Stirling Infrastructure
PARTNERS LTD

Infrastructure and Energy

Global Medium-Term Outlook to 2028

www.stirlinginfrastructure.com

INSIGHT PAPER

For institutional and strategic investors

Stirling Infrastructure
PARTNERS LTD

Stirling Infrastructure is a leading advisor to institutional investors, listed companies and private market investors. The firm identifies and evaluates both projects and companies that offer a sound investment thesis in the energy and infrastructure sectors. Upon the investment opportunity qualifying through our firm's due diligence process, the investment opportunity is then presented to institutional and strategic investors, including listed companies for debt and equity financing. Our firm also provides M&A, capital restructuring and due diligence services to our clients.

For more information visit: stirlinginfrastructure.com

CONTENTS

Stirling Infrastructure
PARTNERS LTD

EXECUTIVE SUMMARY

This paper outlines Stirling Infrastructure's global outlook. First, it presents the macroeconomic overview, followed by a more detailed analysis of global infrastructure and energy. All assets and sector categories highlighted within this paper have been analysed by our firm. We have done so with the aim of continuing to provide transaction advisory and capital raising services to our clients from an acquisition, co-investment, or refinancing viewpoint for a global investor base.

The following executive summary gives an overview of each section.

Macroeconomics

- After a weak 2023, global output recovers in 2024, driven by emerging markets.
- Economic and global trade uncertainty entrenches higher structural inflation, higher interest rates, and higher cost of capital.
- Foreign direct investment declines in China but remains strong in the US, with geopolitical allies contributing to strength in Qatar, Morocco, and India.

Public versus Private Markets

Private markets remain attractive, but only carefully considered strategies will drive outperformance

Historically, private markets have exhibited good returns when compared to public markets during times of uncertainty and crisis. Based on current information trending in line with this, over the short-to-medium term we expect private markets to see more investment opportunities than their public counterparts. The infrastructure asset class presents more stable recurring revenues for institutional investors and provides inflation-linkages which makes it attractive.

Exchange rates critical to successful private emerging market exits

Exit strategies are important to prevent fire sales in times of uncertainty. This is particularly true in nascent markets, where the exit window tends to be small. In less developed markets, an optimal exit can be sensitive to currency differences.

ESG factors come to the fore when making final investment decisions

Executive decision-making will increasingly be dominated by environmental, social and corporate governance (ESG) considerations. ESG is expected to be brought onto boardroom agendas of both providers and users of capital through greater use of incentives and penalties introduced by regulators to impact investment behaviour. Investment strategies will therefore change from those of previous decades, and investment committees will increasingly allocate more time to ESG appraisals and benchmarking when reaching a final investment decision.

Investment boards will therefore need to understand how ESG factors will need to be considered and reported to stakeholders and regulators. Although no uniform national or international benchmarking standards have been agreed, companies and investors in an expanding geographic range will increasingly become more accountable for reporting and optimising their business model according to ESG considerations. With new carbon pricing schemes progressively becoming a reality, both public and private companies will need to monitor, understand and mitigate their carbon intensities. Corporate strategy will therefore need to adjust to a new, more responsible and accountable business model.

Infrastructure

Global infrastructure spending has been consistently low for decades, with the most significant investment gaps occurring in the Americas, Africa and South East Asia. In this section, we examine eight infrastructure sectors for key trends and risks and investment opportunities.

Key opportunities for inflation-linked airport investments in India and Africa

After a financially challenging period during the COVID-19 pandemic, the air transport industry is poised to recover completely in 2024, and then to grow substantially thereafter. The airport industry is relatively more price-elastic than other infrastructure assets, for example water, broadband and energy. As a result, the airport industry is subject to greater price and demand volatility during economic cycles. Most commercial airports in North America are wholly government-owned, whilst a significant portion of commercial airports in Europe have private ownership. China remains an attractive country for airport investment, but more focus should be directed towards India and Africa, since the economies and populations of both regions are expected to grow significantly in the coming years. This is exemplified by the recent announcement of Qatar Airways' agreement with the government of Rwanda to own, operate, and finance 60% of Rwanda's new international airport and Ethiopian Airlines' $5 billion investment in a new airport in Addis Ababa. Additionally, Indian airline Indigo recently placed an order for over 500 Airbus aeroplanes, the largest single-purchase agreement in commercial aviation history.

Against a backdrop of growing consumer demand, infrastructure, commodities, and geopolitical issues create headwinds for EVs

The electric vehicles (EV) market has witnessed astounding growth over the last decade, with more EVs sold per week today than during all of 2013. This has been driven primarily by policy support, such as government subsidies and incentives – countries with heavier subsidies have seen larger EV penetration. Currently, however, EV prices are still high when compared to their internal combustion engine (ICE) counterparts; therefore, we will see further EV penetration as competition increases between manufacturers, as new technologies emerge, and as the sector is supported by regulatory and policy changes.

Energy demand supports investments into power grids and interconnectors

Interconnectors, which allow countries to trade power generated across borders based on supply and demand, provide new investment opportunities for both strategic and institutional investors, especially given the rapid increase in demand from markets seeking more diverse sources of energy. At the national level, there are opportunities for providing grid response through battery energy storage systems. There is also growth in the number of companies developing their own private grid networks to create independently produced power from the centrally managed grid network.

Bankable rail investments possible in high density areas

Railways are efficient and eco-friendly modes of transportation, especially with electric trains encompassing the majority of passenger rail transport activity. Legislation in both China and the West has earmarked capital for high-speed rail development. However, major opportunities lie in emerging economies, where high population density increases the probability of profitability. One area to monitor is the development of hydrogen powered trains. Where full electrification of the rail network is too capital intensive, hydrogen powered trains may become a lower cost alternative.

Port infrastructure in South East Asia presents attractive opportunities

Seaport development positively impacts regional economic growth, and encourages investment in adjacent infrastructure, such as roads and railways. The COVID-19 pandemic resulted in significant e-commerce growth, which has increased the value of real estate near key seaports. Trade volumes are predicted to continue growing, which will further increase demand for logistics space. South East Asia in particular will see significant growth, so inland dry ports and logistics real estate will present attractive opportunities for investors. Increased localisation of supply chains in the wake of geopolitical tensions will move some portions of the value chain closer to consumer markets. However, given "China +1" – where manufacturing occurs in China plus one other market - plus other supply chain diversification strategies, South East Asian countries will, and have already, experienced significant investment inflows. This will be buoyed too by the expansion of their own domestic markets.

Accelerating investment into road infrastructure

Several countries around the world are heavily investing in building road networks to enhance transportation infrastructure and stimulate economic growth. Notable examples include China, India, the United States, Brazil, and Nigeria.

China leads the pack with its ambitious $1.8 trillion infrastructure spending plans, aiming to bring what is already the biggest motorway network in the world to a total of 130,000 kilometres by 2027. This represents an 11% increase from 2021. India is also investing significantly into its road networks to bolster its domestic connectivity, reduce transportation costs, and support economic development. The country's National Highways Development Project and Smart Cities Mission are driving these investments. The United States introduced the Bipartisan Infrastructure Law, which marks the largest investment in roads and bridges since President Eisenhower's investment in the interstate highway system back in the 1950s. Brazil, with its vast geographical size, is investing in road networks to connect remote regions, improve logistics, and foster economic integration. Nigeria is focusing on road infrastructure as part of its efforts to diversify the economy, enhance regional integration, and promote trade.

Data security creates problems for 5G and broadband infrastructure

With growing global digitalisation, the need for reliable and fast broadband infrastructure is increasing. 12% of the world population gained internet access for the first time in just the past three years, rising from 54% in 2019 to 66% at the end of 2022 (the most recent figure available). Mobile operators, governments, and large corporations are investing large sums of money in improving internet speed. However, with the advent of 5G, policymakers in North American and European markets are faced with a decision between rapidly enhancing internet coverage using 5G at the expense of data security (given the movement in their policies to remove Chinese 5G infrastructure from their territories), and a slower and secure rollout.

The markets that present promising investment opportunities for broadband and 5G infrastructure are those characterised by significant growth potential, supportive regulatory environments, and increasing demand for high-speed connectivity. Emerging economies with large populations and expanding middle classes, such as India, Brazil, and Indonesia, offer substantial prospects for infrastructure development. Additionally, developed nations that prioritize digital transformation and have robust technological ecosystems, such as the United States, South Korea, and Germany, are attractive investment destinations. Furthermore, sectors like healthcare, smart cities, autonomous vehicles, and the internet of things (IoT) are driving the need for enhanced broadband and 5G infrastructure, making them lucrative areas for investment.

High-tech cities will require deeper digital infrastructure

Highly developed cities of the future will demand more extensive digital infrastructure to support their advanced technological systems. As urban areas become increasingly connected, there will be a greater need for robust and high-capacity network connectivity, data centres, and communication channels. Infrastructure such as high-bandwidth 5G will enable seamless integration of technologies including IoT, artificial intelligence (AI), and autonomous systems, which will power improvements in urban life including transportation, energy management, healthcare, and public services such as waste management and emergency response. Deepening digital infrastructure will be crucial for the efficient and effective functioning of these high-tech cities.

Energy

Climate commitments are pushing governments and industries to decarbonise by reducing their reliance on traditional fossil fuels and investing in renewable energy sources. The US presidential election is a key area for investors to watch as a barometer of United States policymaking towards its commitment to reducing carbon emissions. In terms of ongoing usage of fossil fuels and specific activities like fracking, Republicans demonstrate greater support, considering them as potential means to mitigate US inflation.

However, Democrats are generally more in favour of driving innovation, and the industrialisation of green technologies, through government incentives to accelerate the achievement of net zero through energy transition. Moreover, recent events, such as Russia's invasion of Ukraine and the subsequent spike in oil and gas prices, have underscored the imperative of energy security, affordability, and their role in reducing carbon emissions, especially in Europe. This section explores a range of transitional energy alternatives, consisting of green and blue hydrogen, wind and solar power, and nuclear energy.

Both blue and green hydrogen may gain traction

Green hydrogen, produced using water electrolysis, is gaining prominence as a low-carbon fuel alternative. Investment opportunities abound in ammonia production, regional hubs, heavy industries, and hydrogen fuel cell trains. Blue hydrogen, made from natural gas, offers an attractive diversification pathway for oil and gas companies, with Gulf and MENA regions poised as production centres.

Small nuclear reactors provide a possible but unproven contribution to net zero

Nuclear power, particularly in the form of small modular reactors (SMRs), is beginning to pique investor interest due to net zero commitments and energy security concerns. SMRs are smaller than traditional nuclear power plants (<300 MWe) and, because they are modular, can be produced en masse in factories. Due to these factors, they could benefit from lower production costs, faster construction times, and diverse use cases, including providing baseload power, co-generation, and decarbonising heavy industries. They could also serve as an affordable alternative to conventional nuclear power plants in developing countries with smaller electricity grids and fossil fuel dependency. However, many SMR technologies are still in their infancy and those with the highest technology readiness level (TRL) are still prohibitively expensive for the private market. Therefore, whilst SMRs and nuclear power in general offer significant investment opportunities, investors should ensure awareness of all the associated risks posed, and note that much of the current market interest is still in early stages.

Wind and solar becomes economically competitive; capacities expand in the Middle East, Africa, and Asia Pacific

The levelised cost of electricity (LCOE) for renewables like wind and solar has dropped, which makes them more competitive with traditional energy sources. Investment opportunities in wind are primarily in the US, China, France, Germany, and the UK, while emerging economies like India and Argentina offer higher risks and returns. The solar market is divided into residential, non-residential, and utility uses, with the Asian Pacific region expected to dominate utility-level solar production. The Middle East and Africa are predicted to experience significant solar production growth due to their ideal conditions and efforts to reduce fossil fuel dependence.

Sustainable aviation fuel enters the market; investment opportunities present in bioenergy production technology

Decarbonising the aviation industry is critical, and sustainable aviation fuel (SAF) can reduce emissions by 80% compared to conventional fuels. Despite its higher cost, SAF usage is expected to increase, offering investment opportunities across supply and production chains. Bioenergy, produced from biomass, is versatile, renewable, and can provide carbon-negative energy. As bioenergy production is still relatively inefficient, investment opportunities lie in technologies to increase efficiency, energy storage, transportation infrastructure, and carbon capture technologies.

LNG offers a potential bridge towards renewables and storage

The LNG market has grown significantly, linking natural gas production regions with demand centres. Europe has increased import volumes, especially since Russia's invasion of Ukraine. Natural gas is expected to be a "bridging fuel" during the energy transition, complementing intermittent renewables until large-scale power storage becomes viable. Investment opportunities exist in new and expanding LNG projects. However, there exists a risk in the medium to long-term of facilities becoming stranded assets if the global switch away from hydrocarbons happens faster than expected.

Purpose of this paper

The firm's objective in writing this paper is to support institutional and strategic investors to make responsible direct investments into infrastructure and energy opportunities globally. The firm has subject matter expertise in advising investors, project sponsors, and company management in the selection of target companies for acquisition, co-investment, joint ventures, capital allocation, and refinancing in all the subsectors outlined in this paper.

