MACKENZIE Investments

QUARTERLY INSIGHTS
Q1 2024

Global electricity grid: energy transition linchpin or bottleneck?

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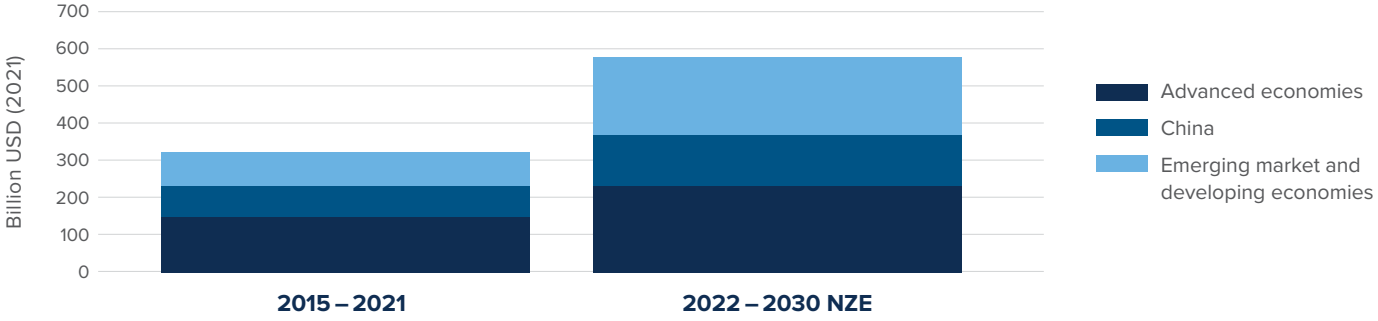
Last month, Mackenzie Greenchip analyst Johnathan Prestwich was in Madrid visiting Iberdrola, the largest power utility in Spain, when the lights literally went out. Power was restored in seconds, but the regional outage was clearly an embarrassment for the executives sitting around the table. More serious outages, such as during the Texas deep freeze of 2021, left 4.5 million homes and businesses without heat, resulted in almost $200 billion in damage and was responsible for at least 200 hundred deaths.[1] It is impossible to overstate the importance of robust and reliable regional electricity delivery. In coming decades, the global "grid" will either become the linchpin of the energy transition or its greatest bottleneck. This note will explore the breadth of grid investment opportunities and why Greenchip believes investors should increase exposure.

Thomas Friedman once described the global electricity grid as the "largest machine ever built." According to the International Energy Agency (IEA), there are about 80 million km of overhead and buried cables worldwide, roughly 100 trips to the moon and back.[2] Reaching countries' national energy and climate goals by 2040 will require at least doubling this length of wire. In their landmark report, Electricity Grids and Secure Energy Transitions, the IEA argues current annual investment of about $300 billion USD will need to increase to about $600 billion by 2030 and then reach $800 billion per annum between 2040 and 2050.[3]

Average annual investment spending on electricity grids
IEA Net Zero scenario, 2015 – 2030



Source: International Energy Agency

It is all based on growing demand. In its base case scenario, the IEA projects that total global electricity demand will more than double — from 25,000 TWh in 2021 to 54,000 TWh in 2050 (IEA Net Zero scenario is higher).[3] This equates to a compound annual growth rate (CAGR) of 2.7% — fairly similar to the growth experienced in the 1991-2021 period. While the last few decades were defined more by developing economies bringing electricity to formerly unconnected households, the drivers of future growth are electrification of sectors that previously used other sources of energy, like transportation (oil) or industrial and residential heat (natural gas), and the intensification of modern electricity-based digital services. In the latter category, there is no greater source of demand than the explosion of investment in AI and, more generally, in data centres.

The enthusiasm for AI set off by the release of ChatGPT and by the massive gains in the NVIDIA stock price has launched a global arms race to accelerate the already rapid build out of data storage and processing capacity. Bank of America expects that an additional 0.5% of electricity demand CAGR will be attributable to data centres in the coming decade, equivalent to what they expect to be added by the transition to electrified transportation.[4] Market research group Dell'Oro estimates annual global data center CAPEX to nearly double from $240 billion to more than $400 billion between 2022 and 2027.[5] Considering recent announcements from dominant tech companies, these estimates could be low. Amazon is projecting $150 billion in data center investments over the next 15 years, while Microsoft, in combination with OpenAI, is planning a single next-generation super data center project with a price tag of more than $100 billion.[6,7]

> **When the dust settles, America's power needs and the consequent capital expenditure will be staggering. – Warren Buffett** [8]

We'll leave questions of the investment returns — or benefits to humanity — from AI to businesses that could justify such massive allocation of capital to future commentaries. Regardless of AI, Greenchip expects that the enormous capital investment required to rebuild and expand the grid will in fact materialize. Politicians realize that electricity blackouts are potentially fatal to their incumbency. In the past year, we have observed that large power utilities are already shifting CAPEX from renewable installations to transmission and distribution. Our belief that the risk adjusted return on grid investments can be very attractive is shared by utility executives.

Segmenting grid opportunities

At Greenchip, we have been investing in grid suppliers and operators since the foundation of the company, seeing it as essential to integrating new renewable electricity supply and to the environmental case for electrification of transport and other energy-intensive industries. Unsurprisingly, such a complex machine has numerous suppliers and operators and numerous ways to invest. "The grid" is much more than just wires, though the wire itself is an interesting investment opportunity.

One way to explore the investment opportunities is to divide them into three buckets based on voltage:

1. **High voltage transmission**, roughly 345kV to 1,100kV;
2. **Medium voltage products** for distribution and commercial/industrial applications, 2.4kV to 230kV; and
3. **Low voltage products** for residential and small commercial consumers, 240V to 600V.

