RBC Global Asset Management

Green Infrastructure

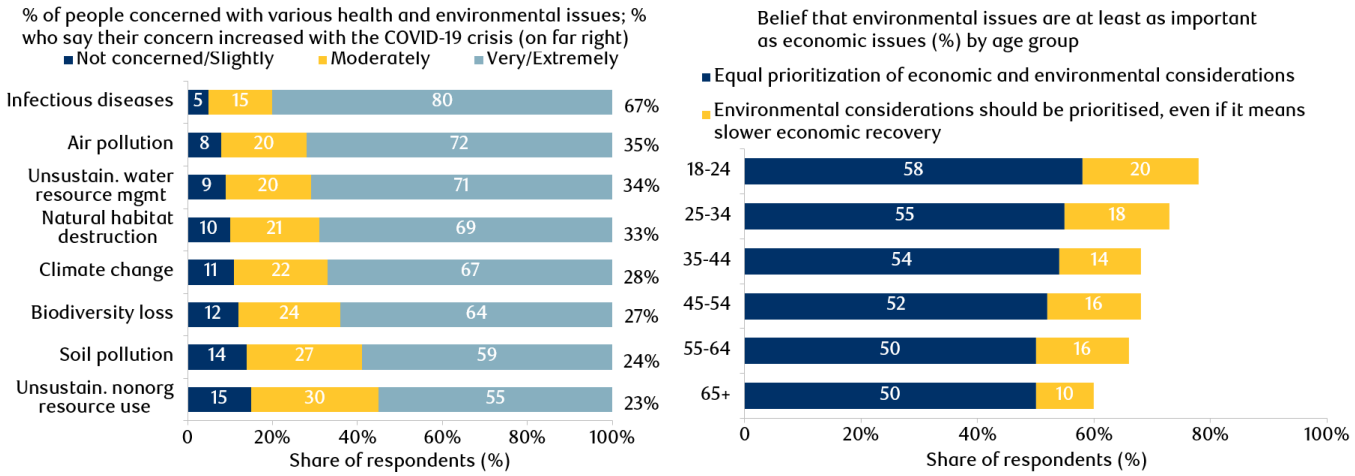
The RBC Emerging Markets Equity team

Introduction

Climate change is an unavoidable area for corporates, consumers and governments alike. The World Economic Forum has identified environmental issues as a top risk globally but we believe that this risk is even more pronounced in emerging markets (EM). The combination of geography, higher carbon emissions and the ability to deal with unexpected natural events are key reasons why we believe that climate change will have strong economic and political ramifications for EM governments. Furthermore, we believe that COVID-19 has further heightened awareness of the climate change problem. Younger generations, in particular, believe that environmental issues are at least as important as the economy (Exhibit 1).

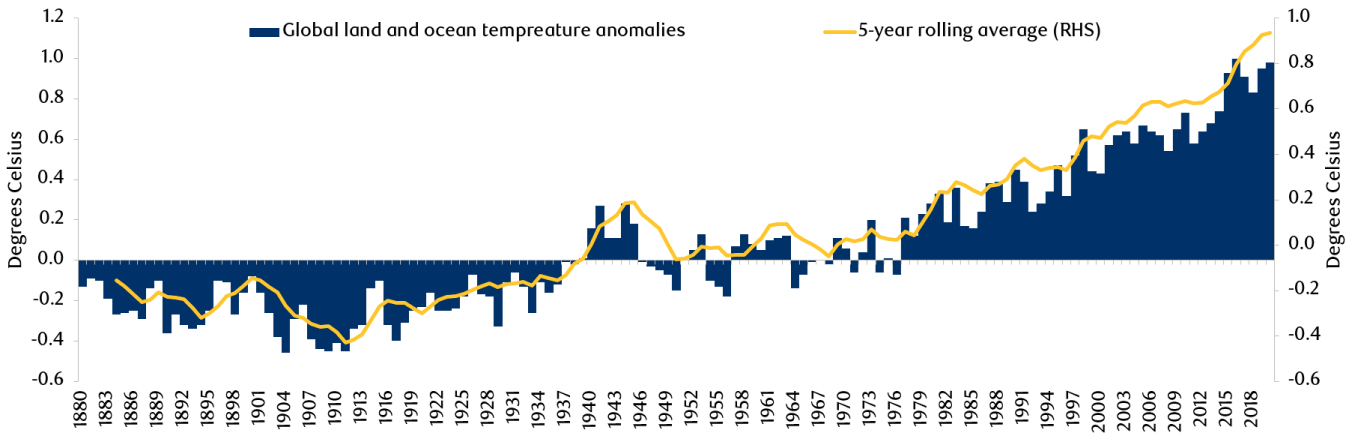
Infrastructure has been an important theme in the RBC Emerging Markets Equity team's portfolios for some time, as infrastructure assets have supported the sustainable growth and development of the countries in which we invest. As environmental risks become increasing sources of both opportunity and risk, we have decided to focus our Infrastructure theme on 'Green Infrastructure'. We believe this is a multi-decade growth story and we want to increase our exposure to this theme across all our portfolios. In this report, we summarise the key drivers behind the Green Infrastructure theme and analyse the best ways to play this theme.

