MACQUARIE

MACQUARIE ASSET MANAGEMENT

Perspectives

Renewables: Normal service resumes, with improved economics

Green investments | October 2024

Audrey Lee | Research Analyst

Daniel McCormack | Head of Research

Executive summary

- Renewables have faced an unusually large number of challenges in recent years.
- However, costs and interest rates have since come back down and power prices have adjusted upwards, helping to preserve margins and maintain (or even improve) the economics of projects.
- The long-term outlook for renewables remains compelling:
  - The demand for clean power remains robust, with new data-intense technologies, such as artificial intelligence (AI), driving strong demand for power.
  - The long-run cost trajectory continues to forecast significant declines in the per unit cost of renewables power, as scale and technical improvements drive gains.
  - New, cheaper forms of energy historically have helped to unlock extended periods of rapid economic growth, and renewables could play a similar role in the decades ahead.

Investments in wind and solar are generally seen as lower risk and more reliable, given the long-term contracted nature of revenues and expenses, the high EBITDA[1] margins, and the fact that the technologies (wind and solar) are mature and well understood. They also benefit from powerful structural tailwinds courtesy of society's need to move to a much lower-carbon energy system. But in recent years the sector has faced an unusually large number of challenges:

- **Supply chain challenges.** The supply chain disruptions as the world emerged from COVID-19 caused the prices of many of the commodities used in the production of wind turbines and solar panels (steel, copper, aluminium, polysilicon) to rise significantly, with knock-on effects for the cost of wind and solar projects.
- **Increased cost of capital.** The cost of capital also went up not long after, as the world's central banks battled the post-pandemic surge in inflation. Being more capital intensive than coal-fired power plants or CCGTs[2] (the fuel is 'free' for renewables), renewables were hit harder than others.
- **Permitting challenges and queues for grid connection.** Government approval times have lengthened, adding to uncertainty and risk for the sector.

These developments manifested themselves very publicly in a number of cancellations, write-downs, and divestments. For example, Ørsted impaired $US4 billion against its US offshore wind portfolio and abandoned the development of two wind farms off the coast of New Jersey in November 2023, citing rising US interest rates, inflated costs, and supply chain challenges.[3] The company further suspended development of two offshore wind projects in Maryland in January 2024, stating that the projects were no longer economically viable.[4] All of this saw some listed renewables and clean energy companies experience a selloff.[5]

Many of these developments have been only transitory, however. And for those that have proved more durable, the sector has now adjusted. Indeed, in the cases that garnered much of the headlines, the main issue appears to have been one of timing – many of the affected projects locked in electricity prices with customers before securing build costs, leaving them vulnerable to input price fluctuations and changes in market conditions. Costs have now subsided, or power prices have adjusted to compensate.

Moreover, the baseline need for renewable power to drive the energy transition, and the need for private capital to build that capacity, remains. At the same time, power demand is being boosted by a range of data-intense, and therefore energy-intense, new technologies such as AI. Finally, renewables remain the world's cheapest form of power on a levelised cost of electricity basis and have the potential – like other cheap sources of power before them – to unlock a period of sustained, strong economic growth.

1. Earnings before interest, taxes, depreciation and amortisation
2. Combined cycle gas turbines
3. Reuters, "Orsted hit by up to $5.6 billion impairment on halted US projects," November 2023.
4. S&P Global, "Ørsted pulls Skipjack offshore wind projects out of Md. state contracts," January 2024.
5. The S&P Global Clean Energy Index fell around 60% peak-to-trough, although it is worth noting that it includes several service and supply businesses that are not pure renewables businesses and therefore not the same as what private markets renewables funds invest in.

Higher costs: Supply reaction and upward adjustment of power prices

Between one-third and one-half of the cost of a wind turbine is made up of commodities such as steel, copper and aluminium, and the surge in the price of these commodities over 2021 and into early 2022 (Figure 1) amounted to a sizeable increase in underlying project costs. In Europe, these pressures resulted in an up to 40% increase in the cost of wind turbine manufacturing by 2023 compared with 2021.[6] The price of silicon, a critical material for solar panels, also underwent substantial price fluctuations in the same period, impacting the overall cost of solar projects (Figure 2).