The paper provides Stirling Infrastructure's global infrastructure and energy outlook for direct investments with analysis. The firm has long established relationships with most of the world's largest institutional investors and many of its listed companies, with an international footprint managing and operating assets and investing in energy and infrastructure across international markets. The views shared within this paper are the collective views of Stirling Infrastructure's Investment Board. In addition to independent analysis, this paper also includes intelligence from working closely with a wide and diverse range of international sources of capital.

MACROECONOMIC OUTLOOK

2022 contained a range of significant and unusual events, which impacted global economies. The Russian invasion of Ukraine took centre stage and accelerated swelling inflation by exacerbating shortages even as global consumption recovered from the COVID-19 pandemic. Central banks were slow to respond, and as a result have been faced with the choice of either raising rates aggressively to quell inflation but risk a hard-landing recession, or playing it safe, but risking stagflation. Going forward, investors should consider three key themes: firstly, anaemic global output; secondly, structurally higher inflation; and thirdly, higher cost of capital. We will briefly touch on these themes in the sections below and provide guidelines for investors to navigate the coming uncertain environment.

After a weak 2023, global output recovers in 2024 thanks to emerging markets

Figure 1[1]

Real GDP (percentage change from previous year)	2022E	2023F	2024F
World	2.9	1.7	2.7
% difference from June 2022 estimates	0	-1.3	-0.3
Advanced economies	2.5	0.5	1.6
% difference from June 2022 estimates	-0.1	-0.17	-0.3
EMDE	3.4	3.4	4.1
% difference from June 2022 estimates	0	-0.8	-0.3

The World Bank estimates[2] that global output will be weak in 2023 before rebounding to more healthy levels in 2024. Much of this growth will be driven by emerging markets and developing economies (EMDE). Asia and Africa will see the fastest growth, followed by the Middle East and Latin America with projected growth rates of 2.5-3.5%. Accordingly, EMDEs should be geographies into which investors consider allocating capital towards investments in the energy and infrastructure sectors.

Within the burgeoning Asian economies, India is set to experience the most rapid expansion. This is partially due to its steep population growth – in 2023, it surpassed China as the world's most populous country (Figure 2). Nevertheless, China is still forecasted to be the largest source of economic growth globally in the next 5 years (Figure 3).

Figure 3 - Expected contributions to global economic growth (2023 - 2028)

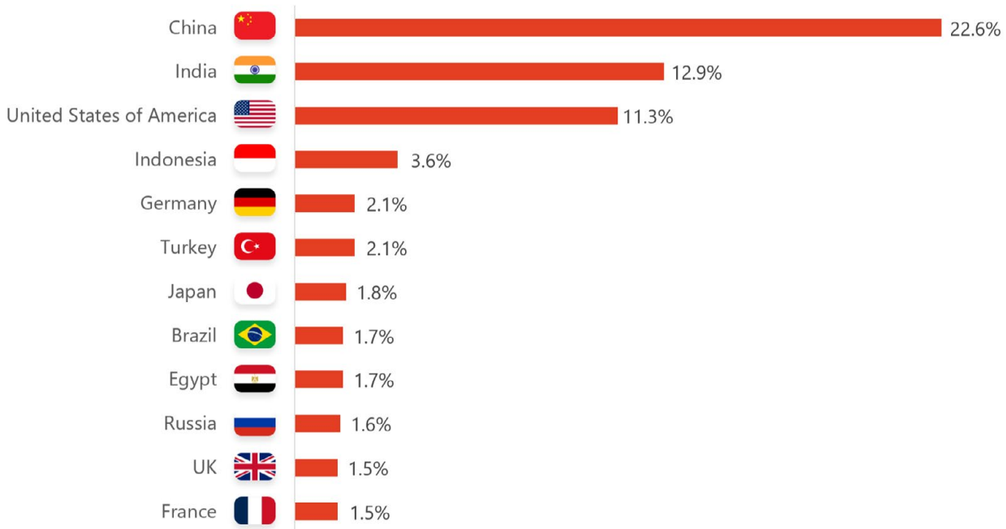
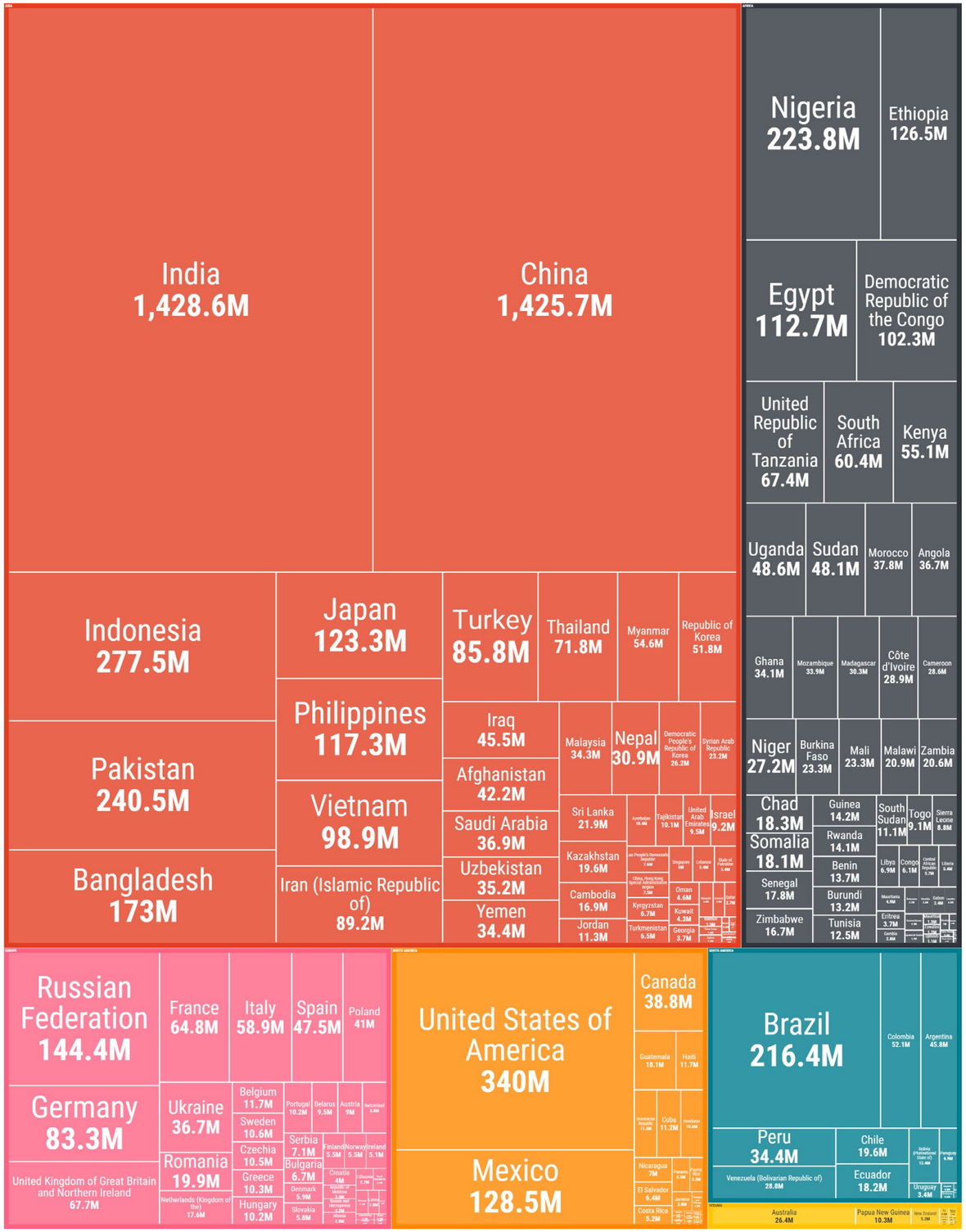


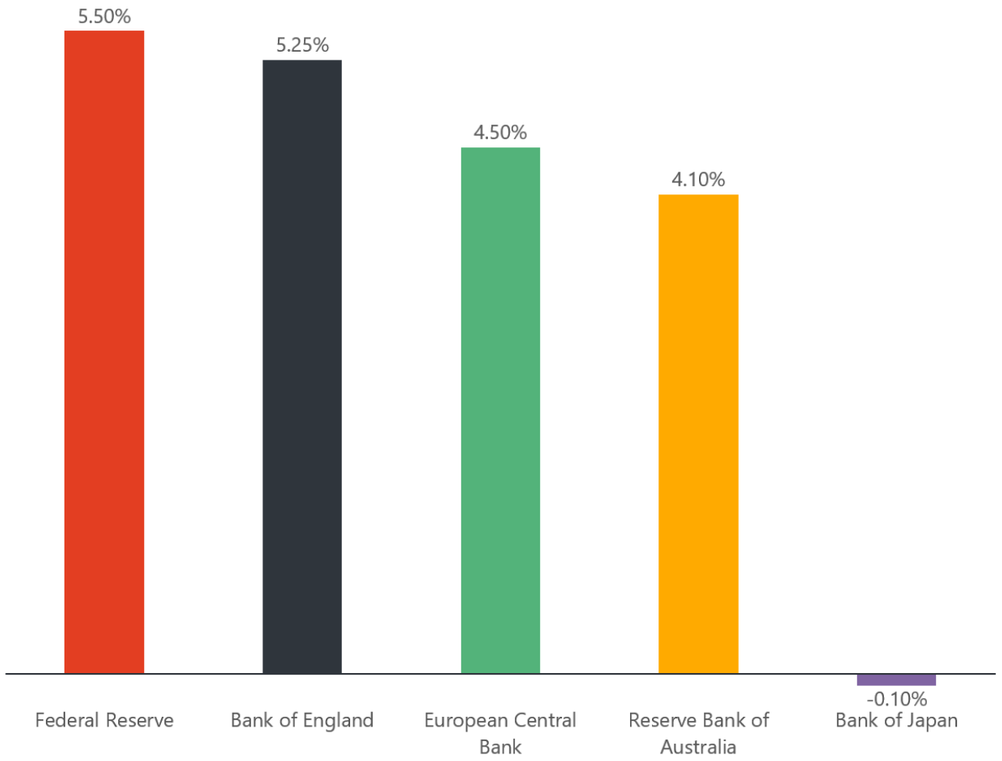
Figure 2 - Global population (2023)



Economic and global trade uncertainty entrenches higher structural inflation, higher interest rates and higher cost of capital

Apart from the economic slowdown, there remains significant uncertainty in the current macroeconomic environment. Inflation in the West has reached its highest levels in 40 years, and interest rates have risen considerably at the fastest pace in decades (offset to some extent by fiscal policy). Raising interest rates further may pose national balance sheet predicaments as a burgeoning national debt refinanced at higher rates, coupled with weak national output, may pressure fiscal budgets considerably and trigger hard recessions.

Figure 4 - Central banks have raised rates at the fastest pace in decades[3]



Rates correct as at 3rd August 2023

Moreover, the global structure of trade has altered considerably since the pandemic: with an increasing share of global oil production, the OPEC+ cartel is able to determine the price of oil simply by altering its actual and planned output, and global corporations are diversifying supply chains, opting for resilience in lieu of cost efficiency leading to higher prices. Poor political decisions in recent years will also lead to long term repercussions. For instance, Brexit will leave residual implications on structural inflation, restrict labour mobility, and drive up the cost of international trade due to increased regulatory hurdles. We expect that sticky inflation will lead to structurally higher interest rates going forward and global uncertainty will increase the risk premium, cumulatively augmenting the cost of capital for investors.

Key Analysis: Persistent inflation will likely lead to structurally higher interest rates at least for the shorter term, whilst global uncertainty will increase the risk premium, together raising the cost of capital for investors.

FDI declines in China but remains strong in the US, with geopolitical allies contributing to strength in Qatar, Morocco, India, and neighbouring Asian countries

Foreign direct investment (FDI) will maintain strong momentum in the US, and initiatives in Europe will attract large amounts of foreign capital. On the other hand, China has been seeing a decline in FDI. Saudi Arabia has also established itself as an attractive FDI hub and in the coming decade, we expect the nation to be less reliant on oil and gas. Major recipients of FDI capital include Qatar, Morocco, India, and neighbouring Asian countries like Pakistan and Bangladesh, due to friend-shoring (manufacturing and sourcing from geopolitical allies). Their credit ratings are laid out in Figure 5.