Exhibit 1: Public believes that environmental issues are at least as important as economic issues



Source: BCG. Data as at May, 2020.

Exhibit 2: Global average temperatures have been rising (data from 1880-2019)



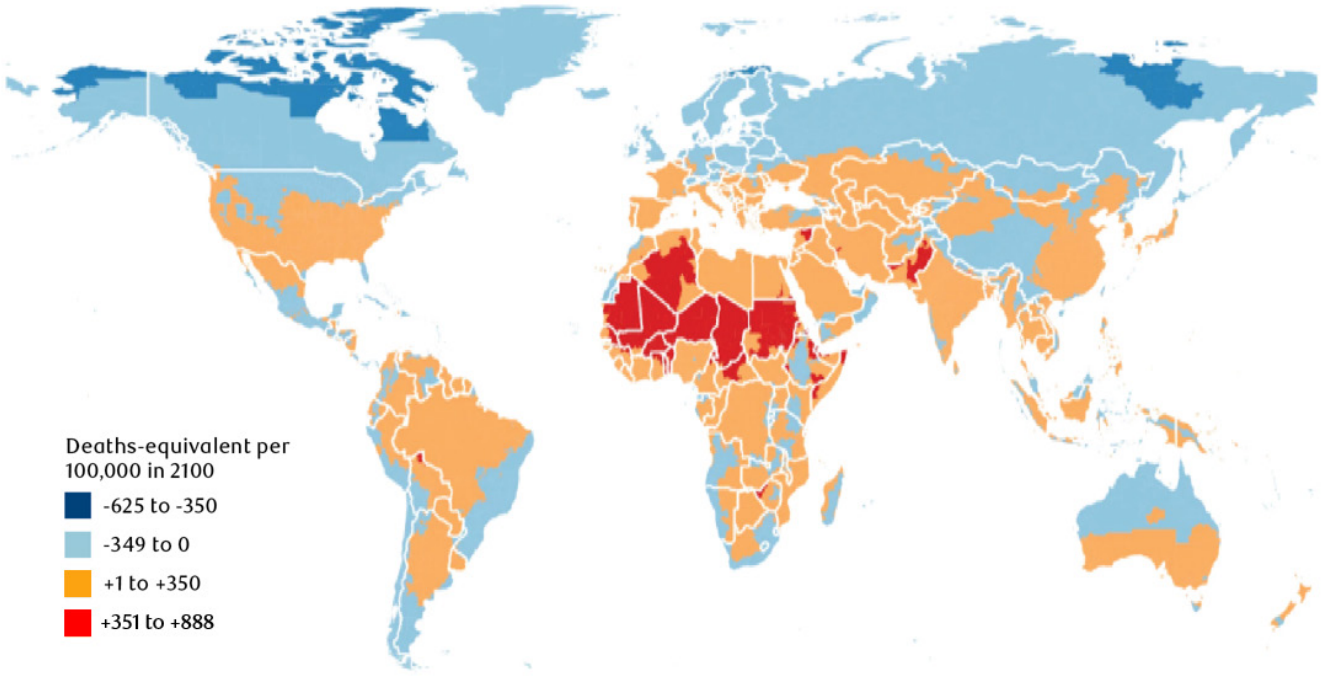
Source: Hadley Centre. Data as at December, 2020.

What are the key drivers behind the theme?