Figure 1:
Commodity prices surged in the aftermath of COVID-19

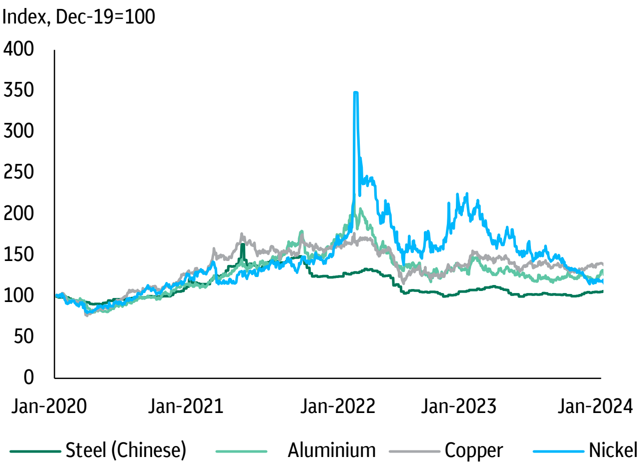
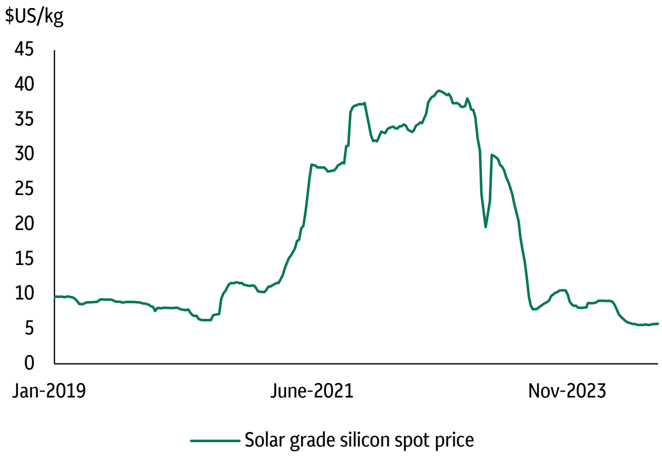


Figure 2:
The silicon spot price also experienced pronounced volatility



Sources: Macrobond, Bloomberg New Energy Finance (BNEF) (October 2024).

Across the Atlantic, the US government's strategy of incentivising domestic renewable energy production while imposing restrictions on imports exacerbated the supply chain challenges. The Inflation Reduction Act (IRA) promoted a surge in renewable projects by supporting domestic equipment manufacturing. But the supply of materials was initially unable to keep pace with the increase in demand, with import tariffs and regulations on essential components like solar panels, wind turbines, and batteries complicating sourcing from abroad. Markets have since adjusted to these shocks, however, with silicon prices falling all the way back down to pre-pandemic levels as supply has improved.

At the same time, power purchase agreement (PPA) prices have adjusted to the higher cost environment to preserve project margins. Since 1H21, PPA prices in the US and Europe have experienced compound annual growth rates (CAGRs) of about 23% and 20%, respectively.[7] Some contracts signed pre-COVID-19 have also been renegotiated, in recognition of the escalated project costs and to create a more secure financial footing for supply. For example, in June 2024, New York State awarded updated contract prices to Empire Wind and Sunrise Wind, two offshore wind projects developed by Equinor and Ørsted, respectively. The renegotiated contracts secured offshore renewable energy certificate prices of $US155/MWh for Empire Wind and $US146/MWh for Sunrise Wind,[8] which represent a more than 30% increase from the prior respective contract prices of $US118/MWh and $US110/MWh signed in 2019.[9] In our view, the combination of the substantial correction in costs and the recent uplift in PPA pricing has resulted in significantly improved economics for many of today's renewable energy projects.

6. The Guardian, "Giant windfarm off Norfolk coast halted due to spiralling costs," July 2023.
7. LevelTen Energy, LevelTen's PPA Price Index, 2024.
8. S&P Global, "Rebid New York Contracts Highlight New Normal for Offshore Wind Costs," July 2024.
9. Offshore WIND, "Equinor, Ørsted Sign New Empire Wind 1, Sunrise Wind Contracts with New York State," June 2024.

