



Global Matters 39

The importance of emerging markets to the infrastructure opportunity

June 2023

Global investors often exclude emerging markets¹ (EMs) from their investment universe due to perceived unacceptable risk. In this article, Sarah Shaw (4D's Global Portfolio Manager and Chief Investment Officer) and the 4D team explores why 4D believes EMs are too important to continue to ignore in a global asset allocation, and why listed infrastructure is the perfect way to gain exposure to the long-term EM growth thematic.

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¹ 'Emerging markets' include emerging and developing economies

Introduction

The infrastructure asset class offers defensive characteristics with earnings resilience, exciting long-term growth themes and an ability to capitalise on the entire economic cycle.

Many investors are aware of the defensiveness of the asset class, but the growth opportunity is still largely under-appreciated. Around the world there is a huge and growing need for infrastructure investment, due to chronic underspend over a number of decades as well as the changing dynamics of the global population. This sees four key long-term growth drivers that are immune to short-term economic events:

1. **Developed market replacement spend** – our infrastructure is old and inefficient, and a failure to upgrade it could have significant social and economic consequences (health, safety, efficiency);



Source: Clockwise from top left corner – Colorado Springs Business Journal (warning sign), Cincinnati.com (bridge collapse), flintwaterstudy.org (aged water pipes), Daily Express EPA (Genoa Bridge collapse 2018), Time Magazine, John Minchillo (East Harlem gas explosion), deeptrecker (European water leakage)

2. **Global population growth** but with changing demographics – the developed world is getting older, but much of the emerging world is younger and both dynamics require increased infrastructure investment;
3. **The emergence of the middle class** in developing economies, with infrastructure both a driver and a first beneficiary of improved living standards; and
4. **The energy transition** that is currently underway – without EMs on board, the world has no chance of reaching net zero by 2050.

Three of these core investment themes involve EMs. When you consider that these markets account for 85% of the global population, 75% of the global land mass and the majority of future population and GDP growth, you can appreciate why we think they are too important to continue to ignore in a global portfolio allocation.

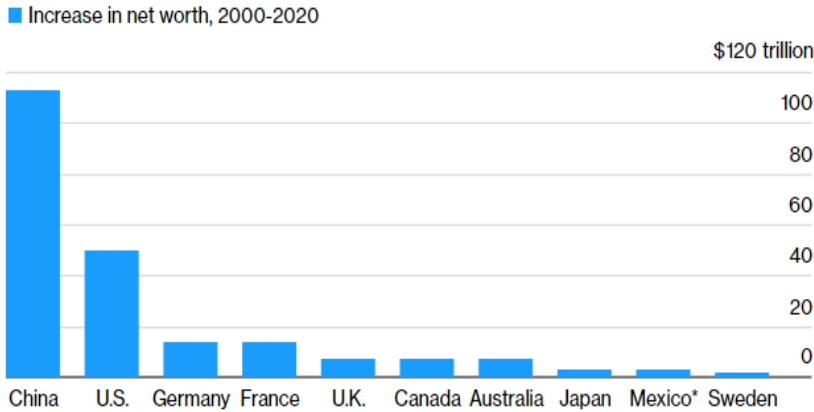
This article will focus on the EM infrastructure opportunity, which is supporting both the EM domestic demand story and the demand for global infrastructure.

Global economic growth: coming from EMs

Global wealth tripled in the last two decades, with the US falling behind as China took over the top spot. Net worth worldwide rose to US\$514 trillion in 2020 from \$156 trillion in 2000. China accounted for almost a third of the increase².

² According to a report by the research arm of consultants McKinsey & Co. that examines the national balance sheets of ten countries representing more than 60% of world income

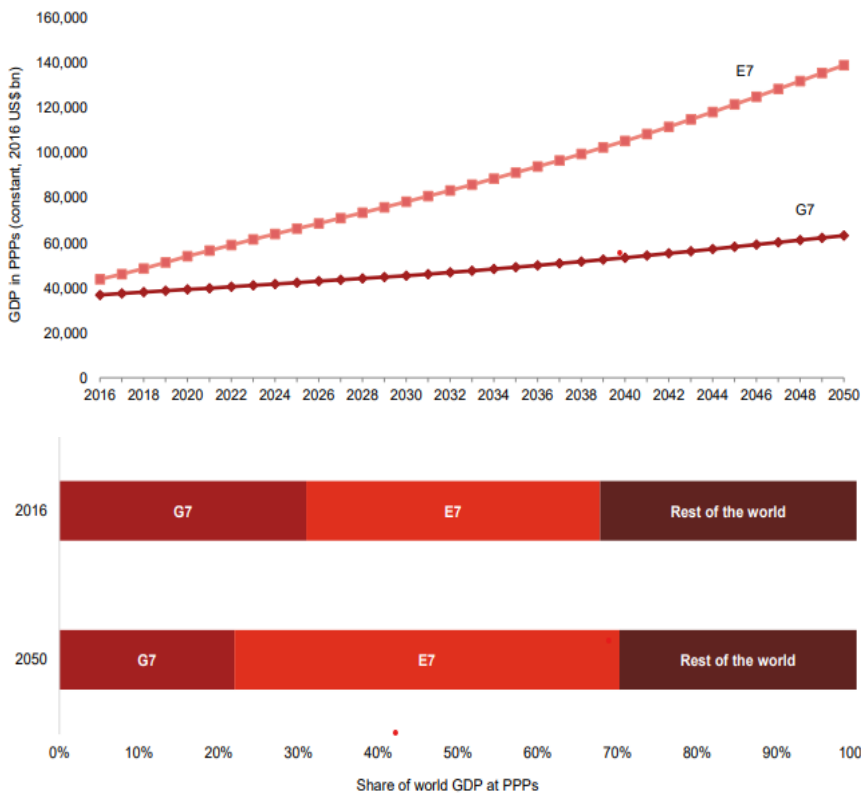
Chart 1: Expanding global wealth



Source: McKinsey Global Institute
 *Note: Mexican data covers period 2003-2020

EM economies are expected to continue to grow rapidly over the next 30 years, altering the world economic order which has been in place for much of the post-World War II era. *Capital Economics* recently³ forecast that the world economy will average annual growth of around 2.5% out to 2050. However, beneath that headline figure the divergence in major economies will see a significant shift, with EM growth continuing to outpace the developed world, particularly on a PPP⁴ basis. *PwC* forecast that the E7 could grow twice as fast as the G7 to see the E7 double the size of the G7 by 2040 on a PPP basis.