1. **Global Warming.** The incidence of extreme weather events is intensifying globally. The Australian wildfires in late 2019 and early 2020 are a good example of the impact that extreme weather events can have on physical infrastructure. Rising temperatures are a main cause of extreme weather events and most regions have experienced a rise in temperature of around 1% since the late 1880s (Exhibit 2). July 2019 was the hottest month on record in 140 years, and on current trajectories global warming and associated climate risks are likely to continue which will encourage the move towards decarbonisation and, as a result, Green Infrastructure.[1]

2. **Health**. The impact of climate risks on people's health is becoming more apparent. The World Health Organization estimates that 9 out of 10 people breathe air containing high levels of pollutants. Air pollution is responsible for approximately seven million deaths worldwide each year.[2] According to the Institute for Health Metrics and Evaluation, the number of deaths caused by air pollution is expected to be higher in EM. Similarly, the impact of climate change on mortality rates is projected to be higher in both emerging and developing economies by 2100 (Exhibit 3).

Exhibit 3: Predicted mortality impact from climate change in 2100 by region



Source: Carlton et al. Data as at December, 2018.

[1] BAML research. [2] BAML research.

3. **Increased Government Focus.** Public concern about climate change has caused it to become an important part of the political agenda. As a consequence Green Infrastructure is likely to provide a source of economic growth for many countries around the world. President Biden has already announced that the intended USD2.5tn infrastructure plan is likely to focus on Green Infrastructure and Decarbonisation. China has announced a net zero carbon target by 2060 and has invested heavily in electric vehicles and renewable sources of energy. We expect to see similar announcements from other governments globally. It has been estimated that the economic impact of climate change could reach USD69tn this century and that energy transition spending needs to rise by USD4tn per year to meet the targets set out in the Paris Agreement.[3] We expect that the public sector would help to meet any shortfall in the investment required.

We think that continued tension between the U.S. and China could be another growth driver. Following the recent trade and technology disputes, it is likely that the next chapter in U.S.-China tensions will be about climate. Climate strategies offer a route to global supremacy and have shifted beyond environmental conservation to become a competitive race on long-term and industrial viability. Exhibit 4 shows the differences in policy between the U.S., Europe and China and we think the continued drive towards global supremacy in this area will further underpin the Green Infrastructure theme.

Exhibit 4: Regional advancements in Green Infrastructure

		US	China	Europe
Policy	Green deals or green fiscal stimulus	USD 1.9tn.	N/A	EUR 1.0tn.
	Net zero target	N/A	2060	2050
	Energy transition investment 2010-20	USD 0.7tn.	USD 1.2tn.	USD 0.9tn.
Electricity	2020 Share of zero carbon electricity	36%	33%	57%
	2030 Share of zero carbon electricity (BNEF)	42%	47%	85%
	Share increase of zero carbon electricity by 2030	6%	14%	28%
Wind	2019 Annual installations	9 GW	26 GW	15 GW
	2019 Installed base	104 GW	236 GW	205 GW
	2030 Installed base (BNEF)	214 GW	644 GW	480 GW
	2030 vs 2019 Installed base	2.1x	2.7x	2.3x
Solar	2019 Annual installations	13 GW	30 GW	16 GW
	2019 Installed base	76 GW	205 GW	132 GW
	2030 Installed base (BNEF)	238 GW	827 GW	377 GW
	2030 vs 2019 Installed base	3.1x	4.0x	2.9x
Hydrogen	Electrolyser capacity 2030	N/A	N/A	40 GW
	Green hydrogen annual production - 2030	N/A	N/A	10 mt
	Share of hydrogen in energy - 2040	N/A	N/A	10%
Batteries	2020 Battery manufacturing capacity	44 GWh	330 GWh	17 GWh
	2025 Battery manufacturing capacity forecasts	129 GWh	1365 GWh	489 GWh
	Battery capacity growth	2.9x	4.1x	28.6x
Electric vehicles	2020 Electric vehicle sales	0.3 million	1.3 million	1.4 million
	2020 Electric vehicle sales share	2%	6%	10%
	2030 Electric vehicle sales forecasts	4.0 million	12.6 million	6.5 million
	2030 Electric vehicle sales share forecasts	24%	47%	39%
	Share gains in electric vehicle sales by 2030	22%	42%	29%