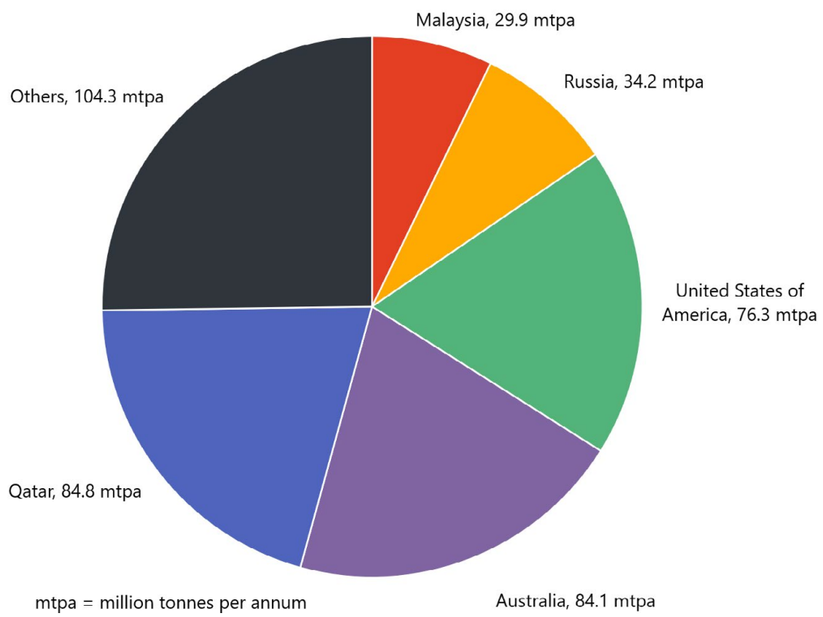
Figure 5

Country	S&P	Fitch
US	AA+	AAA
China	A+	A+
India	BBB	BBBB
Saudi Arabia	A	A+
Qatar	AA+	A
Morocco	BB+	BB+
Pakistan	CCC	CCC+
Bangladesh	BB	BB

Correct as at 27th July 2023

Investors looking to capitalise on secular trends should be aware of key FDI flows in the medium term. Our analysis supports forecasts that major economies in the Middle East and North Africa will experience the greatest investment growth in 2023 – particularly Qatar (the world's largest exporter of LNG as seen in the chart below), India (the world's largest recipient of R&D investments) and Morocco (fertile ground for green hydrogen production). Moreover, due to friend-shoring and supply chain diversification, outbound FDI from the US will be directed towards friendly Asian countries, such as India, Taiwan, Philippines, and Vietnam. On the other hand, China has already seen a decline in greenfield projects and inbound M&A transaction values over the last couple of years. The flow of FDI to the aforementioned nations should serve as a tailwind to economic output and provide significant employment opportunities across these regions.

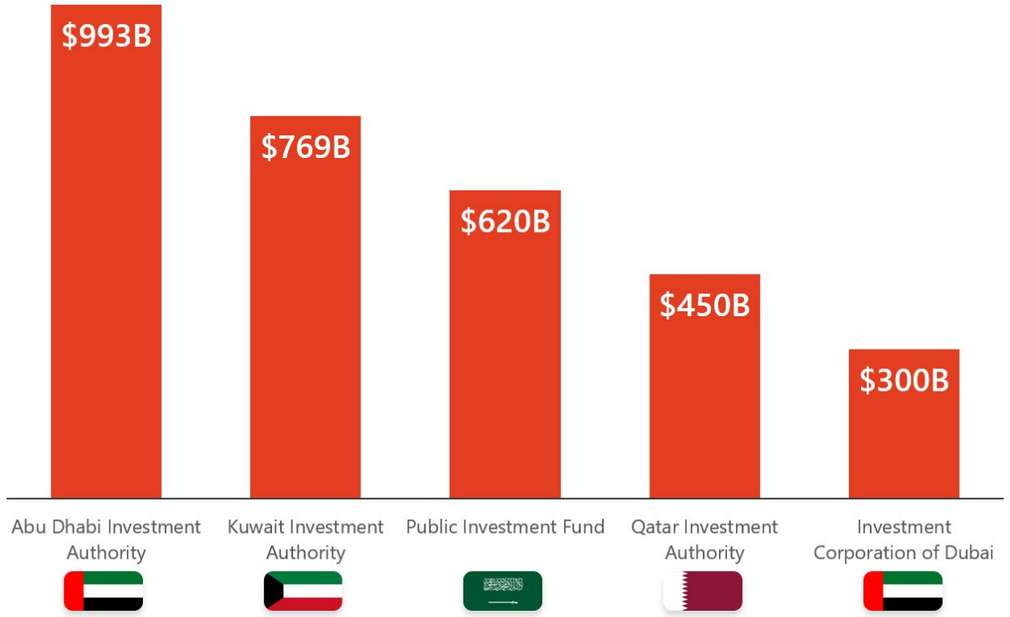
Figure 6 - LNG exports[4]



The European Union (EU) will also see dramatic infrastructure development in the coming years. The EU has adopted a recovery fund of €750 billion to facilitate economic reparation and recovery post COVID-19. Much of this fund is directed towards encouraging digitisation and transition to net zero, and will stimulate infrastructure and clean energy investment. The Kingdom of Saudi Arabia (KSA) has also marketed itself as an attractive FDI hub,[5] establishing the Saudi Arabian General Investment Authority (SAGIA) in 2000 to simplify inbound investing and initiating visa regimes, as well as facilitating tourism and labour mobility. The cumulative effort saw a 20% increase in FDI inflows in 2020, despite regional neighbours facing a slump. Looking ahead, the Kingdom's Vision 2030 plan seeks to diversify its economy and reduce the KSA's reliance on oil and gas – investors will find opportunities within tourism and real estate as these sectors flourish.[6] The United States is likely to remain the top destination for inbound FDI, and whilst Africa may see short-term reductions in FDI due to global economic weakening, China will remain a key investor in the years ahead as Africa's population increases and demographics shift to a predominantly younger workforce. However, intelligence supports that both Europe and the US will also be progressively increasing direct investments into the African continent.

Finally, Gulf wealth funds have significant assets under management (AUM) and have become increasingly active in global markets.

Figure 7 - Middle East assets under management as of January 2023[7]



Key Analysis: Due to friend-shoring as a result and attempts to diversify supply chains, outbound FDI from the US will be directed towards friendly Asian countries, like India, Taiwan, the Philippines, and Vietnam.

PUBLIC VERSUS PRIVATE MARKETS OUTLOOK

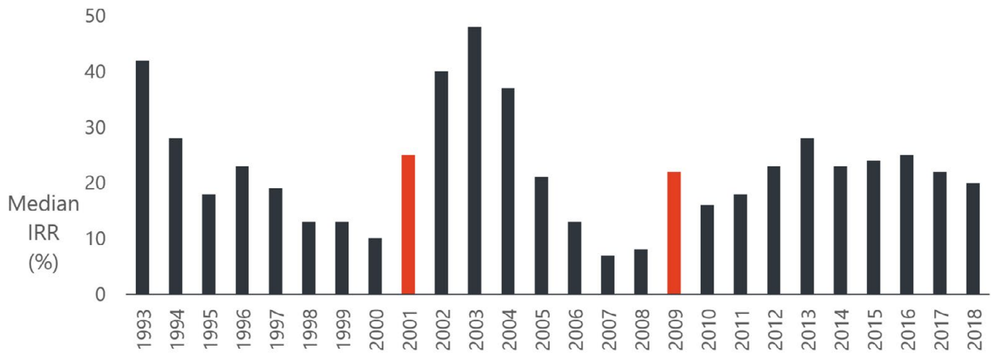
Private markets remain attractive, but only well-considered strategies will generate good returns

Private markets have historically exhibited good returns during crises while maintaining comparatively less volatility than public markets. Moreover, the set of available private market opportunities are wider than those of public markets. Conversely, although private market assets offer less liquidity in exchange for this benefit, by making investments in suitable assets offering inflation linked returns and consistent cash flow to investors, the effect of this capital growth illiquidity can be minimised. The environment going forward, however, will require a different private market strategy than the previous decade. Infrastructure investing presents an attractive class of investments given inflation-linkages; ESG will also be an increasingly important consideration for investing going forward.

Despite the global uncertainty laid out above, Stirling Infrastructure believes that long-term investors can find rewarding investment opportunities in the current climate. The opportunities set in private markets are poised to increase considerably in the coming years. Over the last 20 years, the number of public companies in the US has halved whilst the number of private companies has quadrupled. Key reasons include the costs of running a public company due to reporting requirements and regulations and the need to attend to short-term shareholders via quarterly earnings reports, which can make it difficult to effect genuine, transformative operational changes when necessary. Hence, firms are considering an IPO much later in their lifecycle, if ever.

Private equity investments have outperformed public assets across a broad spectrum of economic and interest rate environments, whilst exhibiting lower volatility. Long-term investors should also be reminded that returns are generally better during times of uncertainty, as exhibited in the diagram below – 2001 marked the bursting of the dot-com bubble and 2009, the Great Recession – as highlighted in red. In both instances, investments made during these periods have outperformed preceding years by a wide margin.

Figure 8 - Global buyout deal IRR by year of entry[8]



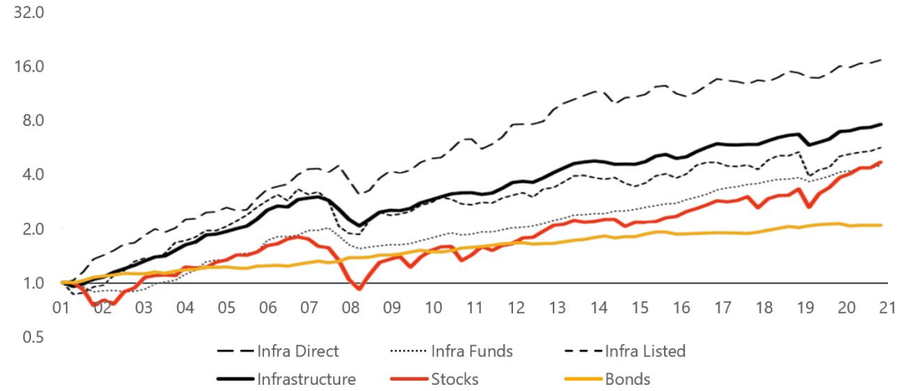
Figures up until 2018 as fund investments in recent years have yet to be liquidated

Given the structural changes mentioned above, future returns will no longer originate solely from multiple expansion; creativity and risk-seeking will be required – namely, i) taking advantage of the growth in emerging markets, ii) prioritising assets that serve as inflation hedges, and iii) managing portfolio companies for organic growth and margin expansion. However, portfolio managers should nevertheless maintain an adequate proportion of high-quality income generating and growth assets in developed economies to balance the total risk portfolio.

Over the last decade, European private markets investments have outperformed public markets, as opposed to in the US, where returns from public and private markets have begun to converge instead.[9] The persistence of this phenomenon is to be determined, but the fact remains that many of the highest quality companies are publicly listed in the US and remain a haven for capital in times of uncertainty, driving returns. We believe this creates a scarcity of capital access in other areas of the globe, despite better output growth and nascent opportunities, which intrepid investors could take advantage of. Pension funds have been quick to seize the opportunity set, increasing their allocations in Asian emerging markets and the Middle East in the post-COVID era.[10]

Private infrastructure investment has emerged as a highly significant asset class with promising prospects for investors in the future. Not only have infrastructure assets consistently delivered impressive performance, surpassing both stocks and bonds over the past two decades, but they also possess inherent attributes such as regulatory and contractual inflation escalators. This makes them an ideal hedge against inflation, particularly in our present economic climate. Their returns demonstrate a stronger positive correlation with abnormal inflation levels, further accentuating their appeal. It is worth noting that this relationship is more pronounced in direct infrastructure investments, as opposed to infrastructure stocks, which can be influenced by external factors like investor sentiment.

Figure 9 - Cumulative returns since 2000 (multiple)[11]



The graph above exhibits the correlations between quarterly year-on-year changes for the total returns of each asset class and the changes in US CPI above 3% and below 0%

Finally, it is worth noting that infrastructure assets offer the added advantage of lower asset price falls in times of crisis. This characteristic makes them an excellent choice for portfolio diversification, enhancing the risk-adjusted returns of a portfolio.

With that said, generic assets without direct inflation linkages will experience exit multiple compression (more so than infrastructure assets). To avoid this, investors ought to be selective, pursuing conservative entry multiples, and ensure there is room for operational improvements in target companies and pick firms which command greater pricing power.[12]

Finally, investors should not neglect alternative energy and ESG. Alternative sources of energy to hydrocarbons have seen significant growth opportunities, as has the infrastructure sector required to facilitate this growth, and this upward trend will continue. ESG will too be an increasingly important investment variable going forward. Studies show that firms with excellent ESG ratings outperform those with lower ESG ratings on shareholder returns, despite similar financial performance.[13] The positive correlation between ESG and returns should further increase as greater global awareness for energy security and government policies, such as the Inflation Reduction Act (2022) and the EU's new Green Industrial Plan (2023) further incentivise ESG- conscious investing.

Key Analysis: Assets without direct inflation linkages will experience exit multiple compression. To avoid this, investors ought to be selective, pursuing conservative entry multiples, ensuring room for operational improvements in target companies and picking firms with pricing power.

Exchange rates critical to successful private market exits in emerging economies

Exit strategies are important to prevent fire sales in times of uncertainty. Especially so in nascent markets, the exit window tends to be small and is usually contingent on domestic currency appreciation and atypically high valuations. Investors ought to seize these windows when they arise.

Given the macro-uncertainty in the coming years, investors ought to prioritise exit strategies, especially when investing in nascent markets. Private market exits generally come via a public listing, a secondary buyout, or a trade sale. Better exit liquidity is generally preferable, because it prevents fire sales in times of sudden client redemptions and, therefore, an illiquidity risk should be factored in the cost of capital of the investment. Factors that affect liquidity include degree of capital movement control and economic outlook, the latter of which is dependent on demographic trends, urbanisation, technological advancements and various other factors. Research on the private equity industry in Brazil, a volatile emerging market,[14] has shown, however, that changes in exchange rates and high price-earnings ratios relative to the broader market sector are key determinants of exit metrics. In other words, market conditions are often the main determinant, and accordingly, investors ought to exploit these windows when available to extract liquidity, especially in frontier markets at the limits of the investable universe.