Cost of capital turns back down

When inflation rose in mid-2021 as a result of the fiscally induced surge in consumer demand against the backdrop of severe supply chain disruptions, central banks responded by increasing interest rates and taking monetary policy into restrictive territory. This was particularly challenging for renewables, given their capital-intensive nature and the amount of capital needed to drive the rapid growth in the sector.

But with the inflation problem now under control (Figure 3), central banks are moving to take monetary policy back to neutral territory. Based on futures markets pricing, the US Federal Reserve is expected to lower the federal funds rate to 2.75% by the end of 2025, which is more than 200 basis points below where it is now (Figure 4). Similar moves are expected from the European Central Bank and the Bank of England. The lower financing costs and cost of capital this implies will increase the cash flow generation of renewables projects and work to reverse the negative impact on value from higher interest rates and improve the relative attractiveness of renewables for investors.

Figure 3:
Inflation has been conquered

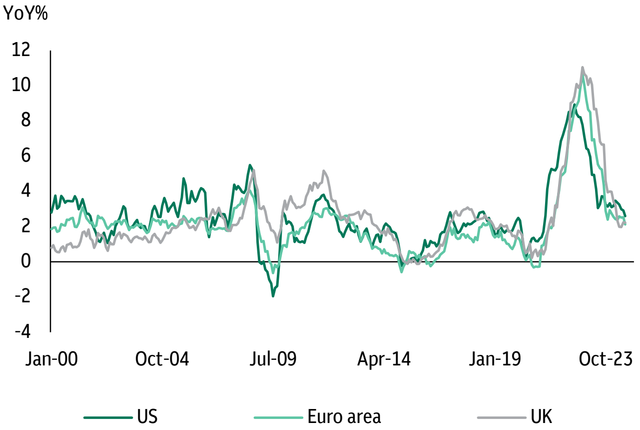
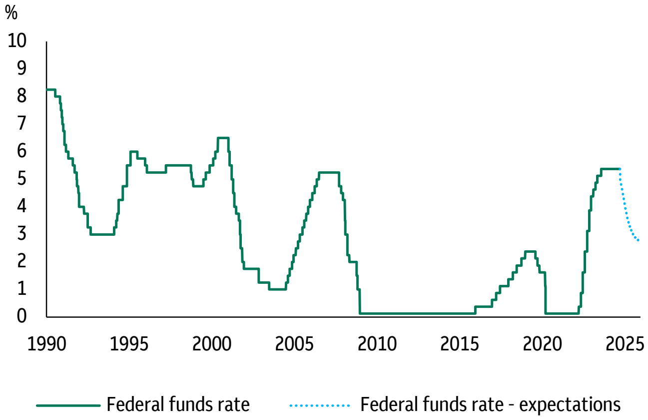


Figure 4:
Central banks are lowering policy rates



Source: Macrobond (September 2024).

Government actions to improve permitting delays and congestion for grid connection

Bureaucratic delays have also created a bottleneck for the development of renewable energy projects. A country's ability to increase its renewables capacity can be hindered by delays in obtaining the necessary permits to connect completed projects to the grid. In many jurisdictions, the permitting process is governed by layers of regulation, involving environment assessments and local consultations carried out by multiple agencies.

The complexity in permitting can delay projects by months or even years. In the European Union (EU), there is a time limit of two years for renewable project permitting, but many EU countries are unable to meet this target.[10] As a result, in the EU in 2023, the amount of wind and solar capacity at the permitting stage was five and eight times the amount under construction respectively (Figure 5 and Figure 6). The US has had similar challenges.[11]

10. Energy Monitor, "Could too much permitting reform hurt EU renewables?", June 2023.
11. Energy Monitor, "Could too much permitting reform hurt EU renewables?", June 2023.