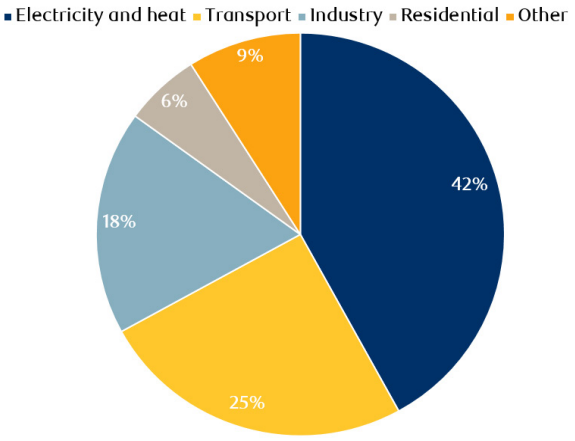
Source; BofA Global Research, BloombergNEF, GWEC, PV-Magazine.com, EV-Volumes.com. Data as at February, 2021.

[3] Bank of America (BofA) Merrill Lynch, May 2020.

What are the best ways to play the theme?

Energy consumption accounts for 73% of man-made greenhouse gases. Of that 73%, and specifically looking at CO_2 emissions, electricity, heating and transport account for the majority of CO_2 emissions (Exhibit 5). We have concluded that the best way to play the Green Infrastructure theme is in relation to these sectors. In this section, we will summarise what we believe are the best ways to play the theme under the following headings: renewable energy, electric vehicles (EV) and transmission metals. Other sectors such as energy storage, food and agriculture, and hydrogen are also interesting ways to play the theme and may be key areas to investigate in future but currently there are very few investable names in these sectors. (Exhibit 6).

Exhibit 5: Global CO_2 emissions by sector

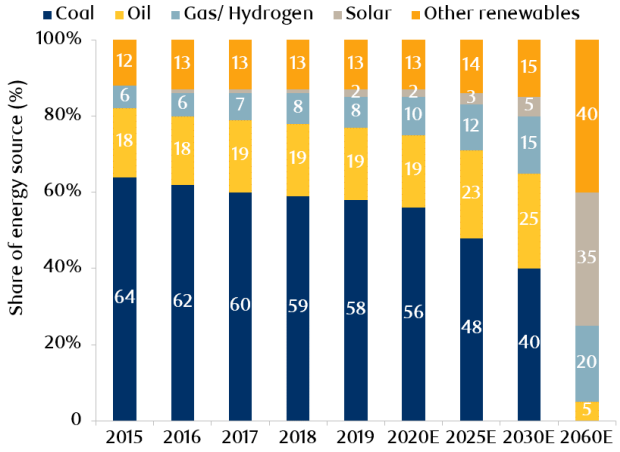


Source: IEA World Energy Database, BofA Global Research. Data as at December, 2018. Article produced in December, 2020.

Renewable energy

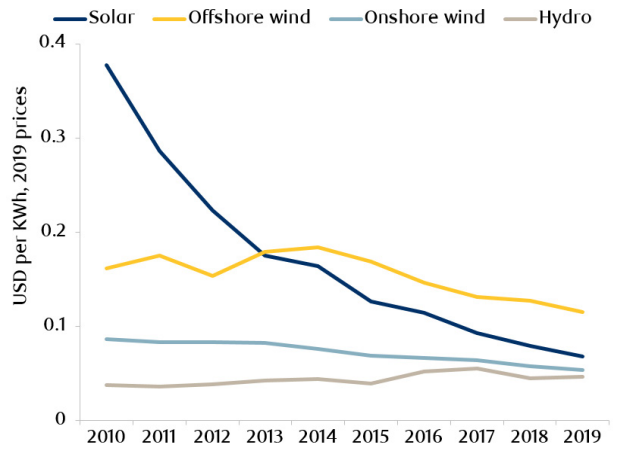
Renewable energy is set to be the fastest growing energy source over the next two decades, driven primarily by solar and wind power. This is especially the case in China where the government has set ambitious targets, particularly for solar power. It is anticipated that by 2030 only 40% of energy will come from coal, compared with 64% in 2015.[4] Looking further ahead, it is expected that solar and other renewables will account for 75% of primary energy consumption in China and we also expect there to be a similar trend in other EM (Exhibit 6). The shift towards renewable energy has been driven not only by environmental concerns but also falling costs. For example, wind turbines are 25% cheaper today than they were five years ago, while turbine efficiency has improved by about 30% over the last decade according to the International Renewable Energy Agency (Exhibit 7).[5] The most significant reduction of costs has taken place in the solar space, however, where the cost of solar modules has reduced by 90% between 2010 and 2019.