INFRASTRUCTURE OUTLOOK

Infrastructure is a sector which experiences chronic and persistent underinvestment: global infrastructure spending reads well below the sweet spot of 3.5% of GDP globally. The Americas and Africa suffer from the largest deficit particularly with respect to roads, ports, and airports.[15] Asia is poised to be the dominant player in the global infrastructure market in coming years,[16] and electricity and roads will account for more than two-thirds of global infrastructure investment. The sections below will cover various infrastructure sectors and highlight key data and trends to assist investors in making informed decisions within the space.

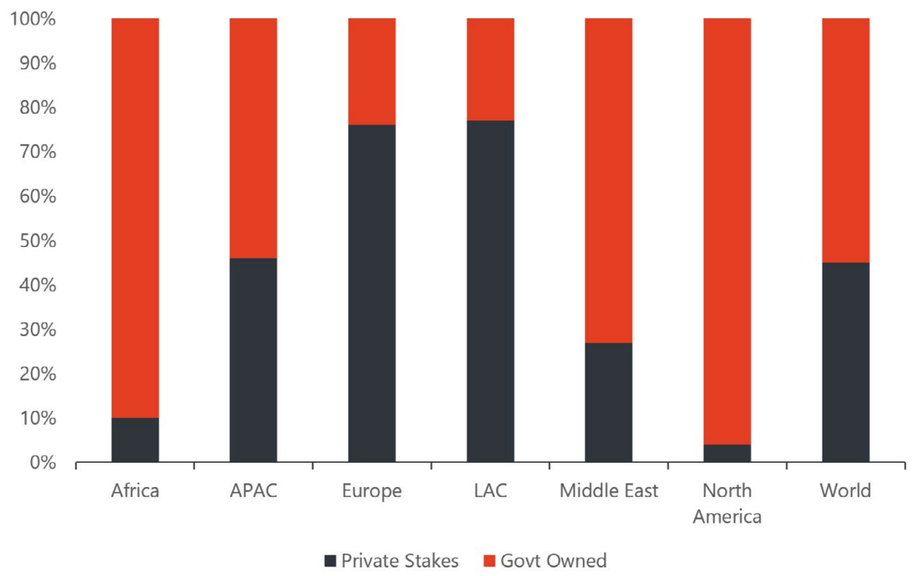
Key opportunities for inflation-linked airport investments in India and Africa

Air travel is poised to recover completely in 2024 and then grow substantially. The airport industry features both revenue and cost inflation linkages which aligns well with the investment strategy of institutional investors seeking stable inflation-linked returns. Most airports in North America are wholly government-owned, whilst most European airports have private ownership. Whilst China remains an attractive country for airport investing, more focus should be directed towards India and Africa, both of which have significant latent potential.

In 2020-2022, global travel all but stopped due to the COVID-19 pandemic, and its recovery was then hit by the Russian invasion of Ukraine. The International Air Transport Association (IATA), however, is forecasting global passenger travel to return to 2019 levels by 2024, before expanding substantially over the next two decades, at approximately 3% annually to 8 billion passengers by 2040. The APAC region will be the fastest growing, due to favourable income growth and demographic factors, followed by the Middle East, Africa, and Latin America.

Airports, carefully selected, remain key attractive assets, given inflation pass-through abilities, monopolistic characteristics, and secular growth trends. In this regard, it is important to understand the difference between single-till and dual-till airports. Both aeronautical and non-aeronautical activities are regulated under a single-till structure, whilst only aeronautical activities are regulated in a dual-till structure. In other words, for the latter, there are no predetermined capped returns from the airports' customer-facing operations (e.g., retailing, food, and beverage etc.). This gives leeway for a dual-till airport to extract higher rents dependent on a variety of factors, i.e., airport location, customer type etc. In both operation structures, however, contracts tend to have inflation linkages and therefore inflation is passed through to consumers.

Figure 10 - Airports with private stakes (2019)[17]



Private investment stakes in airports are uniquely low in North America, at a mere 4% based on passengers handled, even lower than Africa (10% and growing) and other developing regions. Private stakes in European airports and LAC (Latin America and the Caribbean) airports are the highest globally. With regards to emerging opportunity sets, investors should take note of governments set on constructing more airports and a willingness to partner with private investors – a key example being India. In August

2022, India's Minister of Civil Aviation reported increased operational airports from 74 in 2014 to 141, with plans to construct 79 more airports by 2026, a 56% increase to 220 airports. This figure would place India on the same ground as China – 248 operational airports in 2021 – although the nation has already surpassed China in terms of population. This shows that whilst India has been less economically developed than its neighbour historically, it is on an accelerating trajectory.[18]

Whilst China was a key investment hotbed for airports, going forward, geopolitical tensions and a weak economy beset by falling real estate weakens the investment case. Moreover, specialist investors such as Fraport are divesting from China (as is the case with Xi'an Airport), after expressing disappointment in their ability to expand operations in China. While China will continue to be a growth market, it is not the only option, and it will serve investors well to shift attention to emerging neighbouring countries such as India, Philippines, and Vietnam.

Africa is another region to watch, as the continent holds one-fifth of the world's population and carried only 3% of global air passengers pre-COVID. Africa suffers from poor airline load factors and has not kept up with the trends of low-cost airline development seen in developed markets. However, Africa is a growth market and the open-skies initiative, the Single African Air Transport Market (SAATM) signed in 2018, sets the stage for flight development. Moreover, Qatar Airways is an investor in the upcoming, $1.3 billion, state-of-the-art Bugesera Airport in Rwanda, setting a precedent for more greenfield modern airports across the continent.

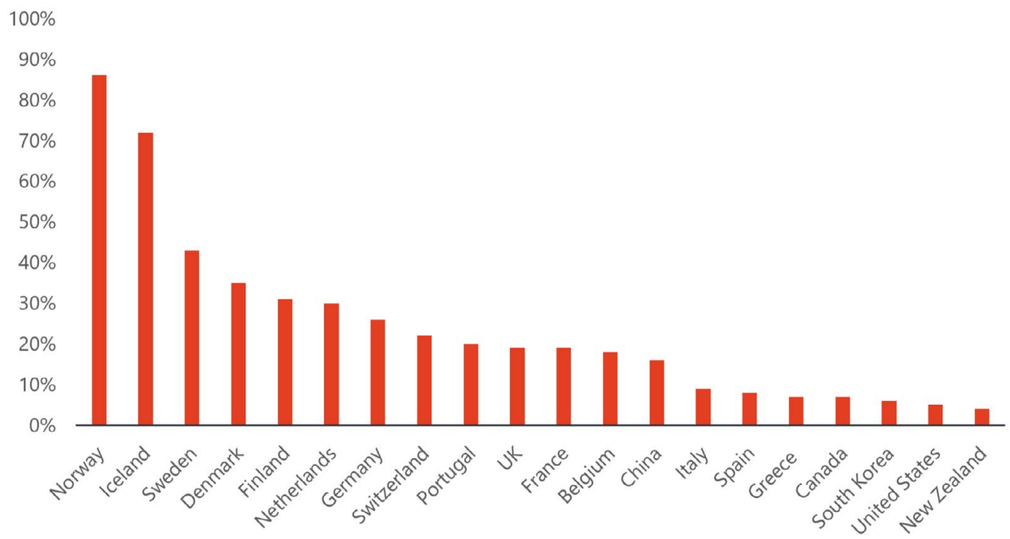
Key Analysis: Carefully selected airports remain attractive assets, given inflation pass-through abilities, monopolistic characteristics, and secular growth trends.

On a backdrop of growing consumer demand, infrastructure, commodities and geopolitical issues create headwinds for EVs

Sales of electric vehicles (EV) have seen astounding growth over the last decade, driven primarily by policy support, such as government subsidies and incentives, and countries with heavier subsidies have a larger EV penetration. However, EVs are still more expensive than ICE vehicles. As EV prices drop, penetration will increase and so further stimulate global demand. Nevertheless, there are still key challenges that may stifle future growth: a lack of charging infrastructure, shortage of key commodities, and battery supply chains' concentration within Chinese territory.

The EV market has seen rapid and significant growth in the past decade. Sales of EVs increased over 55% year-on-year in 2022 to a record 10.5 million.[19] 10 years ago, only 120,000 EVs were sold globally, which is less than the volume sold in a single week today. In 2022, ~14% of global car sales were EVs, five times the market share pre-COVID.

Figure 11 - Electric vehicle sales as a % of overall car sales, 2021[20]



Public spending for EV subsidies and incentives doubled in 2021 to an approximate $30 billion. This is reflected in Figure 11: the top countries, far ahead in the EV adoption curve, have achieved this due to favourable tax policies and incentives. Norway, which leads the market in EV uptake, has proposed a ban on sales of consumer petrol/diesel cars by 2025, far ahead of a similar policy in the UK (2035). Globally, governments and car manufacturers alike have pledged to gradually phase out ICE sales. From the consumers' perspective, there were five times more EV models to choose from in 2021 compared to 2015, bringing the total available models to 450. Additionally, global prices of EVs are set to decline going forward, lowering the bar for purchase. Tesla, a pioneer, and leader of the EV space, has lowered its vehicle average selling price gradually over the past few quarters. A downtrend in input costs may result in lower upfront costs to the consumer for the broader market.

Figure 12 - Tesla's consolidated average selling price ($USD)[21]

Going forward, China will be a key growth market to watch; in 2022, China sold more electric cars than the rest of the world combined. Although in the period post-pandemic subsidies have been progressively rolled back (with some recent signs of resurgence), the continual record sales demonstrated by firms such as BYD[22] attest to the strong demand in China. As the government continues its goal of decarbonisation acceleration via its 14th Five-Year Plan (2021-2025), it has achieved its objective of EVs reaching an annual average of 20% of total car sales, with BEVs making up 21.4% of cars sold in 2022.[23] Growth is expected to remain strong in the coming years.

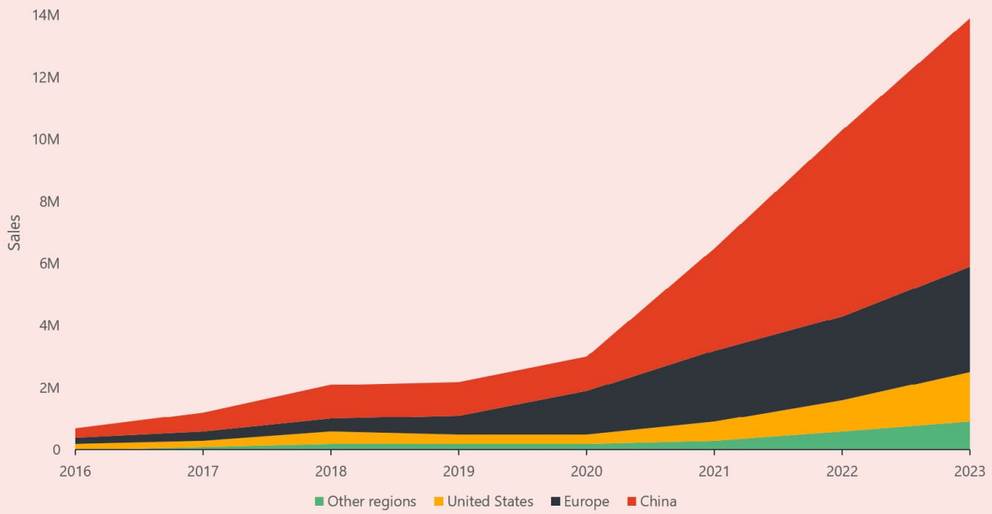
However, globally, the number of public chargers must increase 9 times by 2030 to ensure adequate fleet coverage. Shortage of critical minerals such as lithium, cobalt, nickel, and copper has sent the respective commodity prices surging in recent years; and, whilst batteries are becoming more efficient, there is no guarantee that these efficiency gains will be able to offset inflated commodity prices. Moreover, most of the battery supply chain is concentrated around China. Although the United States and Europe are both far behind China in having access to critical battery minerals, both are now in the process of providing subsidies to attract battery manufacturers to set up facilities in these regions, and both are identifying new sources of these minerals independent of the Chinese EV battery value chain. This has been supported by more flexible state aid rules and new government incentive packages, including the US Inflation Reduction Act and the EU's Net Zero Industry Act and Critical Raw Materials Act. The latter two aim to strengthen the EU's industrial base for clean technologies and to increase Europe's capacity to source and refine critical raw materials rules. The benefits of these subsidies also support the manufacturing of battery energy storage systems (BESS) which have a variety of use cases from utility scale battery storage systems to commercial use cases, including as backup storage for businesses and homes.

However, the status quo of Chinese dominance is unlikely to change before 2030, which may pose problems given the geopolitical tensions. More details can be found in Stirling Infrastructure's EV technical paper.