Figure 5:
EU utility wind capacity in permitting and under construction (MW)

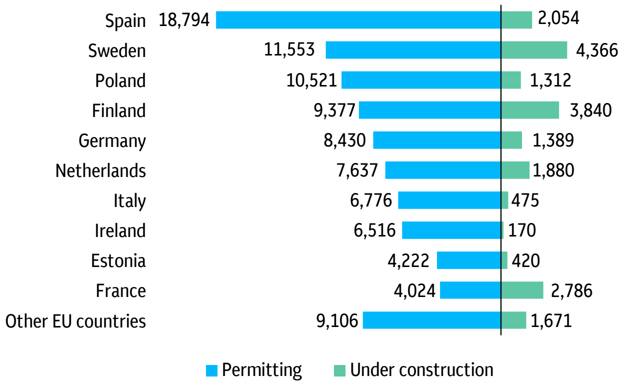
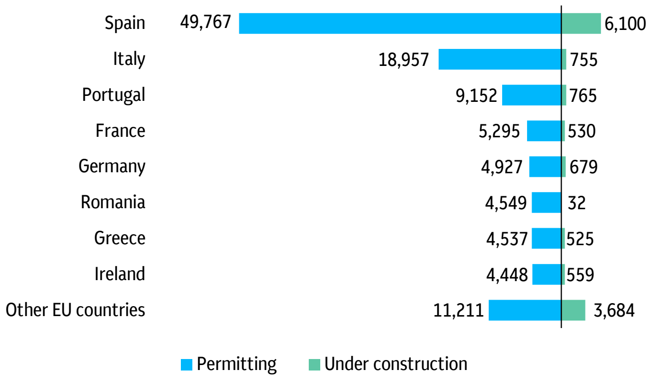


Figure 6:
EU utility solar capacity in permitting and under construction (MW)



Source: GlobalData (September 2024).

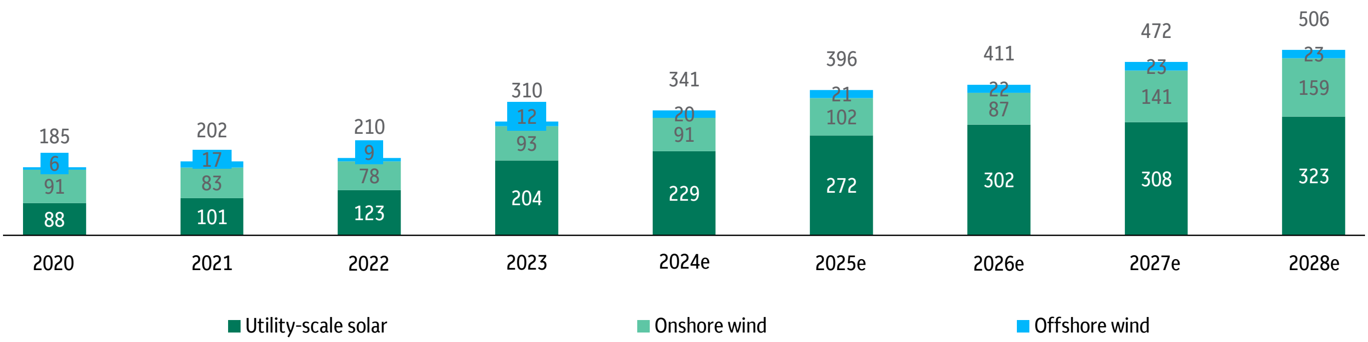
Recognising the need to address the grid connection queue backlogs, governments around the world have taken steps to resolve grid congestion. In the US, the Federal Energy Regulatory Committee (FERC) now requires more substantial financial commitments from project developers to ensure that only serious projects enter the queue.[12] The UK's National Grid also changed the queue management approach in late 2023, switching away from 'first-come, first-served' to a process with project milestones designed to terminate stalled projects.[13] In some countries, the reform impact has already been visible. For example, Germany granted permits for 7.5 gigawatts (GW) of onshore wind in 2023 – almost twice the 3.9 GW issued in 2022 – after regulatory reforms in 2022.[14] The growth has continued into 2024, with permits for 4.8 GW issued in 1H24, a 32% increase compared with the same period last year.[15] These developments underscore the effect of regulatory adjustments in enhancing grid connection processes and facilitating the expansion of renewable energy infrastructure.