Exhibit 6: China: breakdown of primary energy consumption



Source: NDRC, Wind, Daiwa forecasts. Data as December, 2019.

Exhibit 7: Levelised cost of energy



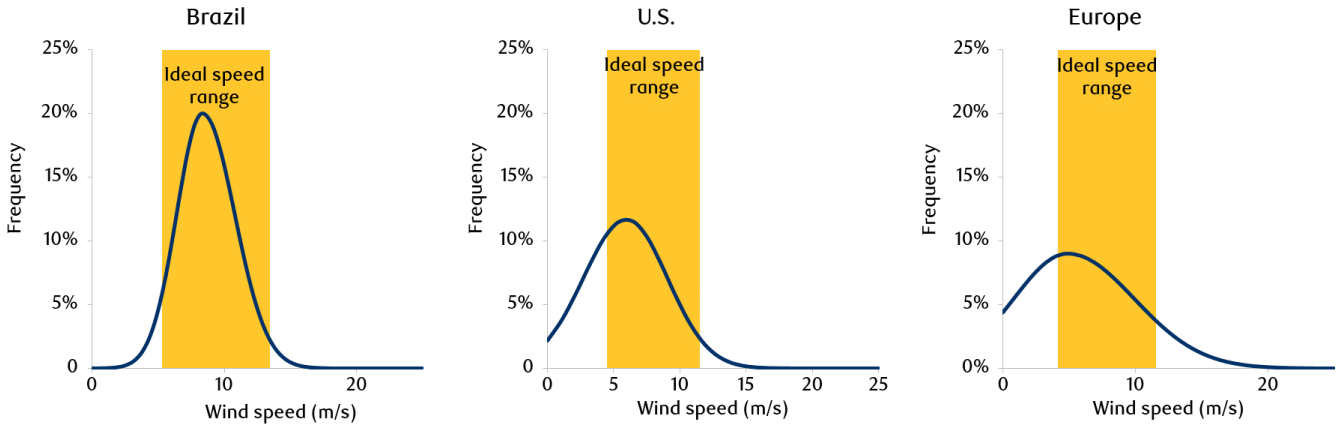
Source: International Renewable Energy Agency, FT. Data as January, 2020.

Wind Power. Wind flow patterns and speeds vary greatly across the globe, however, and are modified by bodies of water, vegetation and differences in terrain. In terms of the high quality conditions needed for wind generation, a combination of constant single direction speeds and lower turbulence and variability is required.

Brazil scores well relative to the U.S. and Europe in terms of wind 'quality' and is benefitting from falling costs and improved technology (Exhibit 8). According to the Brazilian Association of Wind Energy, the country has huge potential for wind power - equivalent to 500GW - which is enough to supply the country at three times the current demand (Exhibit 9).

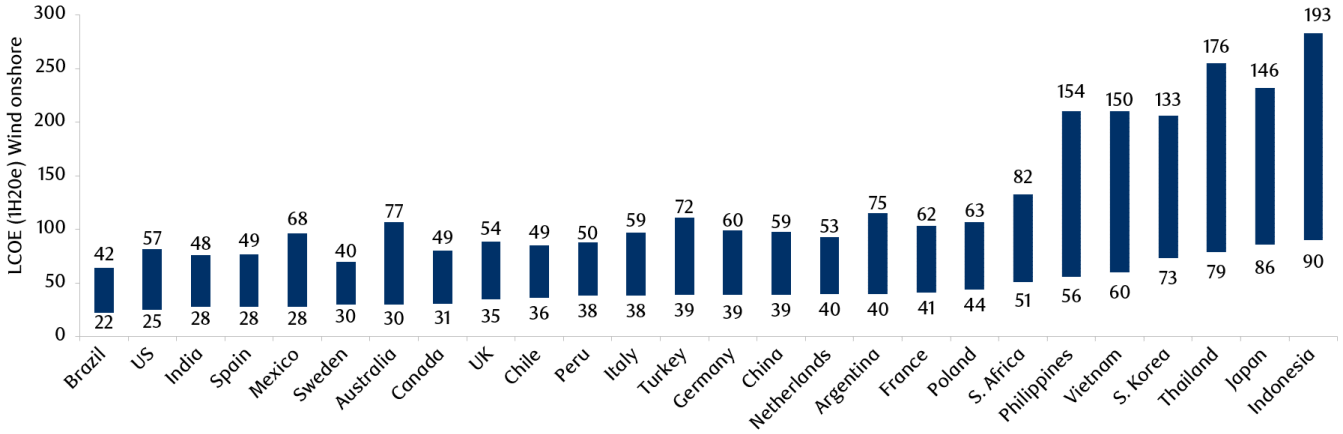
[4] NDRC, Wind, Daiwa forecasts. [5] International renewable energy agency.