Key Analysis: The US and Europe are far behind China in the EV value chain. Global prices of EVs are set to decline going forward, lowering the bar for purchase. Tesla, a pioneer in the EV space, has lowered its vehicle average selling price gradually over the past few quarters, and a secular downtrend in input costs may result in lower upfront costs to the consumer for the broader market.

The electric vehicles (EV) market has witnessed astounding growth over the last decade.

Figure 13 - Global EV sales between 2016 - 2023[24]

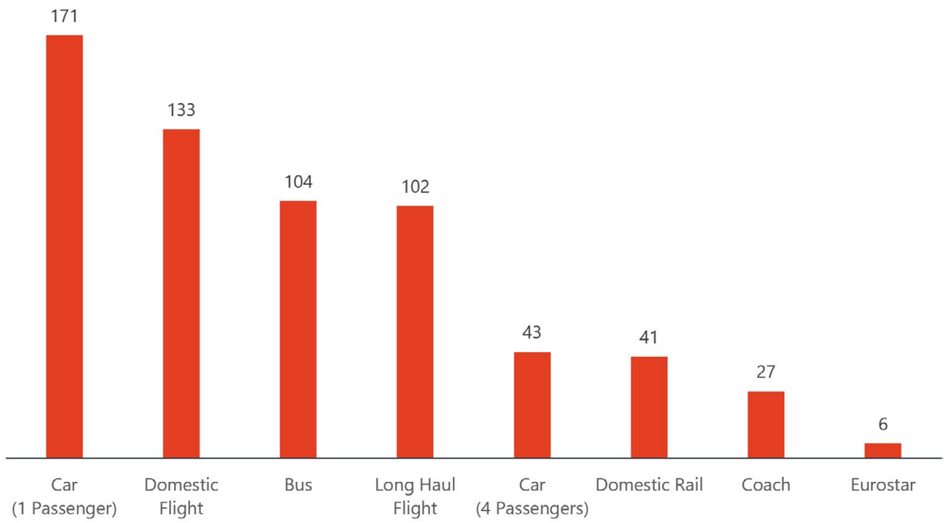


Bankable rail investments possible in high-density areas

Railways are efficient and eco-friendly modes of transportation, especially with electric trains encompassing the majority of passenger rail transport activity. Legislation in the West has earmarked capital for high-speed rail development. There are also major opportunities in emerging economies, where high population density increases the probability of profitability.

Railways promote economic growth whilst minimising greenhouse gas emissions. However, due to slow speeds, inaccessible pricing, and poor reliability,[25] target users often default to substitutes which tend to be less efficient and more harmful to the environment.

Figure 14 - UK CO_2 emissions (g) per passenger per km travelled (2019)[26]



Three-quarters of passenger rail transport activity now takes place on electric trains compared to 60% in 2000, making electric rail the most energy-efficient mode of transport. The investment landscape for rail infrastructure can be categorised[27] into conventional rail (medium to long distance, maximum speed under 250 kph), high-speed rail (HSR) (long distance, speed above 250 kph), metro rail (high-frequency, high-capacity urban services) and freight rail. Whilst conventional rail has not seen changes over the past decades, significant investment has been made in HSR and metro rail with huge growth seen in Europe, Japan and especially China. Freight rail activity, mainly for the transportation of minerals, coal and agricultural products has risen gradually over the last two decades, with most of the growth occurring within China, the United States, and Russia.

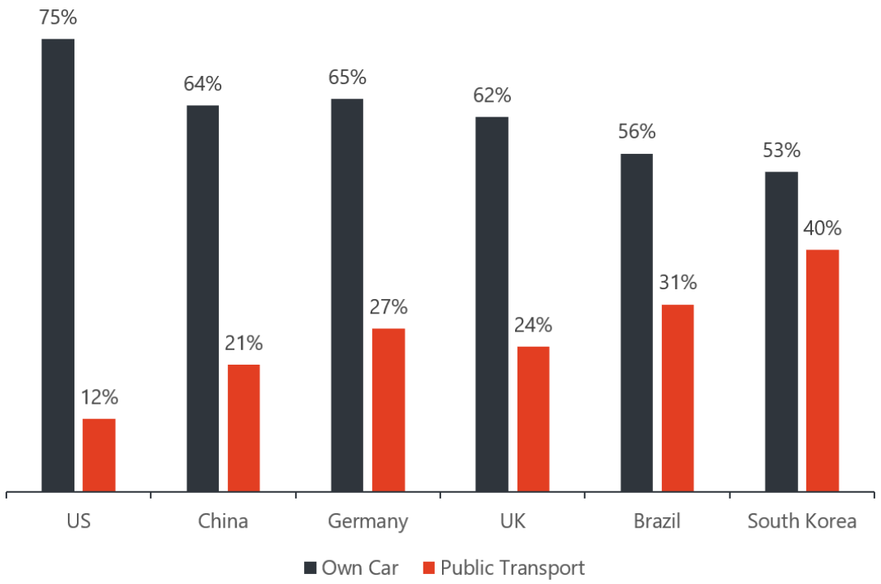
Unlike in Europe, the UK, and Japan, the US rail network is limited, particularly for passenger transport since its primary focus is freight shipment. Amtrak is the only long distance, intercity passenger rail network in the continental US, but with only 500 stations and high-ticket prices, it is not a viable transport option for most passengers. Only the Northeast corridor is well connected by passenger rail. The Biden administration is planning to change this and has proposed a $80 billion investment in rail infrastructure over the next decade, focusing on high-speed rail and Amtrak service improvements. Companies such as Brightline (formerly Virgin Trains USA) has also been investing in HSR projects in Florida and California respectively.

However, those keen to invest in HSR should also consider directing their attention to emerging economies, where increasing population and rising income will incite stronger demand for efficient transport and freight. Data has shown that when HSR is introduced, air travel dramatically reduces in the following years.[28] For example, flights between London and Paris halved after the introduction of Eurostar. However, HSR is not without challenges. Apart from the well-known hurdles, such as regulatory requirements (pricing regulations, safety), geographic restrictions (population and terrain considerations), environmental considerations (wildlife, noise pollution), and political influences on the awarding of contracts (lack of price competition), running HSRs profitably is uncommon. Many HSR projects either make losses or merely cover costs. Thus, investors ought to consider obtaining government subsidies and evaluating population density[29] (there is positive correlation between profit margins and population density) as well as operational diversification - including hotels, real estate, and retail ("Ekinaka" - the shopping complex within a train station model[30]).

Another key trend to take note of is the advent of hydrogen-fuelled trains; in many rural areas with low train frequencies, cost of electrification would not cover the network and hydrogen would offer the best decarbonisation solution for those routes.[31]

Considering population density in more detail, public transport via trains and buses makes up a larger percentage of commuting in highly urbanised countries, such as South Korea, than in less densely populated areas like the US. In other words, smaller countries generally have a competitive advantage in rail network development.

Figure 15 - Primary method of commuting (2022)[32]



India is an attractive hub for investments. As it overtakes China to become the world's most populous country, projects are ongoing, with the first HSR corridor currently under construction between Mumbai and Ahmedabad. It was due to be completed by October 2028, but has been delayed due to land acquisition issues.

The GCC region, especially the UAE and Saudi Arabia, is likely to see more rail network development by the end of the decade; although, the wish for a comprehensive end-to-end network may not be feasible, since not all states are willing to commit necessary funds[33] for subsidisation.

While there are also innovation trends in rail signalling systems, an area in which the firm advises on investments, we categorise these under Advanced Technology which will be covered below.

Key Analysis: Smaller countries generally have a competitive advantage in rail network development compared to larger countries.

Power grids and interconnectors attract institutional investor interest

Interconnectors are electrical infrastructure that enable the transmission of electricity between different power systems or countries. They consist of high-voltage cables or power lines that connect the grids of two or more regions. The benefits of interconnectors are numerous. They facilitate the exchange of surplus electricity, allowing for better utilisation of renewable energy sources. They enhance grid stability and reliability by providing access to diverse energy resources. Interconnectors also promote energy security by reducing dependence on a single energy source or region. Furthermore, they foster competition, leading to lower electricity prices and improved market integration. These operational assets can provide good sources of inflation-linked recurring revenues which are attractive to institutional investors.

The national electrical grid infrastructure network is defined by many governments as a critical asset. However, with the emergence of widespread solar and wind technologies more companies are developing their 'off-grid' private grid networks. The development of 'off-grid' power networks and power storage are areas demonstrating significant growth opportunities as companies both medium and large seek to produce and manage their own power growth. Power assets, whether part of the national grid or off grid infrastructure, are assets which attract the interest of institutional investors.

Port infrastructure in South East Asia presents attractive opportunities

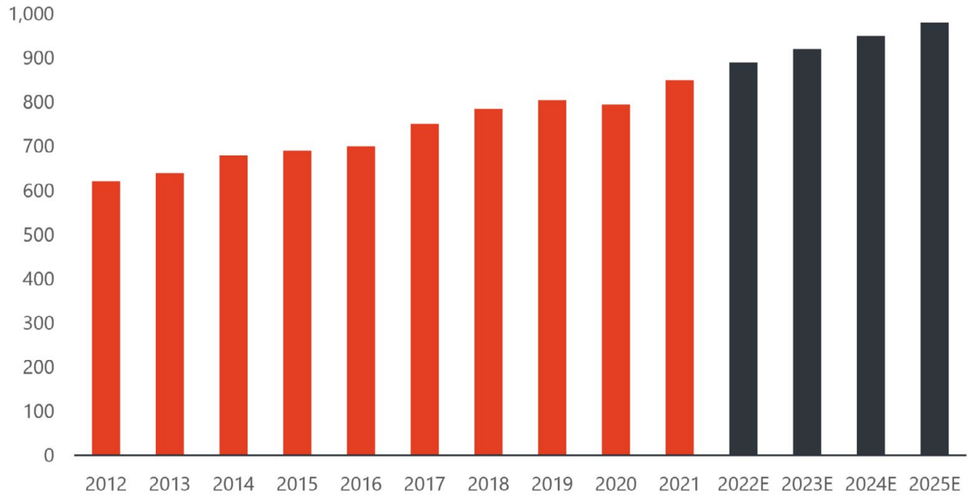
Seaport development positively impacts regional economic growth and encourages investment in adjacent infrastructure, like roads and railways. The COVID-19 pandemic and e-commerce growth have increased the value of real estate near key seaports, with substantial demand for logistics space expected. Trade volumes are predicted to grow, particularly in South East Asia, where inland dry port investments and logistics real estate present attractive opportunities for investors.

Extensive research[34] has demonstrated that seaport development has a positive impact on regional economic growth when measured by GDP per capita. The importance of ports as an enabler of economic growth is demonstrated in the UK's Freeport initiative,[35] which aims to boost trade and create jobs, thereby enabling output growth. Additionally, seaports do not exist in a vacuum, but rather are nodes in a supply chain web. This incentivises collaborative investment in adjacent infrastructure, such as road and railways.

COVID-19 and supply chain disruptions ignited an inflection in port growth. With the increasing proliferation of e-commerce and the supply chain disruption of preceding years, supply chain locations and strategies are being re-evaluated by both investors and corporations alike. Real estate located near key seaports will increase in value as CBRE estimates 1.7 billion sq. ft. to 2.2 billion sq. ft. of incremental e-commerce dedicated logistics space is required to facilitate global e-commerce by 2026. Chinese companies, guided by state directives, have strategically invested in ports worldwide to strengthen political influence. It is reported that Beijing has established a presence in over 100 ports across 63 nations.[36] Investors ought to pay close attention to this trend.

Trade volumes have increased from 2012 to 2021, with container volumes measured in twenty-foot equivalent units (TEUs) growing 36.5% to approximately 850 million, of which more than 80% are seaborne, and the majority of which are shipped in ocean containers. Growth is poised to continue in the coming years ahead.

Figure 16 - Container throughput worldwide - TEU volume (millions)[37]



A TEU, or a 20-foot equivalent unit, is the dimension of a standard shipping container (20 feet long and eight feet high and wide), generally used to determine cargo capacity of container ships and terminals.

Specifically, the IMF anticipates South-East Asia (primarily Indonesia, Malaysia, Singapore, Philippines, and Thailand) to experience the fastest growth in trade volumes up until 2027, since trade is increasingly flowing within the region, as opposed to out of the region as it was historically. There are limitations however to port investments - expansion will be increasingly difficult due to scarcity of appropriate locations coupled with the environmental repercussions. Unlike Singapore, not all countries are able to conduct land reclamation for expansion; therefore, there is a rising trend for inland dry port investments (prevalent in Asia) whereby goods are stored in containers in advance and loaded onto ships immediately upon arrival at the pier, obviating the need to store them for days at the port itself.[38]

Overall, investors should pay attention to the adjacent opportunities with key focus in the South-East Asian region - dry ports and logistics real-estate being direct beneficiaries and enablers of economic growth within the region.