Compelling long-term outlook: The energy transition, price declines, new cheap energy, and AI-related surging demand for clean power

If we step back from the short-term dynamics, the long-term outlook for renewables remains compelling, in our view. First, the need to reduce carbon emissions has not changed and neither has the crucial role that wind and solar will play in the energy transition. In 2024, the world is set to see a new record in installed renewables capacity, with 341 GW expected to be put in place (Figure 7), bringing the total installed renewables capacity to 2,300 GW. By 2028, that number is expected to be 5,108 GW, a CAGR of 10.4%.

12. Reuters, "US overhauls electric grid to make way for more renewables," May 2024.
13. Transport and Energy, "Ofgem to clear 'zombie projects' to cut grid connection queue," November 2023.
14. Wind Europe, "German onshore wind sees record auction volumes, permitting improvements and crucial new port investments," April 2024.
15. Montel News, "Germany to miss annual onshore wind target by 3 GW – lobby," July 2024.

Figure 7:
Actual and forecast annual increase in installed renewables capacity (GW)



Source: BNEF, New Energy Outlook 2024 (September 2024).

Second, the long-run drivers of costs continue to put downward pressure on the per energy unit cost of both wind and solar. For instance, since 2021 there has been a threefold increase in solar manufacturing capacity driven by record investment, resulting in a 50% year-on-year reduction in solar photovoltaics (PV) module pricing. The module price is now at near-record-low levels again (Figure 8). The cost of wind has stabilised after the increases in 2021 and 2022 and continues to benefit from larger blades and better wind capture. In short, the long-term outlook for significant declines in the per unit cost of power from both wind and solar remains in place (Figure 9).

Figure 8:
Solar module pricing

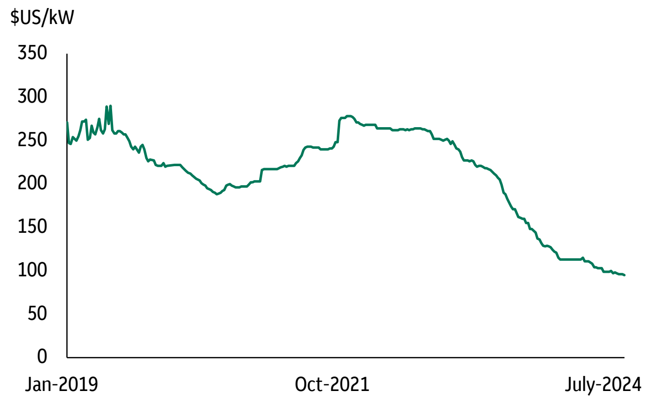
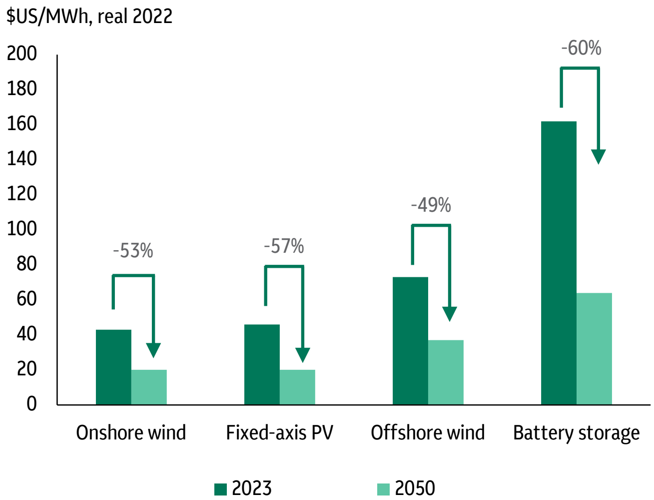


Figure 9:
Average cost forecast of wind and solar



Source: BNEF (September 2024).