Exhibit 8: Brazil has high quality wind concentrated in the north-east of the country



Source: Wood Mackenzie, EPE and BTG Pactual. Data as at December, 2020.

Exhibit 9: Wind on-shore power projects LCOE (1H 2020e) comparison worldwide[6]

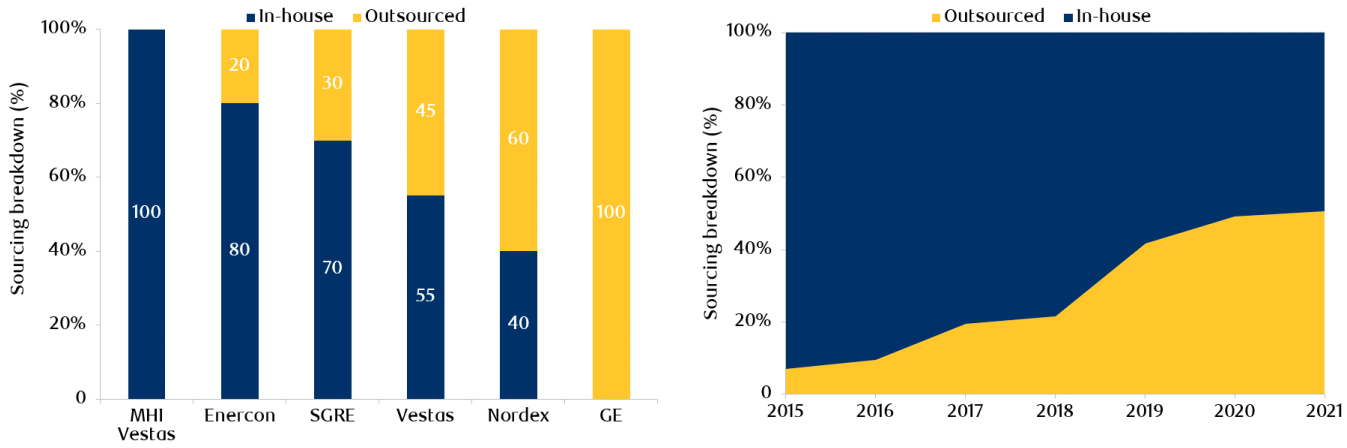


Source: L Aeris, Bloomberg NEF, Morgan Stanley Research. Data as December, 2020. Note: The top category represents the range.

The industry's value chain is composed of a) wind farm site developers, b) wind turbine manufacturers and c) suppliers of wind rotor blades. The key trend within the wind turbine industry has been the consolidation of the wind turbine producers, or OEMs.[7] As a result, there has been an increase in the outsourcing of wind blade production which allows the OEMs to focus their resources on blade design (Exhibit 10). As a result of these trends, we think the best way to play the wind power theme would be within the area of rotor blade producers. These companies have high returns and have scope not only to grow their market share domestically but also globally.

[6] LCOE = levelised cost of electricity. [7] OEM = original equipment manufacturer.

Exhibit 10: Global blade production and outsourcing



Source: Aeris (based on data from Wood Mackenzie), Morgan Stanley Research. Data as at December, 2020.

Solar Power. We believe solar energy in EM has more growth potential than wind energy for the following reasons:

- **Climate.** Many EM have an inherent geographical advantage because of their hot climates; India, for example has over 300 sunny days a year.
- **Availability of good wind sites.** As mentioned previously, certain conditions are necessary for a successful wind site (Brazil meets these requirements) and while it is possible to install wind farms in low wind sites, these would require wind turbines with higher hub height, larger rotor diameters and new technologies. There are fewer suitable wind sites available in EM.
- **Solar panel pricing.** There have been significant innovations in solar technology which have led to a reduction in the price of solar panels. We believe that there will be further improvements across the entire solar panel manufacturing process, from the raw ingredients to the wafers, cells and modules, and that this will make solar energy a more lucrative investment in future.