Chart 2: Growth paths of the E7 and G7 economies in PPP terms



Source: PwC: *The World in 2050 – How will the global economic order change* (February 2017). Note that while this is a 2017 report and does not adjust for COVID, the trend and thematic remain relevant
 E7 – Brazil, China, India, Indonesia, Mexico, Russia & Turkey. G7 – Canada, France, Germany, Italy, Japan, UK & USA

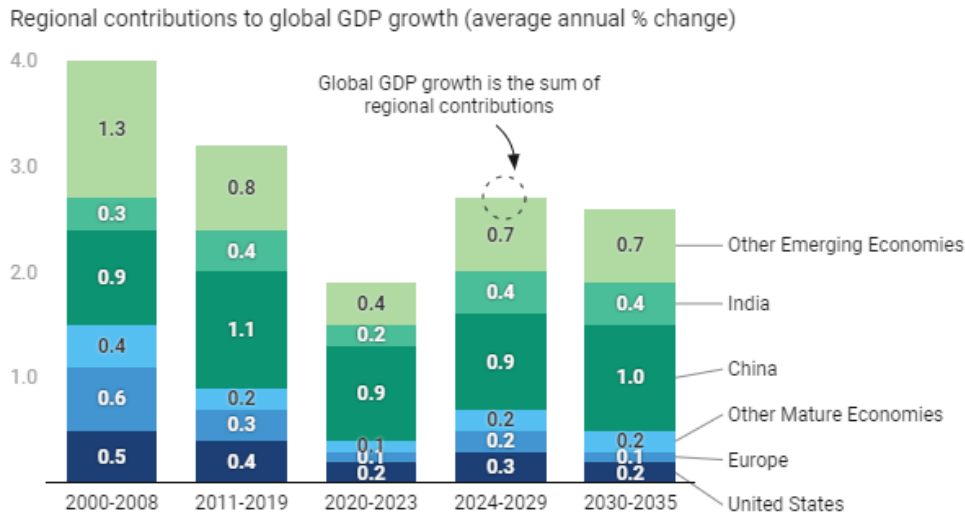
³ Capital Economics Long Run Economic Outlook 2022/23

⁴ PPP = Purchasing Power Parity: adjusts for price level differences across countries

In absolute terms the speed of change is slightly slower⁵, but *Capital Economics* still forecast that the EMs' share of the world economy will exceed 50% in around 2028 and reach 60% by 2050, with *PWC* forecasting the E7 to be at parity with G7 in 2028 and 1.5x the G7 by 2050 on an absolute basis.

This theme is further evolved in Chart 3 from *The Conference Board* which breaks the growth down, highlighting that while China and India will be core drivers, other EMs will be significant contributors. Some will benefit from the green transition (e.g. Chile), while others will benefit from on-shoring (e.g. Mexico).

Chart 3: Emerging economies to remain the key engine for global growth



Source: *The Conference Board Global Economic Outlook 2023*

As a result, it is forecast that by 2050 six of the seven largest economies in the world on a PPP-adjusted basis could be among today's 'emerging markets'.

⁵ Absolute basis reflects the currently much lower average price levels in emerging economies than advanced economies.

Chart 4: Ranking of PPP adjusted GDPs and shift in dominance

Emerging markets will dominate the world's top 10 economies in 2050 (GDP at PPPs)

	2016	2050	
China	1	1	China
US	2	2	India
India	3	3	US
Japan	4	4	Indonesia
Germany	5	5	Brazil
Russia	6	6	Russia
Brazil	7	7	Mexico
Indonesia	8	8	Japan
UK	9	9	Germany
France	10	10	UK

■ E7 economies ■ G7 economies

The US and Europe will steadily lose ground to China and India

Share of world GDP (PPPs) from 2016 to 2050...



Sources: IMF for 2016 estimates, PwC analysis for projections to 2050

Source: PwC: *The World in 2050 – How will the global economic order change* (February 2017)

In its annual *World Economic League Table*, the CEBR predicts these shifts to happen relatively quickly:

- **China will overtake the US in 2036** – while this is significantly later than originally anticipated due to China’s zero COVID policy, the momentum may accelerate as re-opening ramps up⁶;
- **India overtook the UK** to become the world’s 5th largest economy in 2021, and is forecast to overtake Germany to become the world’s 4th largest economy in 2026 and to overtake Japan to become the world’s 3rd largest economy in 2032; and
- **Indonesia**, the world’s 4th most populous country, is expected to advance from the world’s 17th largest economy in 2022 to become the world’s 11th largest economy by 2037.

Regardless of what metrics are used or where the rankings land, it is clear that a large percentage of future global economic growth and wealth creation will be driven by EMs. This is a positive for the infrastructure asset class domestically and globally as this growth will drive necessary investment in the sector.

For example, management from COSCO shipping explains the correlation between GDP and port throughput⁷:

“The average ratio of ‘global port container throughput growth’ to ‘global GDP growth’ during 2010-2022 was about 1.3x positive correlated. It could be a reference to forecast the industry throughput growth based on the future GDP growth in coming years. At the same time, new market opportunities represented by the Regional Comprehensive Economic Partnership (RCEP) and other EMs will drive new momentum into logistics and port business in the world, especially in the Asia region.”

⁶ By contrast, *Capital Economics* stated that it expects the US to retain the top spot due to China’s falling population and declining productivity. However, this is on a nominal basis, not PPP adjusted as per the chart.

⁷ Via email to 4D Infrastructure

Global population growth: coming from EMs

According to UN estimates, the total world population passed 8 billion on 15 November 2022, a milestone in human development. This unprecedented growth is due to the gradual increase in human lifespan owing to improvements in public health, nutrition, personal hygiene and medicine. It's also the result of high and persistent levels of fertility in some countries.

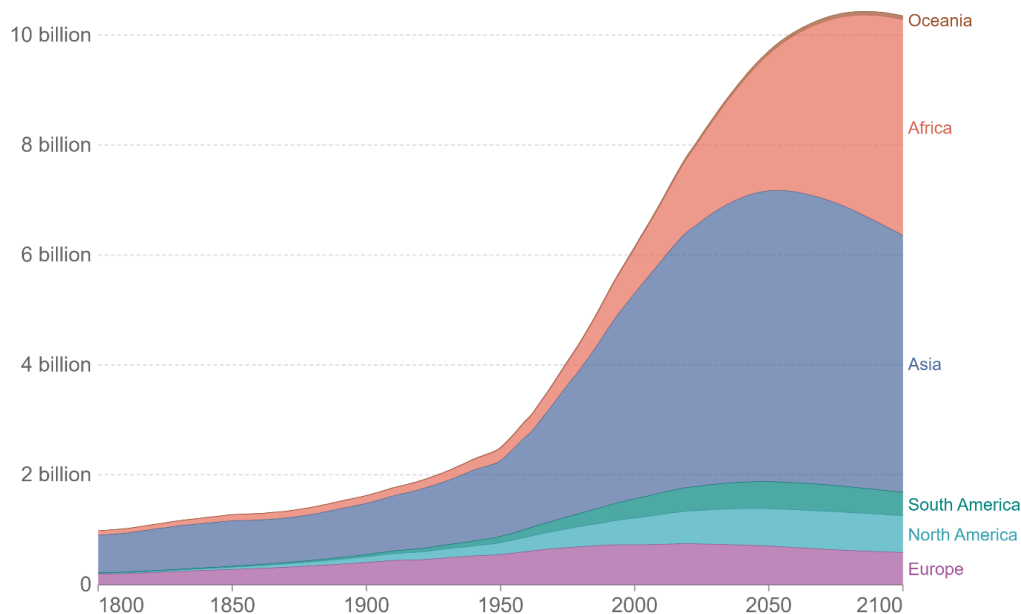
A growing global population drives an obvious need for new, improved and expanded infrastructure development. Importantly, much of this population growth is coming from the emerging world where demographic trends are very supportive of economic evolution and infrastructure investment.

Chart 5: Population growth by region

Population by world region, including UN projections

Historic estimates from 1950 to 2021, and projected to 2100 based on the UN medium-fertility scenario.