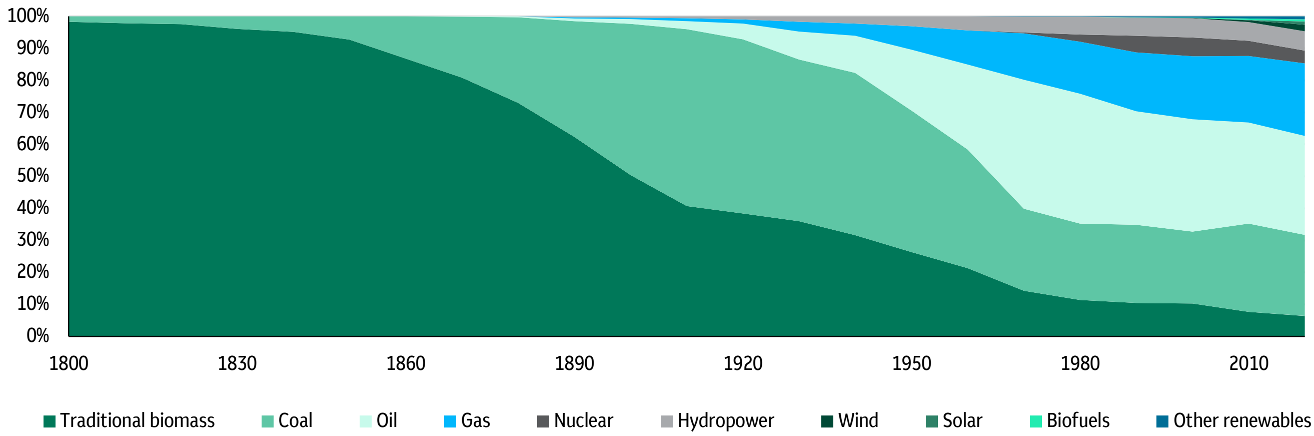
Third, renewables' success as a new, cheap source of energy has the potential to unlock sustained, strong economic growth. Energy is foundational to our economies and societies. We need it to heat our homes, cook our food, use appliances and devices, and move ourselves and goods around. It also has played an epoch-changing role at times: cheap, accessible coal played an important role in sparking the first Industrial Revolution, and the discovery of oil and the mastering of drilling techniques to access it changed our societies, transport systems, and economies immeasurably in the 20th century, particularly in the aftermath of World War II.

Indeed, the mix of energy that the world relies on has changed significantly over time, as new sources of cheap energy have become available, and the structure of our economies and the types of energy they need have evolved. Figure 10 below shows the world's energy supply mix over the past 220 years. Several points are noteworthy:

- Prior to the Industrial Revolution, traditional biomass – i.e. wood – was the overwhelming source of energy.
- Coal's share of the energy mix rose sharply from around 1850 onwards, as the Industrial Revolution spread to Germany and the US.
- Oil's rise came after 1950, as cheap Middle Eastern oil began to dominate global supply, the world adopted automobiles in great numbers, and the internal combustion engine became ubiquitous.
- Gas has grown significantly in importance in the past half century as pipelines to capture and use it were built, its compelling economics were recognised, and its relatively clean nature, compared with coal and oil, grew in importance.
- Renewables, even today, are a small share of primary energy consumption, but are growing rapidly and hold forth the potential of a new era of energy abundance and low cost.

The important point here is that while the energy transition will require large changes in the energy sources we rely on and the technologies we use, such seismic shifts are neither new nor unique to the current period.

Figure 10:
Historical sources of energy



Source: Our World in Data (September 2024).

Finally, the surge in AI adoption and other emerging technologies (such as driverless cars and the internet of things) is driving rapid growth in demand for data and power. Data centres consume vast amounts of electricity to power servers and cooling systems to prevent overheating, and the process of training AI and machine-learning models is notably energy-intensive. Large models, such as those used for natural language processing and image recognition, require extensive computational power and vast datasets, leading to substantial electricity usage.

For perspective, processing a ChatGPT request consumes 2.9 watt hours (Wh) of electricity – nearly 10 times that of a Google search (Figure 11). The expansion of edge computing, which facilitates real-time AI processing by analysing data closer to its source, further escalates electricity usage. Electricity demand from data centres dedicated to AI is projected to jump from 6 terawatt hours (TWh) in 2022 to 90 TWh in 2026, which is equivalent to a 97% CAGR (Figure 12).