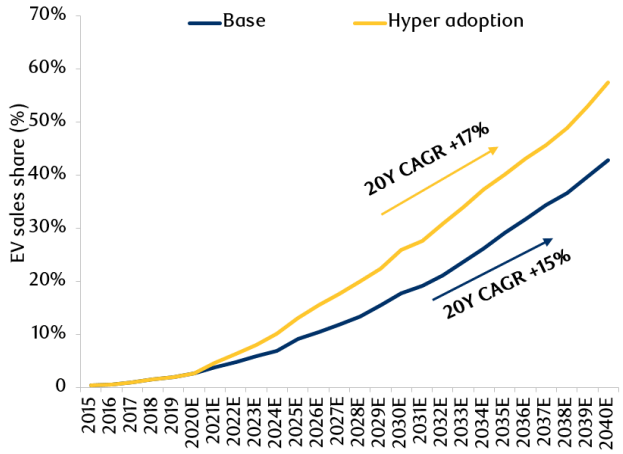
We believe China has one of the best solar energy growth stories. The supply chain is composed of the polysilicon, wafer, solar glass, cells and module manufacturers; however, some parts of the chain have capacity concerns.[8] Furthermore, the solar farm business is not the highest margin and is vulnerable to policy changes. We believe, therefore, that the best way to invest in this area is through pure-play, high-quality manufacturers where there is differentiation through technology.

Electric vehicles

Transport accounts for 25% of global CO_2 emissions, mainly because the sector relies on oil. New modes of transport – for example, electric passenger vehicles, buses and trains - will make the transport sector cleaner. As the cost of batteries falls there will be price parity between EV and internal combustion engine (ICE) vehicles which we believe could mark the inflection point for EV sales. There has been a marked improvement in the charging time, driving distance and battery costs of EV and, according to Goldman Sachs, EV sales as a proportion of total vehicle sales could grow at a compound annual growth rate (CAGR) of 15% over the next few years.[9] China is the largest EV market in the world currently and accounts for almost half of EV sale globally; China is also expected to exceed the EU's EV penetration by 2022 (Exhibits 11 and 12).[10]

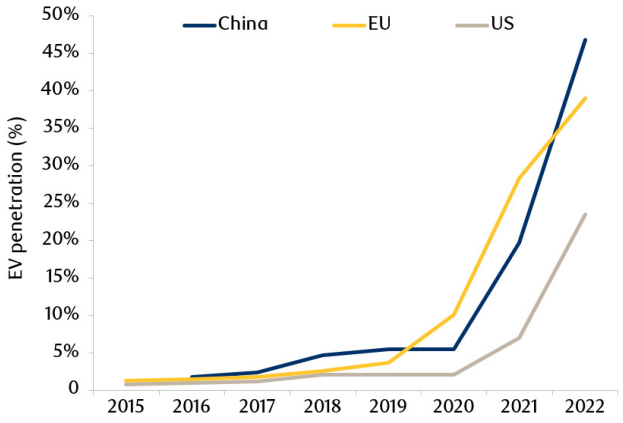
[8] Macquarie Research, December 2020. [9] Goldman Sachs Global Investment Research, December 2020. [10] Bloomberg NEF, EV Volumes, BofA Global Research. Data as at December, 2020.

Exhibit 11: EV sales as a percentage of total vehicle sales



Source: LHG Goldman Sachs Global Investment Research. Data as at December, 2020.