Our World
in Data



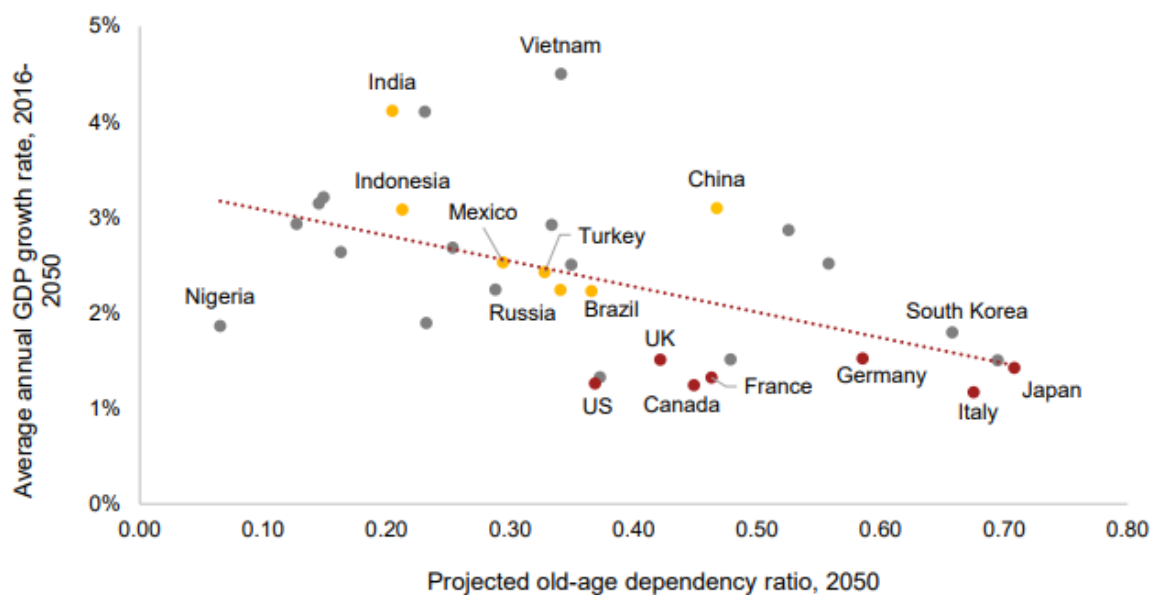
Source: HYDE (2017); Gapminder (2023); UN (2022)

OurWorldInData.org/world-population-growth/ • CC BY

By contrast, population shifts are also creating a number of demographic challenges, key of which are an ageing population in the developed world and environmental concerns globally. Again, both can represent an infrastructure opportunity: the former in increasing demands on government budgets in terms of pensions and health (will rely more on private sector capital for infrastructure), and the latter in the need for increased overall investment.

Deteriorating demographics and slowing population growth are negative for global GDP growth. However, the deterioration in demographics is largely in the developed world and is being partially offset by a younger growing population, an evolving middle class and improved social policies in many of the EM economies. This population shift is compounding the GDP growth dynamic discussed earlier and depicted in Chart 6.

Chart 6: Relationship between the projected old age dependency ratio in 2050 and the average annual GDP growth rate 2016-2050



Source: PwC: *The World in 2050 – How will the global economic order change* (February 2017). Note that while this is a 2017 report and does not adjust for COVID, the trend and thematics remain relevant

While absolute population growth is important for EMs and infrastructure investment, improving living standards and the desire for a sustainable future compounds the infrastructure investment opportunity.

Emergence of the middle class: driven by EMs

The emergence of the middle class in developing economies is supporting both the EM domestic demand story and the demand for global infrastructure. As already discussed, EM economies are expected to grow rapidly over the next 30 years and this growth will be driven by the expanding middle class.

Given the potential size of the middle class in EMs (EMs make up ~85% of the global population), changes in spending and consumption patterns will have significant implications for global business opportunities and investment for decades to come.

As EM wealth improves, the demand for infrastructure grows. From an individual's perspective, as personal wealth increases, consumption patterns inevitably change. This starts with a desire for three meals a day and moves to a demand for basic essential services such as clean water, indoor plumbing, gas for cooking/heating and power – all of which require infrastructure. With power comes the demand for white goods such as a fridge or a TV, which increases the need for port capacity and logistics chains as well as per capita usage of essential utility services. This progresses over time to include services that support efficiency and a better quality of life, such as travel – which increases demand for quality roads and airports – and data usage, increasing demand for communication infrastructure.

Importantly, one of the early and ongoing winners of this growth in the middle class is infrastructure, which is needed to support the evolution. We discuss a couple of key opportunities in air, road, data and waste in the Appendix.

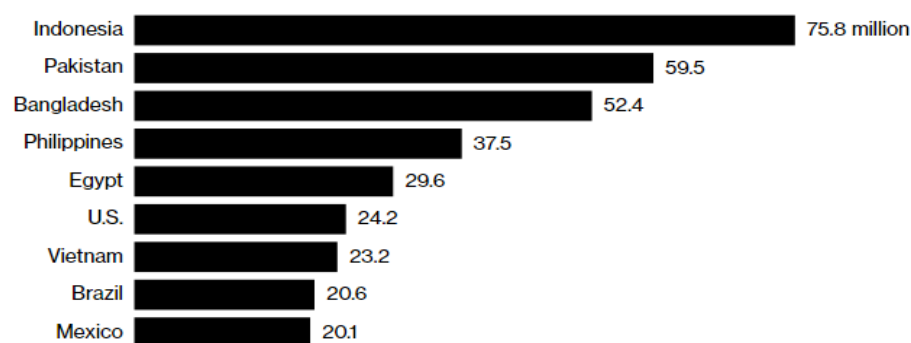
While China and India are big drivers of this shift, the smaller countries are benefiting from this thematic. Vietnam, for example, is proving to be a poster child in EMs as to why infrastructure spend is good for an emerging middle class, while an emerging middle class is good for infrastructure spend. Vietnam has a young and growing middle class, a horde of free-trade agreements, and a booming manufacturing industry. But it is starting to see expectations outrun reality. Businesses are complaining about congested ports and

roads. Infrastructure is the big challenge, especially at its ports, and is garnering a lot of attention and increased investment.

This thematic remains intact despite COVID, reports *Bloomberg*⁸. More than 1 billion Asians are set to join the global middle class by 2030, according to a *World Data Lab* study released in September 2021. The middle class – households where per-capita spending is between US\$11 and US\$110 a day – amounted to some 3.75 billion people in 2022. That cohort is projected to keep growing through 2030, with India and China, the most populous countries, adding about 750 million members between them.

Outside of the world's most populous countries, the following chart shows where the global middle class is forecast to grow most over the coming decade.

Chart 7: Forecast growth in the global middle class over the next decade (ex China & India)



Source: World Data Lab

By contrast, slow or negative population growth in some advanced economies will lead to a shrinking middle class in countries like Japan, Germany, Italy and Poland.

An infrastructure investor can capitalise on this changing demographic through direct investment within the EMs by way of utility, communication and transport, as well as through global investment by way of new and expanded airports, port and rail infrastructure and utility services.

Energy transition: net zero requires EMs

EMs account for 85% of the global population and over 60% of the energy consumption. While emissions in the developed world are gradually falling, EMs have seen their share grow and this is set to continue as their economies evolve. For example, the *International Energy Agency (IEA)*⁹ forecast that EMs will account for 85% of the projected global increase in electricity demand to 2050.

A growing demand for power and a desire for an improved quality of life (e.g. transportation modes) increases the pressure on the environment as it struggles to keep pace with the evolution. Are we to preclude these economies from evolving to a standard of living that the developed world enjoys? Clearly not, but population growth and the growth of the middle class create challenges that should not be ignored, and we believe are better addressed at the outset rather than trying to rectify a growing problem in the future (as we are currently doing in the developed world).