In each of these buckets there are numerous roles in the supply chain: the engineering, procurement and construction (EPC) contractors; equipment manufacturers (transformers and switch gear); materials producers (primarily copper and aluminum) and the operators (utilities).

Equipment providers

Private investment in data centres, warehouses, charging stations, new automated factories and other construction has driven spending in low/medium-voltage products to over 20% growth rate in recent years, especially in the US. Since much of this spending has been driven by aggressive capital markets and government subsidies such as those in the Inflation Reduction Act, there has been relatively little price sensitivity attached to this growth and margins have exploded.

For example, net margins at each of Hubbell and Eaton, US low/medium voltage equipment manufacturers, have increased from approximately 10% to 15% since 2019. Multiples have also expanded — from less than 20 times earnings to nearly 30 times for the same two companies. Share price performance has been dramatic, more than doubling over the time frame, and valuations seem commensurately stretched.

> **Investments into high, medium and low voltage infrastructure must keep pace with each other to avoid exacerbating system imbalances. Unfortunately, investor attention has disproportionately focused on low and mid voltage opportunities so far. – Greg Payne**

While we have owned Eaton and Schneider Electric in the past, price has steered us to more attractively valued companies, mostly focused on the higher voltage space. Companies like Siemens Energy, Hitachi and Mitsubishi Electric Corporation all manufacture high voltage power supplies. In the case of Siemens Energy, the world's second largest provider of such equipment (after Hitachi-ABB, both of which are Greenchip investments), backlog has more than doubled since 2021 and is equivalent to four years of sales at current rates. The company recently raised its guidance for revenue growth in its grid division to 20% and is investing in a new transformer manufacturing facility in Charlotte, North Carolina. Meanwhile, Hitachi-ABB and GE spin-off Vernova (world #3) are following suit.

Utilities

Global power utilities and their regulators are also turning in the direction of higher voltage projects driven both by investment opportunity and necessity. Greenchip holds several diversified utilities such as Engie, EDP, Enel, SSE, Avangrid and Eletrobras. While they are all major developers and operators of generating plants, about 40% of their earnings, on average, comes from transmission and distribution. Business division success is symbiotic. The IEA estimates that there is nearly 1 TW of advanced-stage wind and solar projects around the world currently waiting for a grid connection — about three years of backlog. Grid congestion costs more than tripled between 2019 and 2022.

> **It has not surprised us that our utility holdings are directing more CAPEX to high voltage equipment — equipment that is increasingly backordered, in some cases as much as four years. – Johnathan Prestwich**

Cables and wire

In addition to purchasing transmission equipment, utilities need heavy duty cabling to connect offshore wind developments, replace overhead transmission corridors, bury lines to reduce weather-driven outages, and for interconnections between different electric grid systems. Interconnections enable more import/export of electricity and are utilized for balancing regional variation in intermittent renewable production (for example, bringing North African solar power to Europe by way of the Mediterranean). Leading players in the cable manufacturing and installation industry are all European, led by Prysmian out of Italy with France's Nexans following closely behind. Both have net margins just under 5%, and given long-term demand drivers and barriers to entry, we envision margin expansion opportunity.

As commoditized as cabling sounds, we are watching several technological developments closely. For example, high voltage transmission cables constructed with smaller and lighter carbon fiber (instead of steel) cores enable more of the

conducting aluminum to be wrapped around the cores. Replacing existing transmission lines with this newer technology can increase current and potentially reduce the brutal slog of getting new corridors approved. High temperature superconducting cables are another opportunity. These are composed of wires constructed from composite conducting materials, encased in a tube of liquid nitrogen, or some other super cooling liquid, that enables electrons to flow with almost zero resistance.

According to the New York Times, the United States added just 403 kilometers of high voltage transmission lines in 2023. This in mind, it seems unlikely that the adoption of theoretically possible, but prohibitively expensive, cabling will replace aluminum and copper anytime soon. Copper itself is a more interesting investment opportunity to Greenchip than superconducting materials. We already see that the 25 million tons of copper produced annually is about half of what will be required to meet the growing needs of the energy transition.

Engineering and construction

Historically, transmission and distribution have been small divisions in larger engineering firms (EPC). Increasingly, grid EPC work is covered by highly specialized firms with significant barriers to entry. Companies like Quanta Services and Mastec (a current Greenchip holding), are consolidating the industry. While the business drivers are similar to transmission utilities, EPC returns are earned up front and can come with significantly higher profit margins. That said, these earnings can be more volatile, and diversification is important.

Conclusion

Rebuilding and expanding the global electricity grid is essential to a successful energy transition. It also represents an incredibly rich and diverse set of investment opportunities with multiple entry points and the potential to diversify risks and potential returns. About one-third of the Greenchip portfolio is currently exposed to direct grid investment.

[1] Source: Texas Tribune (February 2021), New York Times (February 2021).
[2] Source: IEA Electricity Grids and Secure Energy Transitions, November 2023.
[3] Source: Net Zero by 2050 – Analysis – IEA.
[4] Source: Bank of America Research Report.
[5] Source: Data Center IT Capex - Dell'Oro Group (delloro.com).
[6] Source: Amazon Bets $150 Billion on Data Centers Required for AI Boom - BNN Bloomberg.
[7] Source: Microsoft's $100 billion 'Stargate' datacenter for OpenAI may be AI's 'Star Wars' moment | Fortune.
[8] Source: Berkshire Hathaway 2024 Annual Letter.