data centres in APAC		
DC operator	**DC Location**	**Details**
CtrlS Datacentres[19]	Mumbai, India	Solar plant façade with 1.3 MWp installed capacity
Next DC[20]	Melbourne	402 kW of solar rooftop panels
Taipower Datacentres[28]	Changhua, Taiwan	Solar with 0.258MW installed capacity and wind power with 2 MW installed capacity (Part of larger installation)
Japan Renewable Energy Corporation and Morgenrot Corporation[21]	Nagano, Japan	100% renewable energy powered DC, PUE of 1.1
DC Two[22]	Victoria, Australia	Bio-Gas Facility - <1MW

Giving back to the grid

Data centres can also use energy storage systems and/or demand response programmes to feed energy back into the grid, and help in improving the grid stability. Giving back energy to the grid can also help data centres save money by generating revenue, avoiding peak demand charges, optimising energy storage, and earning incentives for participating in demand response programmes.

Energy storage

In Taiwan, there are several energy storage methods or solutions available for data centres. These solutions are aimed at addressing the challenges of managing energy consumption and ensuring uninterrupted power supply.

Li-ion batteries: Li-ion batteries are widely used by data centres for energy storage and include control system that monitor battery status, charge/ discharge, DC start etc.

Pumped hydro storage: Although not directly implemented within data centres, pumped hydro storage is an important component of Taiwan's overall energy storage infrastructure. Pumped hydro storage helps stabilise the power grid and ensure a reliable energy supply.

The specific choice of energy storage depends on factors such as power requirements, cost-effectiveness, scalability, and the availability of local resources.

4.2 Design level interventions

Unlocking the power of design: How data centre operators can reduce energy consumption through intelligent facility design

Design level interventions in a data centre facility can help data centre operators reduce their energy consumption by improving PUE and lowering their carbon footprint. Cooling accounts for 30-55% of data centre energy consumption, followed by network devices and storage devices. [27] Optimising cooling in a data centre can significantly reduce energy consumption. Some of the recent technologies in this area are:

Liquid immersion cooling

It is a method of cooling where IT equipment are immersed in a non-conductive liquid such as mineral oil or fluorocarbon fluid. It can be more efficient than traditional air cooling and can enable higher density equipment to be deployed. However, this is a relatively new technology and it will take time to adopt.

AI based automatic cooling

AI-based cooling for data centres is a method of using artificial intelligence algorithms to optimise the cooling systems in data centres. The goal of this approach is to reduce energy consumption and improve the efficiency of the cooling systems, while maintaining a stable temperature and humidity level to protect the equipment.

4.3 Smart management

Smart management systems that monitor energy consumption and automatically adjust it can help data centres reduce their energy consumption and optimise their operations. These include: intelligent power, temperature, cooling, and lighting management systems. AI coupled with IoT, and machine learning can help make data centre greener. As per a Gartner report, by 2025 approximately 50% of cloud data centres will deploy robots with AI capabilities that will help in smart monitoring, security, and maintenance of the data centre.

05 | Conclusion

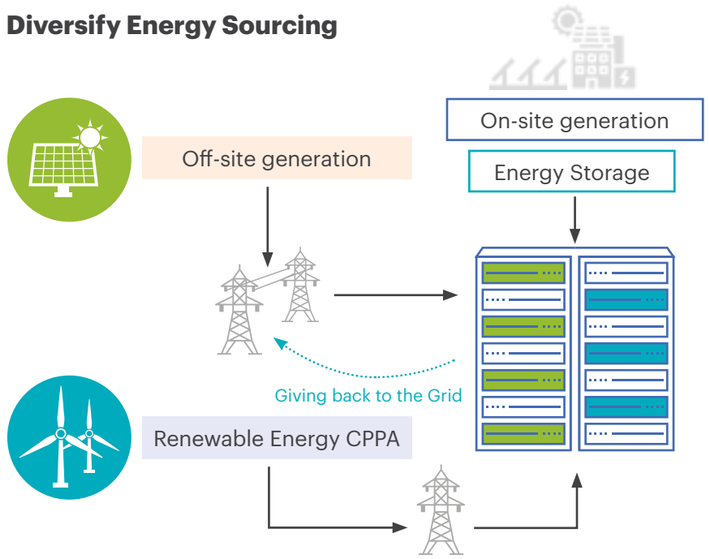
By implementing sustainable practices, data centres can reduce their carbon footprint, contributing to a more resilient and eco-friendly energy infrastructure in Taiwan and beyond.

Taiwan's energy supply and demand challenges are not unique, as many regions worldwide with growing economies and dense populations face similar issues. These challenges include strain on the power grid, rising electricity costs, and environmental concerns. However, Taiwan is actively tackling these challenges through renewable energy utilization and innovative developments.

The government and industry stakeholders are committed to transitioning to sustainable energy sources, implementing initiatives to promote renewable energy adoption. Despite the scale of the challenges, Taiwan's data centre industry is proactively seeking solutions.

Power savings in data centres

Diversify Energy Sourcing



Energy Efficient Design

Building

- Design elements to support energy generation
- Design efficiency
- Future proof design

MEP

- Innovations in cooling tech to optimise PUE

Smartly Manage Operations

- AI based operations
- Identify power draining areas

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06 | About Linesight

Who we are

Delivering professional construction consultancy services and strategic support to multiple sectors globally.

Over **49 years'** experience

29 offices globally

Global reach

Established in Ireland in 1974, Linesight has extensive global reach with 29 offices across four continents.

Local expertise

We employ over 1,250 highly skilled professionals and train them to world-class standards, bringing global knowledge and local expertise to bear for our clients.

Trusted partner

Our bold ambition, honesty and confidence to deliver, together with our commitment to build meaningful relationships is what sets us apart.

Our services

Our services are tailored to your project, delivering maximum efficiency from inception to completion. We specialise in key areas, to provide faster project delivery, greater cost efficiency and maximum value.

Cost Management
Ensuring better value for money at every stage of the construction process.

Project Management
Delivering project success through strategic planning and stringent controls.

Project Controls
Controlling every aspect of a project to ensure maximum performance and long-term success.

Planning and Scheduling
Controlling every aspect of project schedule to ensure maximum performance, transparency on progress and critical path analysis of the effect of change.

Supply Chain Management
Providing efficient logistic strategies to streamline the delivery of equipment and services.

Procurement
Adopting the most appropriate strategy to suit both public and private sectors.

Programme Management
Managing a network of projects simultaneously in order to deliver program success.

Health and Safety
Assuring compliance, and providing design teams and clients with expert advice and independent review.

Consultancy
Providing professional, hands-on advice and guidance throughout every stage of your project.

Benchmarking
Through our global database, we provide clients with benchmarking data across key sectors such as data centres and life sciences.

Market Intelligence
We constantly keep ahead of latest industry trends through research and analysis, shared with our clients.

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