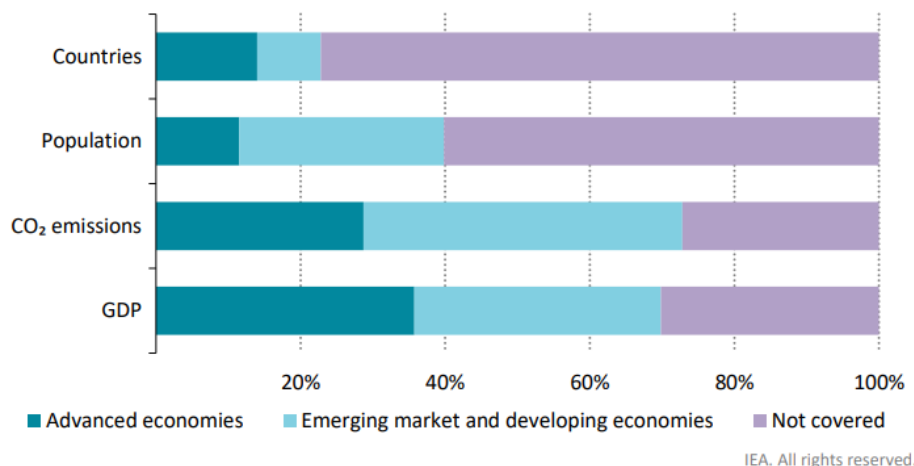
As recognised by the IEA, the energy transition '*must be fair and inclusive, leaving nobody behind*'. This means that many developing countries will need external support in terms of financing and technological developments to expand and support their economies in a sustainable way.

⁸ Bloomberg, [More Than 1 Billion Asians Will Join Global Middle Class by 2030](#), 3 September 2021

⁹ International Energy Agency, *Net Zero by 2050: A roadmap for the Global Energy Sector*, October 2021

Importantly, we are seeing signs that governments in EMs are working to address climate change challenges and learning from their developed peers in an effort to expand sustainably. Multiple EMs have made visible progress towards this, with some governments going as far as committing to net zero and providing incremental policy announcements that aid the energy transition.

Chart 8: Coverage of announced national net zero pledges



Source: International Energy Agency, Net Zero by 2050, October 2021

Infrastructure is key to reducing the global carbon footprint from an efficiency standpoint as well as achieving climate targets. While some of these environmental goals may not seem as advanced as their developed peers, considering the base from which they are moving the goals are huge in absolute terms, with a steep trajectory requiring significant investment and adaptation.

Table 1: Net zero target by core EM country

	China	India	Indonesia	Malaysia	Philippines	Thailand	Brazil	Mexico
Emissions Targets	Net Zero by 2060	Net Zero by 2070	Net Zero by 2050	Net Zero by 2050	70% reduction in emissions by 2030	Carbon neutrality by 2050 & net zero GHG by 2065	Net Zero by 2050	Aiming for a 35% reduction in GHG emissions by 2030
Interim Target	Strive for peak carbon emissions in 2030		32% emission reduction by 2030	45% reduction in emission intensity by 2030		20-25% emission reduction by 2030	End illegal deforestation by 2028, achieve 50% GHG reduction by 2030	
Renewables & Power Plants	Renewables to supply 33% to national power consumption by 2025	500 GW of renewable energy capacity by 2030	Renewables to supply 34% of total power generation by 2030; No new planned coal power plants	31% renewable energy mix by 2025 and 40% by 2035; No new planned coal power plants	Renewables to supply 35% of total power generation by 2030	Renewables to supply 35% of total power generation by 2037	45% renewables in the energy mix by 2030; 23% renewables in the power supply by 2030	Increase clean energy production to 40 GW by 2030

Source: Morgan Stanley and various sources

Finally, recognition of the need for external support and investment to achieve energy transition goals is encouraging governments to set appropriate regulatory frameworks around infrastructure needs in an effort to attract the necessary private sector/external investment.

Decarbonisation must happen, and the goal of net zero is not achievable without the right forms of infrastructure investment across both the energy and transport sectors in the developed and emerging worlds. In fact, *Vivid Economics*, working for the Net-Zero Asset Management program, suggests that around 70% of the investment required to meet net zero will need to come via EMs. This represents a significant and growing opportunity for infrastructure investors who want to be part of the solution, such as 4D.

We prioritise both countries and companies with strong management teams, defined strategic environmental goals that integrate with a complete ESG policy, strong balance sheets to support much-

needed investment, and those that are best in class within their sector in building a sustainable infrastructure footprint. This applies whether it be pure play renewable operators, toll roads supporting electric vehicles and a reduction in congestion, airports that are themselves targeting net zero, water operators, or even the integrated regulated utilities that continue to manage legacy fossil fuel generation to ensure security of supply. As management of Guangdong Investments commented¹⁰:

“...climate change exacerbates water scarcity in some regions of China. Our technology and effort on water supply and conservation would contribute to alleviate water stress and reduce the negative impacts of climate change on water resources. Investing in projects like water supply, treatment, and distribution would bring a reasonable and sustainable profit to the company.”

The scope of the EM decarbonisation thematic is too important to cover in a couple of paragraphs and we look forward to exploring this further in a future article.

Perceived risk: internally assessed

Countries have real risk. Importantly, this risk is not confined to EMs, with some key concerns today coming from the developed world (e.g. persistent inflation, debt ceilings, energy security).

At 4D we have a unique integrated process for investment, whereby country risk analysis is combined with individual stock analysis in a single analytical cycle. We do this because we believe country risk is real, can impact stock investment decision making, and the risk can shift – both positively and negatively – over time. Put simply, a stock cannot find its way into our portfolio unless we are first happy with its country of origin as defined by its listing locality and/or primary sources of income.

Our country review process involves assessing each country based on the four key sovereign risks: financial, economic, political and ESG (sustainability goals). After a country review is completed, each country is given a final grade using a traffic light system of:

- Green: the country is a relatively attractive investment destination
- Yellow: the country is still an acceptable investment destination, but the risk is higher than in green countries. This could be a country that is improving from a red position but is not yet low risk, or a country where we believe the risk has increased and is worth monitoring
- Red: the country is an unacceptable investment destination.

As such, any EM we invest in has passed this screening and EM countries are assessed on the same basis as their developed peers.

Further, if an investor is looking for exposure to the EM growth thematic but wants to mitigate risk, then infrastructure is an attractive way to gain this exposure. It is 100% correlated to the domestic demand story and key investment themes, as discussed, while hedging against key EM risks¹¹ including inflation and sovereign risk.

- **Inflation** – A core concern for EMs over their evolution is domestic growth-driven inflationary spikes, often driven by a weather event (disrupting food sources or fuel supplies). The

¹⁰ Via email to 4D Infrastructure

¹¹ Other risks that we consider before investing include:

- Beware of the benchmarks – know what you are getting and make sure you are capitalising on the EM opportunity set, not just an EM domicile
- Government ownership – avoid or embrace
- Competition – know your assets
- Shadow economies – good (understated growth) and bad (inaccurate data)
- Corruption – perception improving as a general rule
- Go listed – liquidity, first mover advantage, government shareholdings, FCF funded growth

infrastructure asset class provides investors access to the upside of the growth story while explicitly hedging against inflationary pressure (regulation and contracts provide for an inflation hedge). This mitigates one of the key EM investment risks and could be increasingly important moving forward as weather events appear to be on the rise.