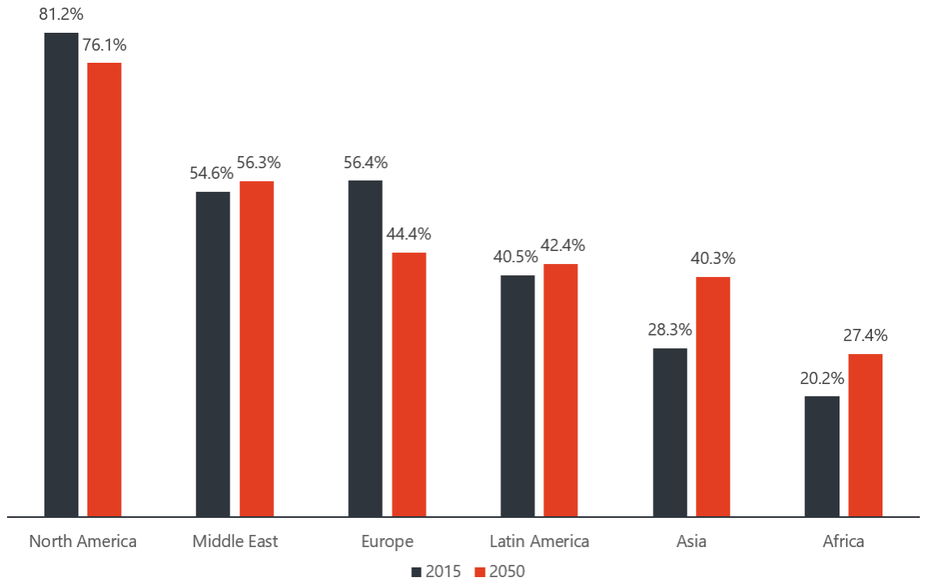
Key Analysis: The pandemic and supply chain disruptions have ignited an inflection in port growth - with increasing proliferation of e-commerce and the supply chain disruption of preceding years, supply chain locations and strategies are being re-evaluated by both investors and corporations alike.

E-commerce and increasing motorisation in Asia generate high spending needs on roads

Roads account for the majority of transport infrastructure spending, with significant investments in China and North America. The growth of e-commerce and increasing motorisation in Asia contribute to the demand for road infrastructure expansion.

Roads form an extremely large share of transport infrastructure spending; in 2018, more than 80% of transport spending for International Transport Forum (ITF)[39] countries were in road infrastructure with the remaining allocated to rail - the bulk of road investments in China and North America with an ~85% and ~89% allocation respectively.[40] The US and Europe will continue to produce investment opportunities, as the Biden administration proposed a $2 trillion infrastructure plan for road and bridge investments, and Europe continues to incentivise public-private partnerships (PPP) for road constructions. Moreover, as shown in the chart below, motorisation is bound to increase drastically in Asia, converging towards Europe and Latin America figures. This provides a unique opportunity to profit from urbanisation and continual population growth.

Figure 17 - Share of all trips taken by car in 2015 and 2050 by world region[41]



The rapid growth of e-commerce is another secular trend that increases the need for road freight transport and necessitates road freight infrastructure expansion. The last mile tends to be the costliest part of delivery, and with road infrastructure easing congestions and enhancing connectivity, this should lower corporate delivery expense and thereby, reduce shipping fees for consumers.

Investors looking to capitalise on road investments ought to pay close attention to India. In line with economic and demographic growth, there will be increased volumes of passenger and commercial vehicle traffic which will spur demand for better road networks. Moreover, the government has provided favourable regulation and introduced innovative investment models i.e., hybrid annuity model as part of its PPP initiative. The hybrid annuity model serves as an inflation hedge as fixed payments are linked to interest rates - this should be enticing for private investors, and accordingly, leading asset managers have dipped into the space.

Key Analysis: The last-mile delivery tends to be the costliest part of delivery expense and with road infrastructure easing congestions and enhancing connectivity, this should lower corporate delivery expense and thereby, passed-on delivery fees.

Rapid digitisation intensifies the need for reliable 5G and broadband infrastructure

With growing global digitisation, the need for reliable and fast broadband infrastructure is increasing. Mobile operators, governments, and large corporations are investing large sums of money in improving internet speed. However, with the advent of 5G, policymakers (particularly in areas with historically low coverage) are faced with a decision between rapidly enhancing internet coverage using 5G at the expense of cyber risks and data security, and a slower but more secure rollout.

As the world becomes increasingly digitised, reliable, and fast broadband infrastructure is an increasing necessity, with mobile operators poised to invest more than $600 billion in 5G networks between 2022 to 2025.[42] Globally, internet access has grown from 54% to 66% of the world population in just three years (2019 to 2022), despite rapid population growth at the same time. In North America, President Biden passed the Bipartisan Infrastructure Law which earmarks $65 billion to ensure all Americans have equal access to reliable, and affordable high-speed internet. In Europe, the EU 2025 Connectivity objectives include a minimum 100 Mbps network reaching every European household by 2025, uninterrupted 5G coverage available in all urban areas and access to mobile data connectivity everywhere. The UK has also recently initiated ambitious plans to boost digital connectivity, in efforts to increase growth and innovation across the country.[43] Technology giants such as Facebook and Google have invested billions in subsea cables[44] to expand broadband capacity in both developed and emerging markets. With the introduction of 5G comes a trade-off - while mobility is enhanced by 5G, this comes at the expense of data security and privacy which fixed broadband provides; further information can be found in Stirling Infrastructure's technical paper, *Financing 5G and Broadband Infrastructure*, featured on our website.

High-tech cities will require deeper digital infrastructure

Advanced technology such as 5G networks, Internet of Things (IoT), big data, cloud computing, and artificial intelligence (AI) are important for smart city development, because they enable real-time data collection and analysis. This facilitates improvements in city operations and services, such as enhancement of public transportation, waste management, and emergency response systems.

Stirling Infrastructure's technical paper – *Digital Infrastructure* – examines the impact of advanced technology on smart city development, and covers various topics, including 5G networks, Internet of Things (IoT), big data, cloud computing and artificial intelligence (AI). Nvidia, in a recent conference, termed this digital transformation trend the "fourth Industrial Revolution". In summary, the implementation of 5G network and IoT devices is necessary for smart city development, enabling cities to collect and analyse real-time data to improve city operations and services. Sensors and other IoT devices can also help to reduce energy consumption, improve traffic management, and enhance public safety. The paper also discusses the impacts of big data and cloud computing, being instrumental in smart city development, not dissimilar to 5G networks and IoT devices, helps with data analysis and concomitantly improves city planning and management. AI and machine learning could also enhance public transportation, waste management, and emergency response systems, by better assessing load and demand more effectively and coming up with efficient solutions. Because there exists a positive relationship between infrastructure quality (defined by road connectivity and quality, train service efficiency, seaport services, electrification rates, reliability of water supply etc.) and human capital (as defined by skills, health, knowledge, and resilience attained by the populace), countries are incentivised to embed modern technology within urban regions to ensure infrastructure quality. This provides ample opportunities for investors.

Infrastructure to perform well on a risk-adjusted basis when oil prices stabilise to mid-range

Infrastructure assets are in large part defined by their financial characteristics – stable, inflation-linked returns with comparatively low risk – and our analysis finds that this will continue to be true going forward. Firstly, infrastructure assets tend to have low price elasticity, meaning that infrastructure providers have price-setting power. The sector can be broken up into Core, Core Plus, Value-Add and Opportunistic investments, in order of ascending risk, with Core including brownfield supply of essentials like water, and Opportunistic involving bets on the future like hydrogen.

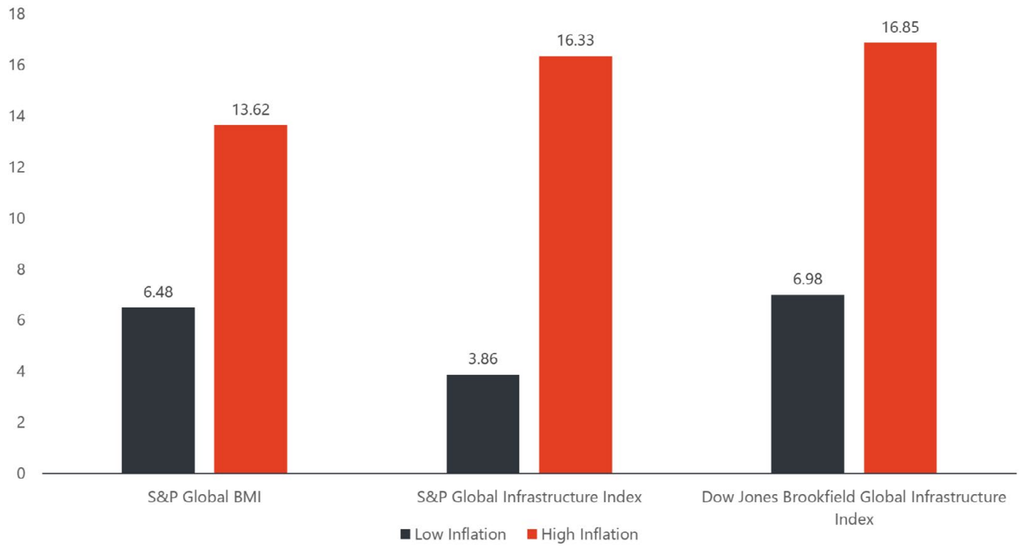
Although infrastructure investments are heterogeneous, with communications and water providing more stable positive returns than ports and diversified investments, the sector exhibits superior returns relative to volatility. This comes through particularly in measures such as the Sortino ratio, which ignores upside volatility. Displayed in Figure 18 are the average annual return, Sharpe, and Sortino ratios of various asset classes at the lower risk end of the spectrum, according to widely used indexes. The table shows that whilst infrastructure investments offer strong returns, the additional risk an investor takes on compared to comparators does not offset the value of those returns. This is represented firstly by the Sharpe ratio, which weighs all asset volatility against returns (higher is better), and the Sortino ratio, which measures only undesirable negative volatility against returns (higher is also better).

Figure 18[45]

Metric	S&P U.S. Treasury Bond 7-10 Year Index	S&P U.S. Investment Grade Corporate Bond Index	S&P U.S. High Yield Corporate Bond Index	Morningstar LSTA US Leveraged Loan 100	S&P Global BMI	Dow Jones Brookfield Global Infrastructure Index	S&P Global Infrastructure Index
Annual return (%)	3.54	4.12	7.04	4.63	8.65	10.55	8.81
Sharpe Ratio	0.36	0.52	0.68	0.48	0.47	0.68	0.48
Sortino Ratio	0.56	0.75	0.96	0.67	0.67	1.00	0.67

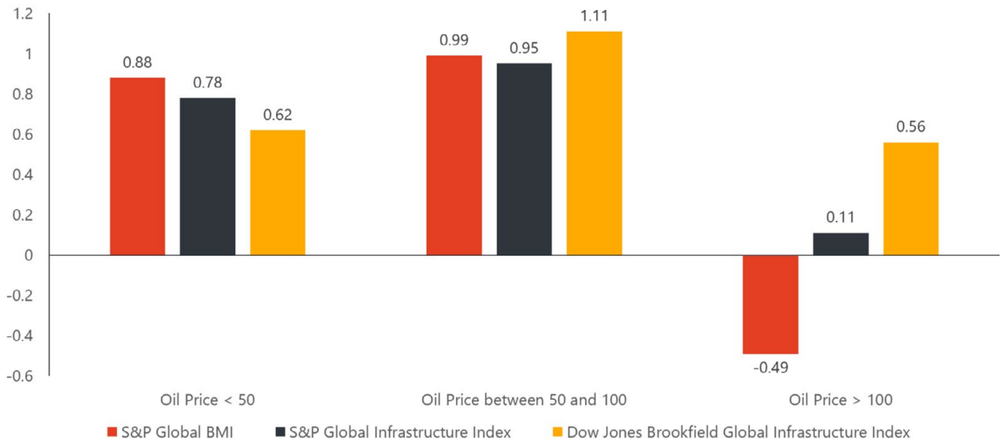
However, more remarkable than the risk-return profile is the strong inflation linkage of infrastructure asset performance. Since most infrastructure is essential to at least some degree, and is often monopolistic or oligopolistic, asset owners have greater pricing power than in other sectors. Total returns can be as high as 17% during inflationary periods, and still manage to outpace inflation during low inflation periods. Conversely, the aggregate equities universe (S&P Global BMI) delivers lower total returns during high inflation, but good to superior returns during low inflation.