Figure 11:
Electricity consumption per request (Wh)

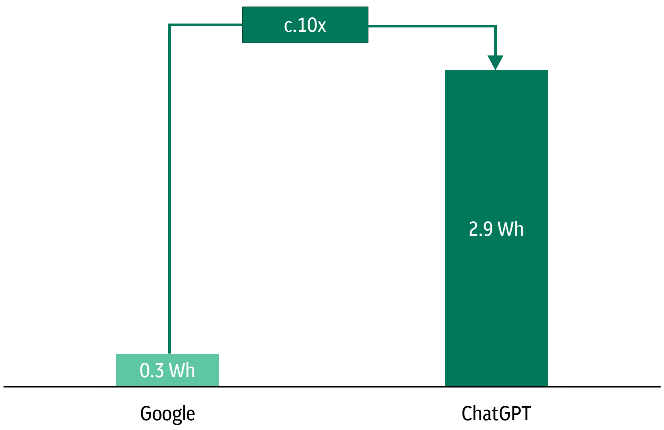
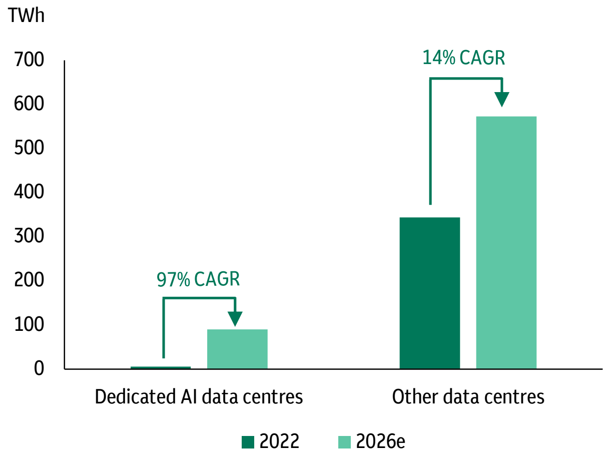


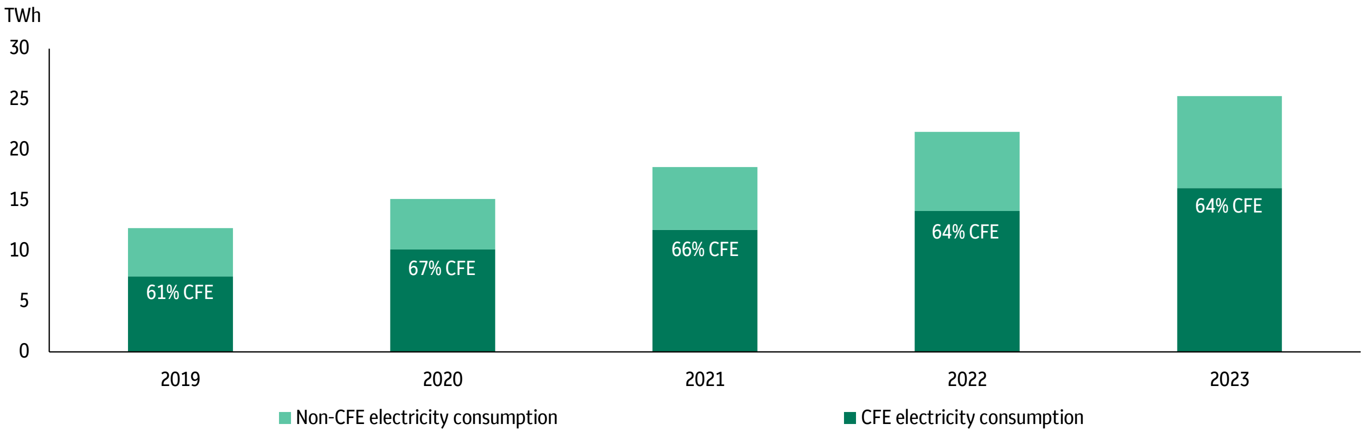
Figure 12:
AI data centres electricity demand, 2022 and 2026e



Source: International Energy Agency (2024).

This surging demand for electricity is complicating matters for some of the large technology companies, with many now falling short of their net zero carbon-emission goals. For instance, Google aims to achieve net zero by 2030, yet its emissions have risen due to insufficient carbon-free energy to keep up with the growing electricity requirements of its data centres (Figure 13). This situation underscores the pressing need for an expanded and more reliable supply of renewable energy, highlighting the significant growth opportunities within the renewables sector.

Figure 13:
Google's total electricity consumption and percentage of carbon-free energy (CFE), 2019-2023



Source: Google 2024 Environmental Report.