- **Sovereign risk** – EM governments and policy makers recognise the need for improved infrastructure to enable their economies to evolve. As they cannot facilitate all the investment needed, they are supportive of private investment in infrastructure assets to provide the essential services needed to facilitate economic growth and deliver improved living standards. While EM governments continue to need private sector capital, investors should have confidence that contract/regulation will be upheld and acceptable investment returns will be supported. When they no longer need your investment dollar it is time to exit, but that is certainly not going to be in our lifetimes given the need for infrastructure capital today! Further, as part of our country review process discussed above, we assess the strength of a country's judicial system – governments will come and go, both in the developed and emerging world, so to ensure our regulation and contracts are secure we must have confidence in the strength and independence of the judiciary. For example, Brazil has a very strong judicial system and while infrastructure contracts have been tested many times over the years, the contracts have always prevailed, giving us confidence to invest.

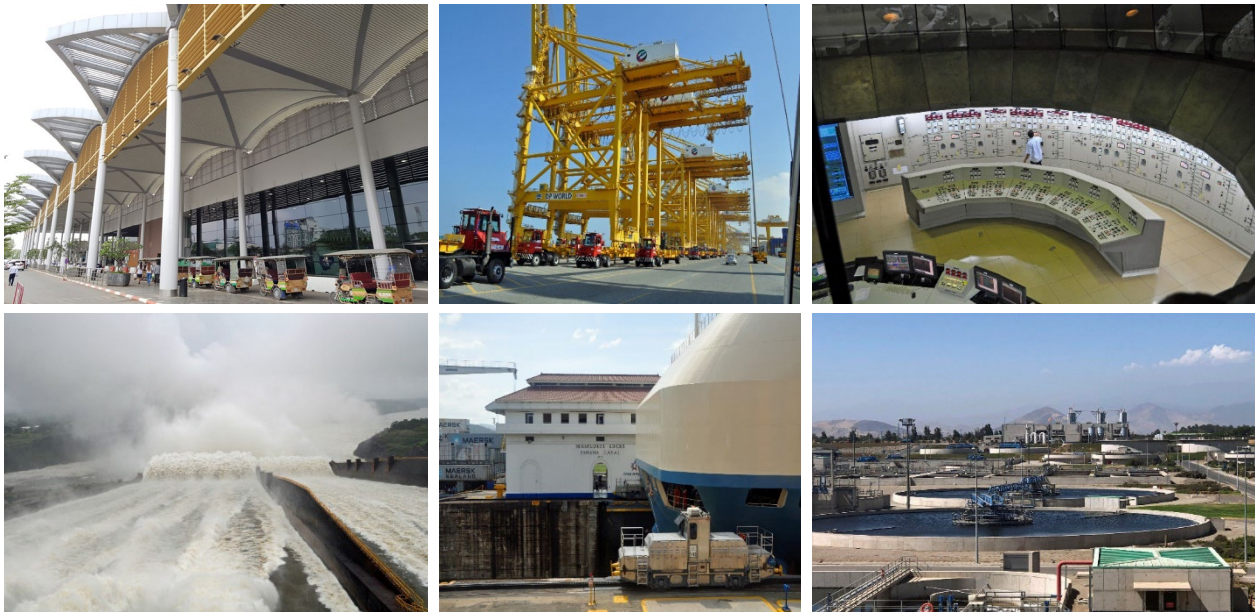
EM infrastructure: access the opportunity while hedging key risks

From an infrastructure investment perspective, the potential is enormous. Given the budget and balance sheet pressures facing governments around the world, including EMs, much of these new and enhanced infrastructure demands will inevitably have to be met from private sector funding, including the listed and unlisted infrastructure equity markets. We at 4D are capitalising on this via:

- **Utility services:** a growing and more affluent/demanding middle class will require an improved and sustainable standard of living across the board, which will pressure the basic utility services such as water, electricity, gas and telecommunications to improve their offering. We are taking advantage of this through renewable, transmission and distribution investment in Brazil; gas distribution, waste and water in China; and towers in Indonesia, to name a few;
- **Airports (international and domestic):** greatly increased overseas travel is leading to demand for new or expanded international airports. We have exposure to airports in Mexico, Brazil and emerging Asia as well as realising the theme through destination airports across Europe;
- **Toll roads:** increased motor vehicle penetration and growing urbanisation will be matched by increased demand for new and enhanced roads, including user-pay toll roads. We are realising the upside through toll road exposure in China, Indonesia, Brazil, Chile & Colombia; and
- **Port infrastructure:** increased import demand will ultimately necessitate enhanced port infrastructure. Our exposure via ports in China, EMEA and Brazil capitalises on this.

EM infrastructure: superior quality and significant value

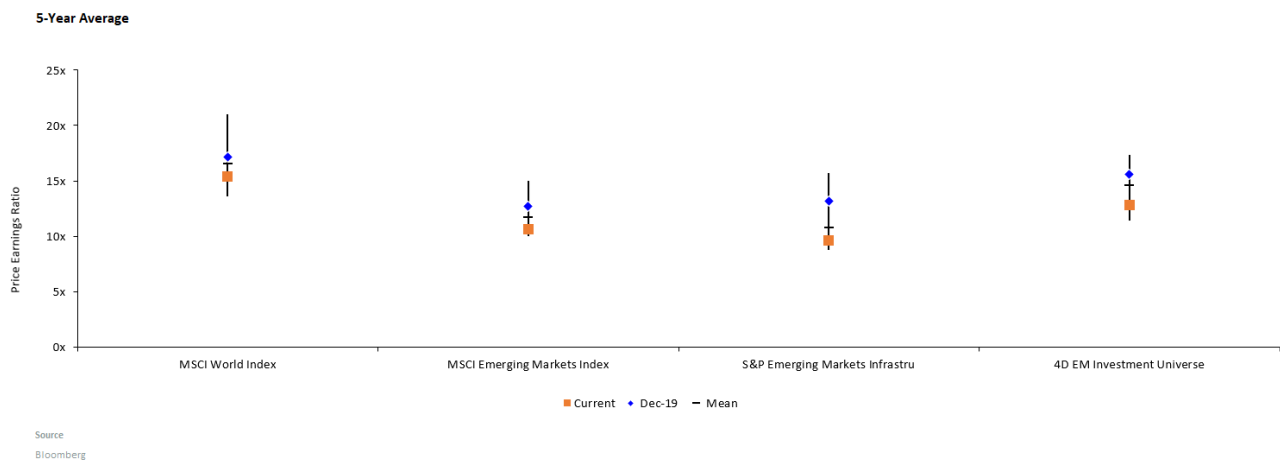
By contrast to the developed world where infrastructure is in a dire state of deterioration, privately funded EM infrastructure is far newer and of a superior quality.



Source – 4D trip photos. Clockwise from top left corner – Phnom Penh Airport (Cambodia), Jebel Ali Port (Dubai), Itaipu control room (Brazil), Itaipu hydro plant (Brazil), Panama Canal, Waste Water Treatment Plant (Santiago, Chile)

An investor willing to capitalise on the opportunity via direct investment into EMs is currently accessing this theme at very attractive valuations, both on an absolute basis (compared to their developed peers) but also relative to historical ranges. This value proposition is even more pronounced when you consider the relative asset quality and the growth opportunities now available compared to developed peers as well as historically in EMs.

Chart 9: Price earnings ratio: historical range using FY1 EPS



Source: Bloomberg as 31 March. Performance data for the 4D Emerging Markets Infrastructure Fund and its benchmark can be found on our website

Conclusion: the EM infrastructure opportunity remains compelling

EMs are expected to grow rapidly over the next 30 years, attracting a huge infrastructure investment. This is a good thing, as EM and infrastructure are natural, complementary investment partners. Rapidly growing EM economies need infrastructure investment to both facilitate and sustain growth. These assets also perform at their best in expanding economies, where robust domestic demand growth drives patronage growth. That is, they reinforce each other in a positive manner, while at the same time offering natural protection against some of the key EM risks, including the critical ones of inflation and sovereign risk.