Figure 19 - Average Year-over-Year Return of the Dow Jones Brookfield Global Infrastructure Index and the S&P Global Infrastructure Index versus the S&P Global BMI during Different Inflation Periods[46]



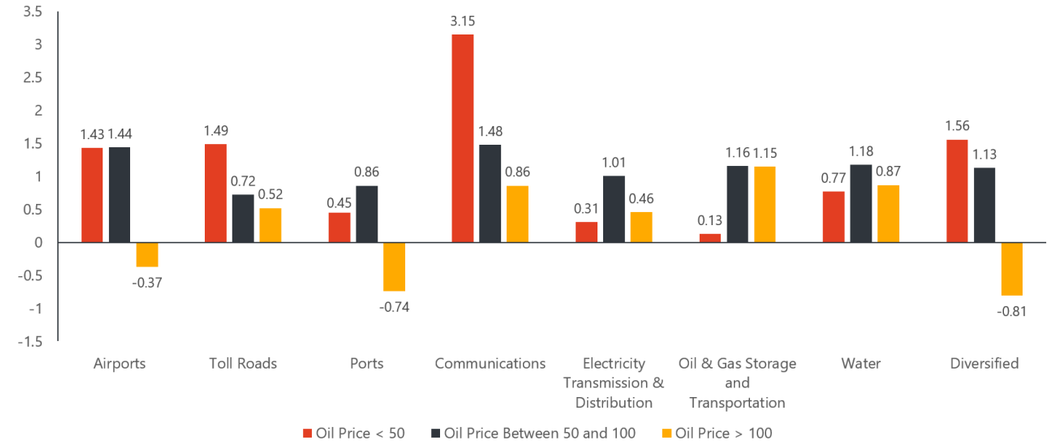
Infrastructure indices are typically invested 25-40% in oil and gas infrastructure, but performance of infrastructure assets is generally best when oil prices fall within a midrange. This is due to methodology – extreme oil prices point to and indeed cause disrupted economic conditions anyhow – but also shows how economies collectively perform best when energy is bought and sold at a moderate cost. Nonetheless, thanks to oil and gas exposure, the relevant infrastructure funds do perform better than the broader market during very high energy prices.

Figure 20 - Average Monthly Return of the Dow Jones Brookfield Global Infrastructure Index and the S&P Global Infrastructure Index versus the S&P Global BMI at Different Oil Prices[47]



However, given our prediction that energy prices will remain at moderate mean levels going forward, toll roads and diversified infrastructure investments are less likely to offer comparatively good performance than airports, electricity, oil and gas, and water. Each of these sectors experience strong monthly returns when oil retails for $50 to $100 a barrel. Communications and toll roads are unique in that they deliver outstanding returns when spot market oil prices are below $50; as are ports and diversified infrastructure investments, which witness negative total return with prices above $100.

Figure 21 - Average Monthly Return of the Dow Jones Brookfield Global Infrastructure Sector Indices at Different Oil Prices[48]

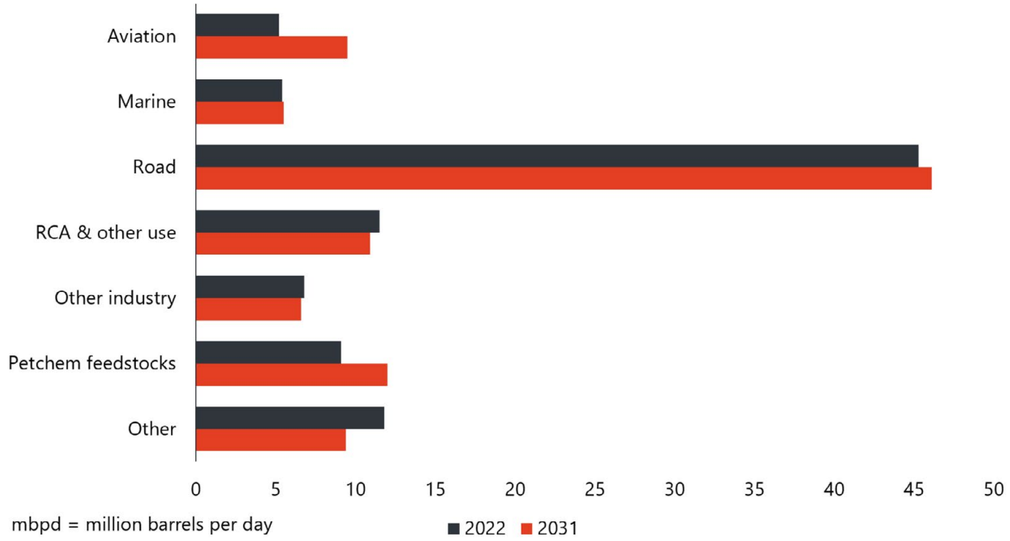


Key Analysis: Price elasticity and consumers' disposable income have a substantial effect on returns for infrastructure assets across different sub-sectors. Many sub-sectors have maximum or near-maximum returns when oil prices moderate to between $50 and $100, except communications and toll roads, which outperform during the lowest energy prices. Given historically elevated energy prices going forward, it may be prudent to avoid those sectors. However, infrastructure investments as a whole benefit from greater return relative to risk across multiple measures.

ENERGY OUTLOOK

In 2022, global energy prices spiked to unprecedented levels following Russia's invasion of Ukraine. While prices now remain elevated compared to historic levels, they have eased considerably from the 2022 spike, as Europe demonstrated greater energy independence than expected, coupled with other contributing factors, including a milder than normal winter and extended lockdown restrictions in China. Looking forward, as the world continues to transition away from fossil fuels to cleaner but more expensive technologies, the low energy price environment of the early 21st century is unlikely to return; this is accentuated by the fact that continual growth in aviation and road transportation, among other causes, will continue to drive demand for oil. However, the extreme price spikes seen in 2022 are also unlikely to be repeated on a regular basis.

Figure 22 - Road vehicles, petrochemicals and aviation set for higher energy needs (mbpd)[49]



Nevertheless, these events have brought to attention the energy trilemma of security, affordability, and lower carbon emissions. Addressing the energy trilemma, particularly as carbon emissions continue to rise despite the growing share of renewables, is crucial moving forward. In this section, Stirling Infrastructure identifies key sectors that will play a pivotal role in facilitating the global energy transition, which investors should closely monitor.

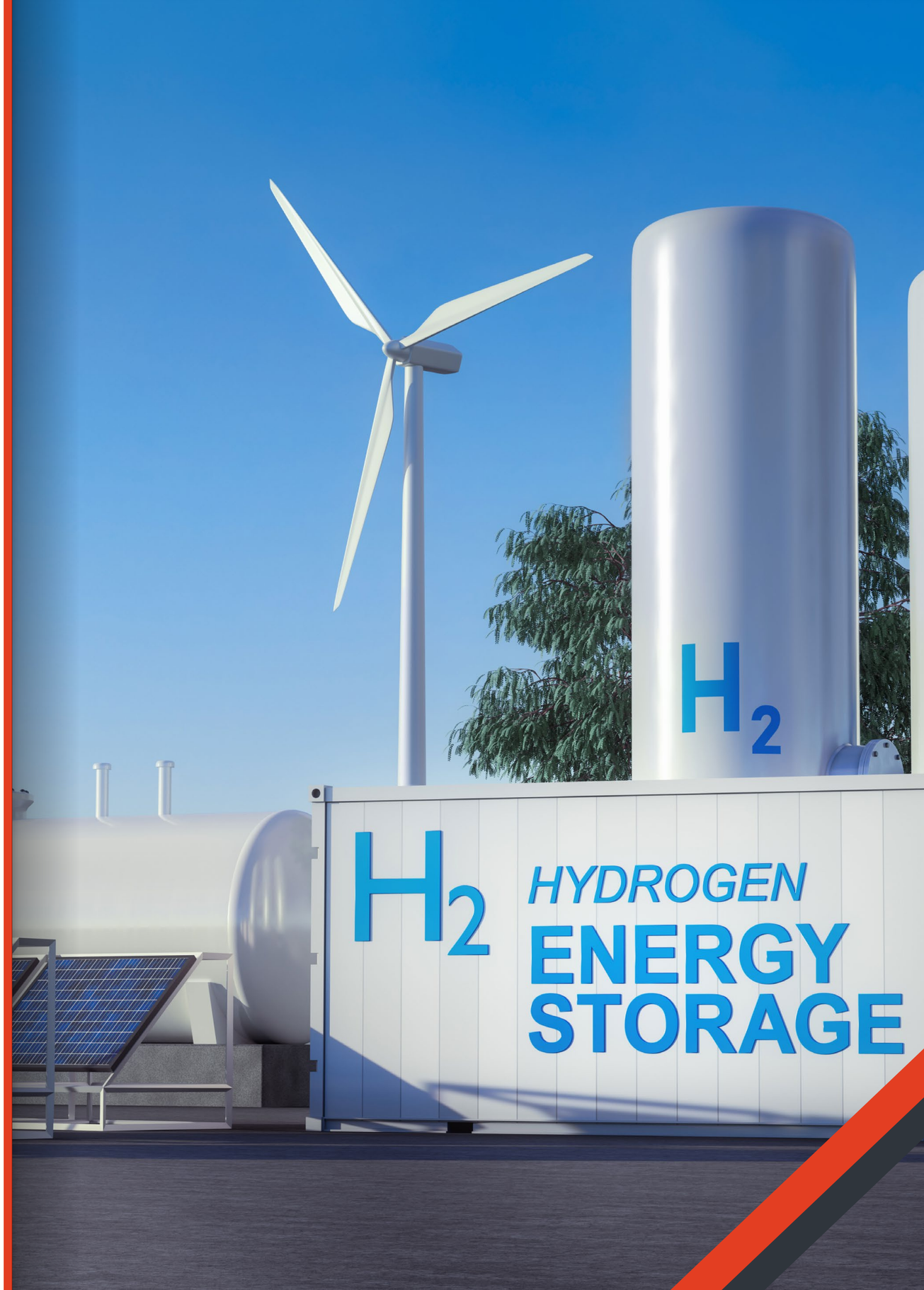
The energy section of this paper is further supported by detailed technical investment and outlook papers which are available on the firm's website.

Both blue and green hydrogen could gain traction

Green hydrogen gains prominence as a low-carbon fuel alternative due to energy transition and recent crises. There are diverse investment prospects available in the areas of ammonia production, regional hubs, heavy industries, and hydrogen fuel cell trains. Blue hydrogen presents a diversification pathway for oil and gas companies, with Gulf and MENA regions poised as production centres.

Globally, demand for hydrogen has been dominated for decades by its use as a chemical feedstock across many industries. However, as the global energy transition gathers pace, green hydrogen (where hydrogen is produced from renewable power) has the potential to serve new roles as a low-carbon fuel for transport and industry, in heating, and as a means of power storage. Furthermore, the Russian invasion of Ukraine in 2022, and the resulting energy crisis, led to rising costs and disruption in natural gas supply. This is driving interest in alternative forms of energy independent of single-state suppliers.

As a firm, we see a variety of use cases and investment opportunities for hydrogen, which are detailed in our hydrogen supply and demand outlook papers. Ammonia production (for use in the fertiliser industry and, potentially, as a zero-carbon fuel) currently constitutes the largest single demand case for hydrogen globally. This presents a huge opportunity for the adoption of green hydrogen to reduce the industry's carbon emissions. The development and emergence of regional hubs, where hydrogen end use cases



are located close to its production, will create commercially valuable opportunities and efficiencies along the hydrogen value chain. Vehicle use in heavy industry also shows promise as a bankable hydrogen investment opportunity, due to fast refuelling times compared with electric equivalents, and the fact that many heavy industrial operations are coming under increased scrutiny in terms of their emissions. Hydrogen has a potential use case in heating and creates investment opportunities particularly when blended with natural gas to be compatible with existing equipment (boilers, gas cookers, pipes). In terms of passenger transport, hydrogen fuel cell technology trains offer the most compelling investment opportunity. Relative to electric trains, hydrogen fuel cell trains offer a longer range, lower total cost of ownership, and less electrical infrastructure change.

Blue hydrogen is generated from natural gas, using steam methane reformation, and most of the resulting CO2 is captured and sequestered – this makes it close to carbon neutral. Due to this generation process, blue hydrogen could be a significant avenue for investment by large multinational oil and gas companies looking to diversify their portfolios and move towards renewable, carbon neutral, and zero-carbon fuels. Our analysis shows that the dominant first movers towards blue hydrogen are the US and Saudi Arabia, where fossil fuel production, refinement, and trade dominate the economy. These will become the centres of blue hydrogen production and trade.

Key Analysis: Hydrogen presents a wide range of investment opportunities and a variety of use cases, one of which is the production of ammonia, which is a central ingredient for fertiliser and a potentially key means of hydrogen transport. Hydrogen also presents opportunities in the transport and energy storage sectors. However, the market is still at an early stage in its development and requires a lower cost of production to compete with traditional alternatives and to identify customer demand.

Small nuclear reactors are an unproven solution to net zero

Nuclear power, particularly small modular reactors (SMRs), is gaining interest from governments and utilities due to net zero commitments and energy security concerns. Although in the development phase, SMRs could offer benefits including lower production costs, faster construction times, and diverse use cases, including providing baseload power, co-generation, and decarbonising heavy industries. They also serve as a potentially less capital-intensive alternative to conventional nuclear power plants in developing countries with smaller electricity grids and higher fossil fuel dependency.

Nuclear power generation is being evaluated by a wider number of governments, private companies, and investors, due to net zero commitments combined with energy security concerns, particularly in the wake of Russia's invasion of Ukraine. Nuclear power has the potential to provide low-cost, low-carbon power to energy grids, and decarbonise heavy industry.

In recent years, small modular reactors (SMRs) have received significant attention and investment. SMRs are defined as nuclear fission reactors, which are smaller than conventional reactors and are modular. They can be constructed in factories, and then be shipped to the reactor site. As such, their total costs of production could be reduced through economies of scale. Further, SMRs can be constructed faster than conventional sized reactors, which take an average of 15 years to complete. By contrast, it is predicted that after first-of-a-kind, SMRs could take only four years to construct. Nuclear power in general, and SMRs specifically, can have a variety of use cases in the net zero energy future, which are detailed further in our insight paper, along with the risks and geopolitical analysis of nuclear power.