In conclusion, while the renewable energy sector faced challenges and disruptions in the immediate aftermath of COVID-19, the sector has since adjusted. Costs have come back down and PPA prices have increased, resulting in much improved economics for the sector. In addition, governments have been working to reduce the permitting and connection delays. We believe the long-term outlook for renewables remains compelling: the need to transition our economies to a much lower-carbon structure remains, renewables are still the cheapest source of power around and we believe are likely to get even cheaper in coming decades, demand for electricity could be on the rise as new technologies (such as AI) proliferate, and corporates' demand for clean power to meet their public commitments remains strong.

Investing with a focus on companies that exhibit a commitment to sustainable practices may result in the Fund investing in certain types of companies, industries or sectors that the market may not favour.

Artificial intelligence (AI) is a set of technologies that enable computers to perform a variety of advanced functions, including the ability to see, understand and translate spoken and written language, analyse data, make recommendations, and more.

Carbon pollution-free electricity (CFE) is electrical energy produced from resources that generate no carbon emissions, including marine energy, solar, wind, hydrokinetic (including tidal, wave, current, and thermal), geothermal, hydroelectric, nuclear, renewably sourced hydrogen, and electrical energy generation from fossil resources to the extent there is active capture and storage of carbon dioxide emissions that meets EPA requirements.

ChatGPT is an artificial intelligence (AI) chatbot that uses natural language processing to create humanlike conversational dialogue.

Compound annual growth rate (CAGR) is the mean annual growth rate of an investment over a period longer than one year.

A combined-cycle gas turbine (CCGT) power plant uses the exhaust heat from gas turbines to generate steam with a heat recovery steam generator (HRSG). The produced steam is then fed to a steam turbine to provide additional power, either running a generator or as a mechanical drive.

Cost of capital is a calculation of the minimum return that would be necessary in order to justify undertaking a capital budgeting project, such as building a new factory. It is an evaluation of whether a projected decision can be justified by its cost.

Earnings before interest, taxes, depreciation, and amortisation (EBITDA) is an alternate measure of profitability to net income, used to assess a company's profitability and financial performance.

A power purchase agreement (PPA) is an arrangement in which a third-party developer installs, owns, and operates an energy system on a customer's property. The customer then purchases the system's electric output for a predetermined period.

Traditional biomass involves wood fuels, agricultural by-products and dung, which are burned for cooking and heating purposes. This source of energy is easily available and accommodates the energy demand of more than two billion people in developing countries.

The **LevelTen PPA Price Index** provides a quarterly in-depth look at PPA offer price averages submitted through the LevelTen Marketplace, for both wind and solar projects, in five independent system operator (ISO) regions, including CAISO, ERCOT, MISO, PJM and SPP.

The **S&P Global Clean Energy Index** is designed to measure the performance of companies in global clean energy-related businesses from both developed and emerging markets, with a target constituent count of 100.

Index performance returns do not reflect any management fees, transaction costs or expenses.

Indices are unmanaged and one cannot invest directly in an index.

Macquarie Group, its employees and officers may act in different, potentially conflicting, roles in providing the financial services referred to in this document. The Macquarie Group entities may from time to time act as trustee, administrator, registrar, custodian, investment manager or investment advisor, representative or otherwise for a product or may be otherwise involved in or with, other products and clients which have similar investment objectives to those of the products described herein. Due to the conflicting nature of these roles, the interests of Macquarie Group may from time to time be inconsistent with the Interests of investors. Macquarie Group entities may receive remuneration as a result of acting in these roles. Macquarie Group has conflict of interest policies which aim to manage conflicts of interest.

Contact us by region

Americas

Market Street
Philadelphia
215 255 1200
mim.americas@macquarie.com

Australia

Elizabeth Street
Sydney
1 800 814 523
miminstitutionalclients@macquarie.com

EMEA

Ropemaker Place
London
44 20 303 72049
mamclientservice.emea@macquarie.com

Asia

Harbour View Street
Hong Kong
852 3922 1256
macquarie.funds.hk@macquarie.com

PERS-NO14-2024 | (3907987-10/24) V6 For institutional investors and investment professionals only.