We believe the infrastructure growth thematic makes the asset class one of the core investment themes of the decade and without EMs, three of the key drivers of growth lose momentum. EMs are providing the

population growth, are driving the emergence of the middle class and will play a vital role in the world meeting net zero targets. We at 4D are actively capitalising on the opportunity EMs present.

For more insights from 4D Infrastructure, visit 4dinfra.com

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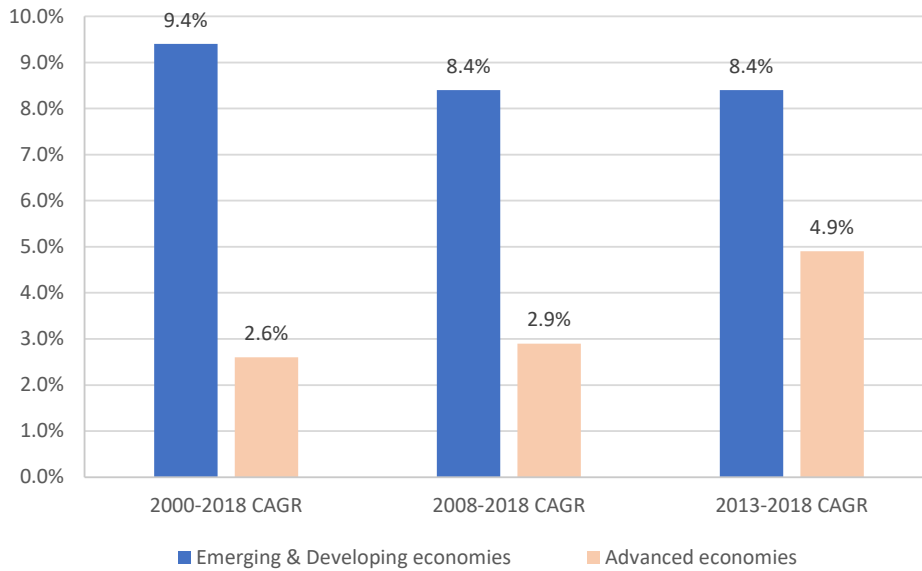
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Appendix: How to capitalise on the emerging middle class via infrastructure

Airports

At present, around 10% of the Chinese population has a passport (less than 5% in India), and yet pre-COVID, airports globally were reporting record passengers driven by the EM traveller.

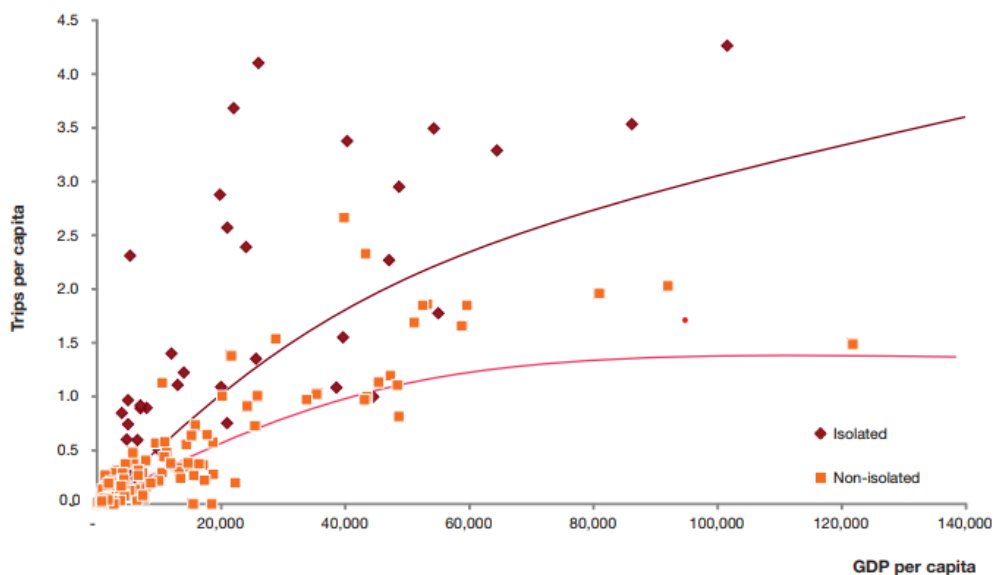
Chart 10: CAGR in passenger traffic – emerging versus advanced economies



Source: ACI World Airport Traffic Database 2019 – emerging versus advanced economies

Due to the natural correlation between air traffic and GDP per capita, in a normalised world China is set to displace the US as the world’s largest aviation market (defined by traffic to, from and within the country) in around three years. India will displace the UK for third place the year after, while in the same year Indonesia will enter the top 10 at the expense of Italy.

Chart 11: Relationship between air trips per capita and GDP per capita



Source: BMI, Sabre Air Transport Intelligence, PwC analysis

This opportunity, however, is not confined to the three large Asian powerhouses. Mexico, for example, is also benefiting significantly from an expanding middle class as reflected by double-digit domestic air passenger growth (as are many of the smaller EMs). This trend is set to continue and is going to require increased airport capacity domestically and globally.

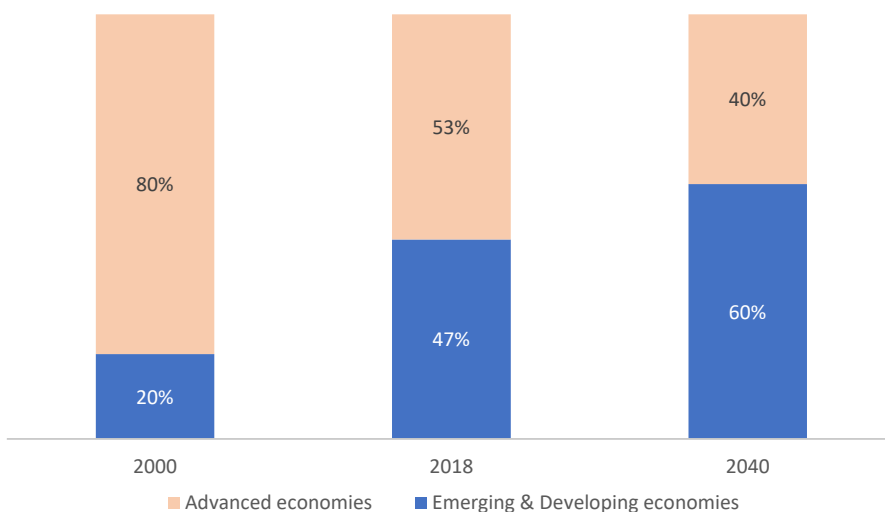
As Raul Revuelta Musalem (CEO of Mexican airport GAP) commented¹²:

"The growth of the domestic middle class has fueled a significant increase in air travel demand. Traveling has become more common than ever before, whether it is for leisure travel or visiting friends and family. This has created a plethora of opportunities for airlines to enhance their operations, open new routes, and cater to rising passenger traffic. This has led to higher load factors, additional fleets, increased revenue, and new market exploration. We have capitalised on this trend by introducing enhanced services and offerings, collaborating with airlines and travel agencies, and contributing to employment and economic growth within the aviation industry. The expanding middle class is a catalyst for air travel sector growth and prosperity."