SMRs are well equipped to provide baseload power to grids which have high penetrations of intermittent renewables (e.g., wind and solar). Further, Generation IV reactors, which include SMRs, can be used for co-generation, as well as energy production. This makes them more energy efficient and profitable: reactors can produce grid electricity, while powering a desalination plant, hydrogen production, or domestic heating. SMRs can also be used for decarbonising heavy industries such as steel and glass making which require vast quantities of energy. In developing countries without existent nuclear programmes, small electricity grids, and heavy fossil fuel dependence, SMRs can offer a more cost-competitive alternative to conventional-sized nuclear power plants (NPPs), which are prohibitively capital intensive to build, and require large grid capacity. However, since SMRs are still in development, early models will not offer a cost advantage, and the ability to bring down costs per kilowatt is uncertain.

Key Analysis: There are a wide variety of risks to be considered by government and stakeholders in evaluating the adoption of this technology, including financing cost, political risk, and environmental risks. There are material benefits if safe and responsible adoption can be implemented. Stirling Infrastructure has carried out significant analysis in appraising the SMR market for investment.

Wind and solar become economically competitive; expand presence in Middle East, Africa and Asia

The levelised cost of electricity (LCOE) for renewables like wind and solar has dropped, allowing them to compete with more traditional energy sources. The more mature and large-scale investment opportunities in wind are mainly in the US, China, France, Germany, the Nordics and the UK, while emerging economies like India, Argentina and Poland are presenting new opportunities for investment. The solar market is divided into residential, non-residential, and utility uses, with the Asian Pacific region expected to dominate utility-level solar production. The Middle East and Africa are predicted to experience significant solar production growth due to their ideal conditions and efforts to reduce fossil fuel dependence.

The recent maturation of key technologies has meant that the LCOE for renewables like wind and solar has dropped below traditional fossil fuel-based energy sources – e.g., solar production costs have reduced 90% in the last decade. This means that, whilst over the last 20 years government support was essential to incentivising wind and solar projects, we can expect this to change going forward.

Investment opportunities associated with solar and wind technologies will be significant, as their capacity grows further. For example, improvements in energy storage to regulate the intermittent output of this power generation will be critical and thus of commercial interest to investors.

As discussed in our insight paper, we believe that opportunities for investment into wind are primarily located within the US, China, France, Germany, and the UK. These countries have strong economic growth drivers, favourable environmental policies, and reliable track records in meeting previously stated targets. Beyond these markets, we can expect to see rapid production growth in emerging economies, such as India and Argentina. Whilst investment in these markets carries more risk, it can also offer good return potential for investors who have the appetite and competitive advantage to enter these markets.

The solar market is divided into residential, non-residential, and utility uses. Utility currently dominates the market, primarily because of the cost of installation, but residential usage is rising due to increasing energy demand and the cost of traditional energy sources.

The Asia-Pacific region is expected to dominate utility-level solar production in the coming years, especially in China, which is already a major global solar producer and consumer. The Middle East and Africa are expected to see the most significant growth rate in solar production and consumption during this decade. Ample sun exposure and large desert areas make both regions ideal for large scale solar production. In the Middle East, this is due to plans to reduce dependence upon fossil fuels, and switch to becoming a renewable energy production hub; and in Africa, particularly in remote areas without grid access, residential solar usage will reduce dependence upon fossil fuel generators.

Key Analysis: Offshore wind projects are becoming adopted in a wider range of international markets. Markets to watch include the east coast of North America and Japan. Onshore wind and solar are becoming more widely adopted across the Middle East and Africa.

Sustainable aviation fuel enters the market; investment opportunities available in bioenergy production technology

Decarbonising the aviation industry is critical, and sustainable aviation fuel (SAF) can reduce emissions by up to 80% compared to conventional fuels. Despite its higher cost, SAF usage is expected to increase, offering investment opportunities across supply and production chains. Bioenergy, produced from biomass, is versatile, renewable, and can provide carbon-negative energy. As bioenergy production is still relatively inefficient, investment opportunities lie in technologies to increase efficiency, energy storage, transportation infrastructure, and carbon capture technologies.

The aviation industry produces around 2.5% of global carbon emissions, and so its decarbonisation is critical for achieving net zero emissions targets. Crucial to this is the development of SAF. SAF is a liquid fuel produced from waste products like oils, fats, green and municipal waste, and non-food crops, but it can also be made through carbon capture. These production methods have a low environmental impact, and if waste marked for landfill is used as feedstock, then its production can reduce landfill usage.

In light of industry emissions targets, we can expect to see SAF usage increase significantly in the coming years. SAF currently costs two to eight times more than conventional jet fuel, and so development in production technologies, feedstock, and transportation is essential to making SAF usage profitable. The necessity of these technological developments, especially for such a critical industry, means we can expect significant investment opportunities across supply and production chains.

Bioenergy is produced by burning biomass, and is primarily used for producing electricity, heat, and as a fuel. Biomass is comprised of four main sources: crops, forest products (including residues and waste from lumber processing), agricultural residues, and animal manure. Bioenergy is highly versatile and renewable, and so will see increased usage and investment in the coming decades. Further, because bioenergy production uses waste or surplus products, and the emissions produced during production can be captured, it can provide carbon negative energy. This will be crucial to reducing total carbon emissions, since it can offset emissions production in other, carbon intensive industries. Bioenergy production is still relatively inefficient, since biomass is comprised of a variety of materials. As such, investment opportunities in technologies to increase this efficiency will be significant, as will energy storage and transportation infrastructure, and carbon capture technologies.

Key Analysis: The regulatory environment at the time of writing this report does not provide for any meaningful obligations for airlines to use sustainable aviation fuels. The demand for this market is likely to increase either through voluntary action by airlines and passengers, or as new carbon commitments are agreed upon by governments and imposed upon industries. However, in the medium-term outlook to 2028, we anticipate new regulations on the air travel industry which will increase the demand for sustainable fuels commensurately.

LNG projects a potential bridge to renewables

The liquified natural gas (LNG) market has grown significantly, linking natural gas production regions with demand centres. Europe has increased import volumes, especially since Russia's invasion of Ukraine. Natural gas is expected to be a "bridging fuel" during the energy transition, complementing intermittent renewables until large-scale power storage becomes viable. Investment opportunities exist in new and expanding LNG projects, but there is a risk of facilities becoming stranded assets if the global switch away from hydrocarbons happens faster than expected.

The LNG market has grown significantly over the past decade and links regions of natural gas production with centres of demand. Until recently, the complexity and cost of the technology have made it non-viable to export gas beyond pipeline routes at scale. Natural gas is filtered, then converted to a supercooled and compressed liquid state by carefully engineered liquefaction terminals located on the coastlines of producer countries. The LNG is then shipped overseas by vast, purpose-built carriers. Finally, the LNG is offloaded in destination markets using regasification import terminals which convert the liquified gas back to its natural gas state for storage, onward transportation, and consumption through domestic pipeline networks.

Traditionally, the largest importers of LNG have been Japan, South Korea, and China, but Europe has also been steadily increasing its import volumes, especially since Russia's invasion of Ukraine in February 2022, as the continent sought to shift away from pipeline imports from Russia. We expect natural gas to play the role of a "bridging fuel" through the energy transition, as it is less carbon intensive than coal but sometimes easier, quicker, and cheaper to deploy as an energy source than newer renewable technologies. For example, open cycle or combined cycle gas turbine power plants are a well-established and relatively cheap and quick to construct source of electricity. Uses of natural gas will also complement intermittent renewables until large scale power storage facilities are technically and commercially viable.

Traditional producers of LNG include Qatar, Australia, and, more recently, the US following the shale boom and continued development of the Permian Basin. Parts of Africa and Canada are emerging as new exporters of LNG and projects here, coupled with the expansion of existing capabilities in the US and Middle East, present opportunities for investors.

As a result of natural gas' role as a bridging fuel, the LNG market is expected to continue growing through the 2020s and into the 2030s. However, a risk for investors is that natural gas demand declines quicker than expected as, for example, power storage technologies, smart grids and perhaps a new wave of nuclear investments makes it increasingly redundant.

In other words, new LNG liquefaction and regasification facilities could be at risk of becoming stranded assets if the global switch away from hydrocarbons happens quicker than expected.

REFERENCES

1. World Bank
2. https://www.worldbank.org/en/publication/global-economic-prospects
3. Independent research
4. Bloomberg; independent research
5. https://www.grantthornton.sa/en/insights/articles-and-publications/FDI_in_KSA/
6. https://www.worlddata.info/asia/saudi-arabia/tourism.php#
7. Independent research
8. DealEdge powered by CEPRES data (as of December 22, 2022)
9. https://www.bain.com/insights/public-vs-private-markets-global-private-equity-report-2020/
10. https://www.oecd-ilibrary.org/docserver/809eff56-en.pdf
11. GLIO, Refinitiv, MSCI, FRED, Ravenhorst, I. and Brounen, D. (2022)
12. Ravenhorst, I. and Brounen, D. (2022) 'Why Infrastructure', Abu Dhabi Investment Authority
13. https://www.mckinsey.com/industries/private-equity-and-principal-investors/our-insights/mckinseys-private-markets-annual-review#/
14. https://www.redalyc.org/journal/841/84160330004/html/
15. https://outlook.gihub.org/
16. https://blog.oxfordeconomics.com/global-infrastructure-outlook
17. AOCI World Inventory of Private Airports (% of passenger traffic handled, 2019)
18. https://ig.ft.com/india-population/
19. https://www.weforum.org/agenda/2023/03/ev-car-sales-energy-environment-gas/
20. IEA Global EV Outlook 2022
21. Company Filings
22. https://newseu.cgtn.com/news/2023-04-27/BYD-boosts-global-EV-sales-that-will-save-5m-barrels-of-oil-a-day-1jkaq1wnihO/index.html
23. http://en.caam.org.cn/Index/show/catid/60/id/1902.html
24. IEA Global Outlook 2022; 2023 sales estimated via trends based on Q1 23 sales
25. https://www.worldbank.org/en/topic/transport/brief/railways
26. BEIS/Defra Greenhouse Gas Conversion Factors 2019
27. https://www.iea.org/reports/the-future-of-rail
28. https://www.ft.com/content/562fdda5-4b83-440d-8c32-c83210edf833
29. https://www.rsis.edu.sg/wp-content/uploads/2020/08/PR200901_Vietnams-HSR-and-the-Profitability-of-Shinkansen.pdf
30. https://www.nippon.com/en/features/jg00055/
31. https://www.railway-technology.com/features/next-stop-hydrogen-the-future-of-train-fuels/
32. Statista Global Consumer Survey; public transport includes buses and train
33. https://www.investmentmonitor.ai/sectors/infrastructure/gcc-railway-built-infrastructure/
34. https://www.mdpi.com/2077-1312/8/12/1017
35. https://www.bdo.co.uk/en-gb/insights/freeports
36. https://www.voanews.com/a/6224958.html
37. Statista, April 2022 (Blue - forecasted throughput)
38. https://www.economist.com/interactive/business/2023/01/14/investments-in-ports-foretell-the-future-of-global-commerce
39. https://www.itf-oecd.org/member-countries
40. https://www.itf-oecd.org/sites/default/files/docs/inland-transport-infrastructure-investment-brief-2022.pdf
41. Statista
42. https://www.mckinsey.com/industries/technology-media-and-telecommunications/our-insights/navigating-the-three-horizons-of-5g-business-building
43. https://www.gov.uk/government/news/new-investment-boosts-uks-digital-connectivity
44. https://tech.facebook.com/engineering/2022/2/economic-impact-subsea-cables/
45. Dow Jones
46. Dow Jones
47. Dow Jones
48. Mercer
49. BNEF

About Stirling Infrastructure Partners

The firm's energy and infrastructure group has a proven track record in advising on the financing of projects and the acquisitions and divestitures of infrastructure and energy assets. The firm has gained a reputation for advising and originating investments and capital for institutional investors, asset owners, and project sponsors across the entire infrastructure and energy sectors, with a focus on core infrastructure and projects which support the energy transition.

For further information please visit: www.stirlinginfrastructure.com

Notice

This paper is supported with research from a range of authoritative data sources. Stirling Infrastructure's views are representative as at the date that this paper was published but the firm's view will change to reflect evolving market conditions where necessary. This paper is published for information and educational purposes only and the firm accepts no liability for any investment decisions taken on reliance of this paper.

For further information please contact:

Stirling Infrastructure Partners Limited
84 Brook Street
London
W1K 5EH
Tel: +44 (0)20 7629 3030

contact@stirlinginfrastructure.com
www.stirlinginfrastructure.com

This document has been developed by our analysts and does not constitute investment advice. It is prepared for information purposes only and does not constitute an investment recommendation.

THIS PAGE INTENTIONALLY LEFT BLANK

Stirling Infrastructure Partners Limited
84 Brook Street
London
W1K 5EH

For further information please contact:

Tel: +44 (0)20 7629 3030
contact@stirlinginfrastructure.com
www.stirlinginfrastructure.com

Stirling Infrastructure
PARTNERS LTD