Cancun airport immigration and baggage hall, January 2023 – chaotic but efficient



Chart 12: Proportion of global passenger traffic – emerging versus advanced economies (2000-2040)



Source: ACI World Airport Traffic Database 2019 – emerging versus advanced economies

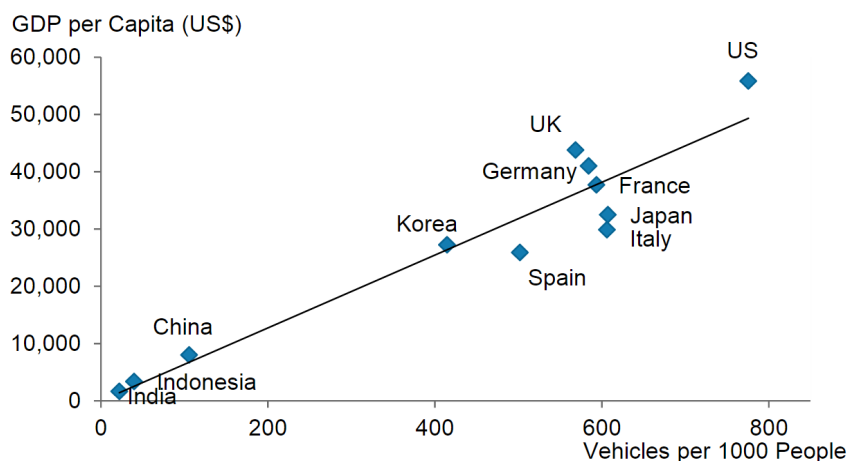
4D has exposure to airports in Mexico, Brazil and emerging Asia, as well as realising the theme through destination airports across Europe.

¹² Via email to 4D Infrastructure

Roads

A further example of the impact of an expanding middle class and increased urbanisation is the similar correlation between growth in GDP per capita and vehicle ownership. EMs in general still have a relatively low level of motor vehicle (MV) penetration. However, as each nation's GDP per capita grows, it is expected that so too will each country's level of vehicle ownership, which equates to the need for more roads. Less than 20% of Chinese own a car, but since 2010 annual MV sales have been well above the USA (where MV penetration is over 70%). As an infrastructure investor, I don't care what car you are driving, as long as it is driven on the road I own!

Chart 13: Asia's Big 3 – auto penetration vs developed nations, 2015



Source: *Why we are bullish on China*, Morgan Stanley Research, blue paper: February 2017

Importantly, it is not just MV penetration that increases the demand for roads. As Chinese diversified operator, Shenzhen Expressway, commented¹³:

“Social and economic development (eg metropolitan areas, urban clusters) has new demands for transportation and other infrastructure.”

We are realising the opportunity set through urban and inter city toll road exposure in China, Indonesia, Brazil, Chile & Colombia.

Data

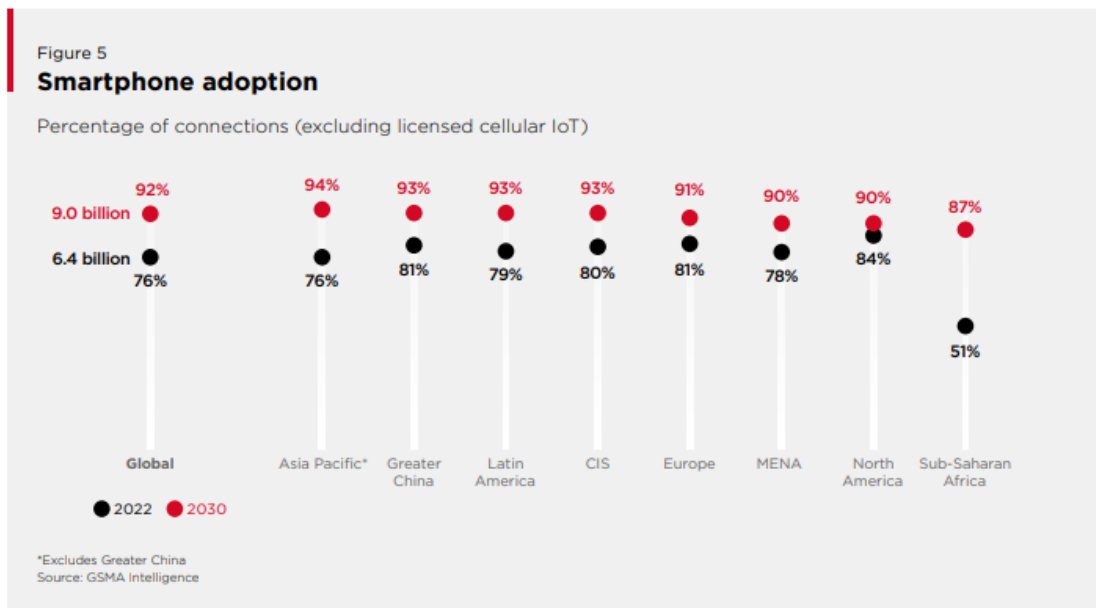
Mobile connectivity has emerged as an important essential service for daily life and economic growth. By the end of 2022, more than 5.4 billion people globally subscribed to a mobile service, with mobile technologies and services generating roughly 5% of GDP, creating more than US\$5.2 trillion of economic value¹⁴. Looking out to 2030, EMs in Asia Pacific, Latin America and Sub-Saharan Africa will see the largest increase in smartphone adoption, driven by improving affordability and the emergence of the middle class. As can be seen in Chart 14, smartphone usage in EMs still has significant potential for expansion relative to the developed world. By 2030, the number of smartphone connections is expected to exceed 9 billion¹⁵, with a considerable portion of this growth originating from EMs given the higher population base and lower overall penetration.

¹³ Via email to 4D Infrastructure

¹⁴ GSMA – The Mobile Economy 2023

¹⁵ ibid

Chart 14: Smartphone adoption



5G has seen significant investment over the past few years, driven by the need for higher speeds and improving technology, which has resulted in record capex intensity. In particular, the explosive growth in the *Internet of Things (IoT)*¹⁶ has been a key driver of 5G rollout given the requirements for rapid speeds and low latency. The total number of licensed IoT connections will double to 5.3 billion by 2030, with Greater China accounting for two thirds¹⁷. Between 2023 and 2030, mobile operators will spend US\$1.5 trillion on their mobile networks¹⁸.

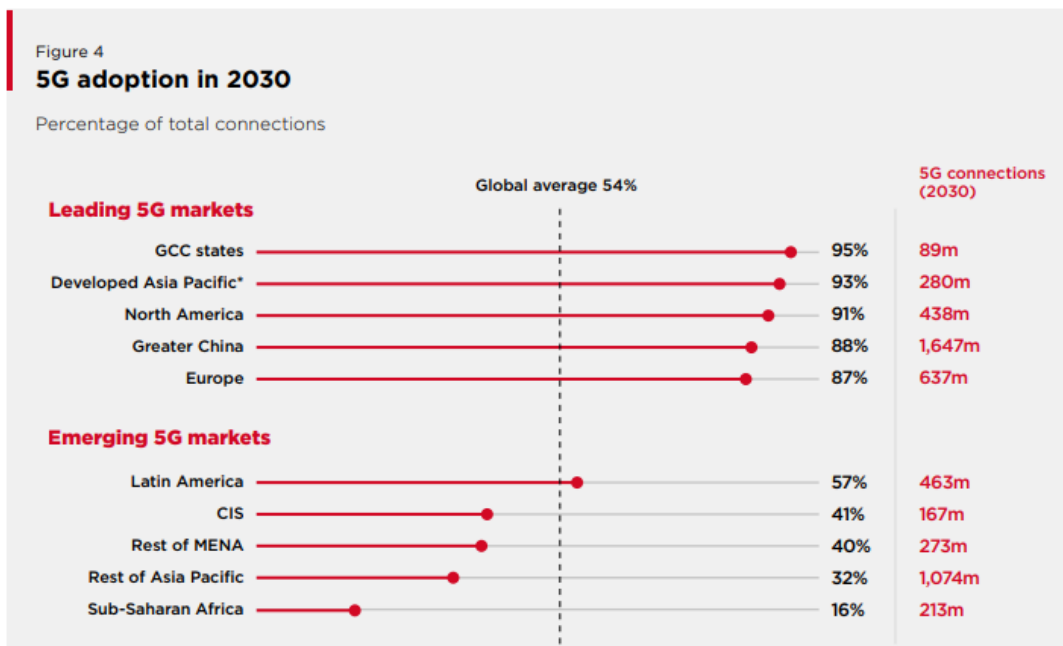
The explosive growth in data consumption and IoT will fuel significant investment opportunities for digital infrastructure owners globally. Cellular towers will play a key role in building out wireless networks, as they house electronic communications equipment and antennae which provide surrounding areas the ability to communicate wirelessly – this is a macro tower as well as small cell opportunity. As can be seen in Chart 15, despite significant investment, EMs' 5G adoption (ex-China) will remain far below the developed world by 2030, presenting an investment opportunity well beyond the next decade as the middle class evolves.

¹⁶ The Internet of Things describes physical objects embedded with sensors and actuators that communicate with computing systems via wired or wireless networks.

¹⁷ GSMA – The Mobile Economy 2023

¹⁸ *ibid*

Chart 15: 5G adoption in 2030



Source: GSMA Intelligence

With the continuous evolution of technology and its expanding significance in our everyday lives, the role of dependable and high-speed wireless networks becomes increasingly important for fostering the growth of the global economy. Considering the significant lag in digital infrastructure investment in EMs to date, coupled with a comparatively lower rate of smartphone adoption, there exists a remarkable investment prospect in data infrastructure within these markets. We aim to capitalise on this opportunity directly by investing in prominent cellular tower operators aligning with this secular growth theme, such as towers in Indonesia. As tower operator Sarana Menara commented¹⁹:

"Indonesia's internet access still has room for improvement. The average usage today is approximately 50% that of India and only 70% of Indonesians have access to internet²⁰. Importantly, towers and fiber optics infrastructure helped Indonesia's population remain educated and with access to communication and commerce during the pandemic.

We continue to grow ex-Java where need of infrastructure is massive and is the place where approximately 55% of Indonesia's foreign capital has been invested in downstream of minerals and industrialisation."

However, we also benefit through the growing importance of technology in enhancing efficiency and therefore profitability of all infrastructure operations, whether that be transport or energy. As management of COSCO shipping out of HK states²¹:

"Technological innovation will push forward increasing automated and smart ports projects, which enable port operators to further improve efficiency for the entire logistics chain and cost control to enhance profitability."

Waste and Waste-To-Energy

When we talk about the infrastructure opportunity, most investors don't immediately think of waste. However, this represents not only a significant opportunity set in terms of collection but rather a dual

¹⁹ Via email to 4D Infrastructure

²⁰ According to Indonesia's internet association

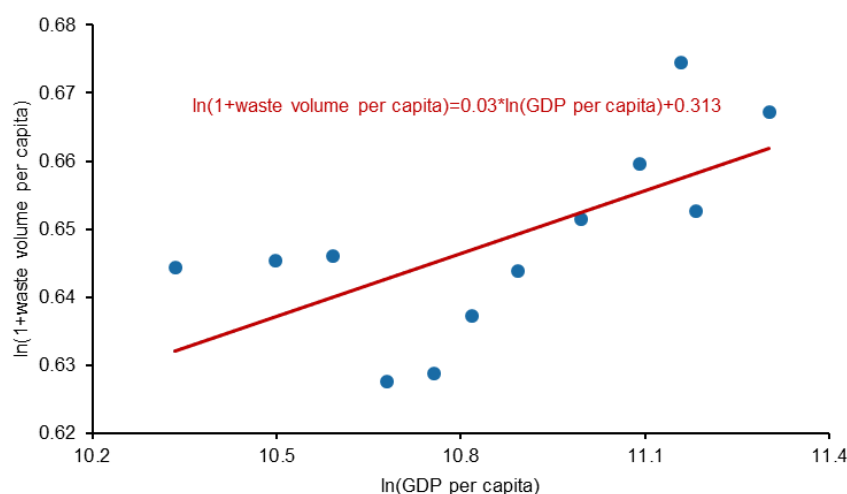
²¹ Via email to 4D Infrastructure

opportunity in utilising said waste for energy – a path for EMs to not only access a basic service, but aid the energy transition as a result.

Cities around the world generate over 2 billion tons of waste annually²². Yet a quarter of the world's population (2 billion people), largely in EMs, do not have their waste collected, and 3 billion (more than a third of the population) lack access to proper waste disposal services²³. The problem is only going to be compounded by future economic growth, urbanisation and the rise of the middle class, with associated increased consumption translating into greater production of waste. As management from Chinese operated Carvest explained²⁴:

“Rising GDP per capita will lead to greater consumption, increasing not only the volume of solid waste that will be generated but the solid waste will have a higher calorific value.”

Chart 16: Correlation between GDP and waste



Source: China Everbright Environment

According to *United Nations*²⁵ the total amount of waste generated globally is expected to double to about 4 billion metric tons by 2050. Without ongoing infrastructure investment, the sheer volume of waste will cause significant issues as inadequate or overutilised waste-management systems have negative flow-on impacts on economic growth, health and ecosystems. So what is the world to do with this waste?

China Everbright Environment (CEI) management highlighted the opportunity set across the value chain, with collection, sorting and recycling offering alternate and complementing revenue streams²⁶:

“...because of waste sorting, we do see huge need for waste recycling”.

One accepted solution for this ‘recycling’, and one we believe in as an investment opportunity, is waste-to-energy (WTE), whereby waste is processed and incinerated, with the steam produced from burning waste turning a turbine to generate electricity. The end-to-end waste process can therefore yield two income streams: the collection fee, generally remunerated on a per ton basis, and power sales, remunerated on a per kWh basis. Importantly, the generation from WTE facilities is categorised as renewable.

²² FS Impact Finance – The Problem and Opportunity of Waste in EMs – October 2020

²³ UN Stats – SDG Indicators Report Goal 11- ‘Sustainable Cities’ 2019

²⁴ Via email to 4D Infrastructure

²⁵ UN Stats – SDG Indicators Report Goal 11- ‘Sustainable Cities’ 2019

²⁶ Via email to 4D Infrastructure

In China, for example, the central and provincial governments have been supportive of developing the market chain for waste. Specifically, WTE is the preferred waste disposal method to landfill, and incineration rate targets have historically been set within the CPP's Five-Year Plans to promote investment.



Private investment in the waste sector will be required as increased volumes and facility utilisation will lead to the need for further waste disposal infrastructure. Investments in this sector can provide attractive economic returns, boost social license, and generate significant non-financial benefits (reduced pollution and improved health benefits for populations). We are capitalising on this through waste and WTE investment in China, but expect the opportunity to expand to other countries as they evolve.