Exhibit 12: EV penetration: EU versus China

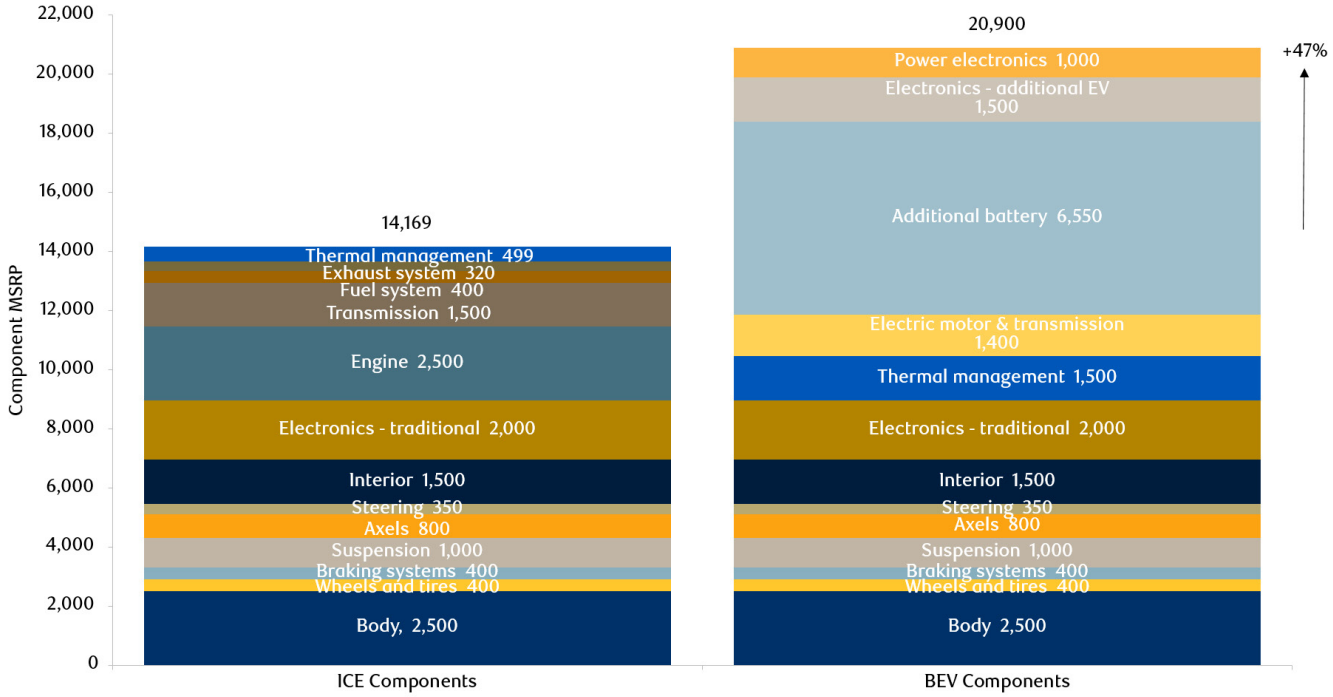


Source: Bloomberg NEF, EV Volumes, BofA Global Research. Data as at December, 2020.

a) Auto components manufacturers

We believe the most attractive part of the value chain is the component manufacturers segment. These companies have pricing power, are high return businesses and will not be exposed to the heavy capex cycle and competitive environment that we see in other parts of the value chain (Exhibit 13).

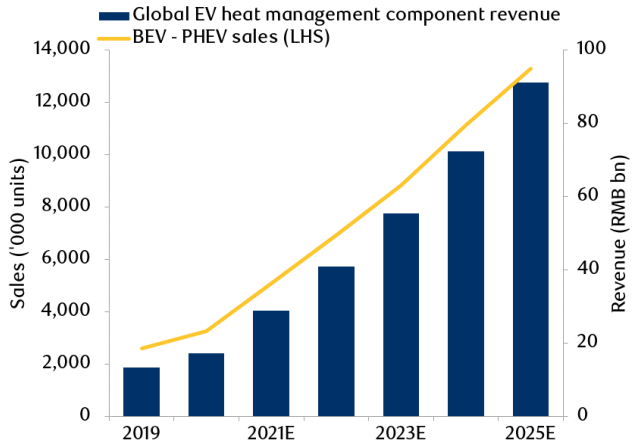
Exhibit 13: ICE versus EV manufacturers suggested retail price by components



Source: Citi Research. Data as at March, 2020.

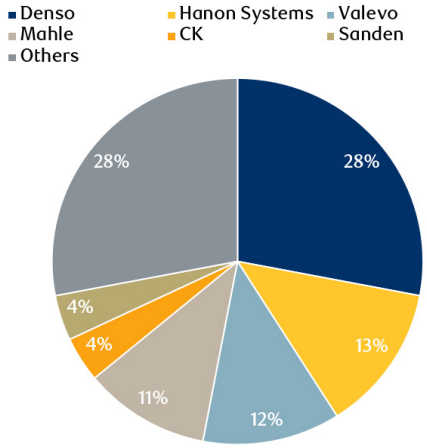
An area that is closely connected to the electric vehicle sector is that of thermal management technology. Air conditioning consumes roughly 20% of total energy and thus efficient thermal management is crucial to the driving range of electric vehicles. Battery performance is sensitive to temperature and unlike ICE vehicles, EV cannot use waste heat from the engine for inside heating. We expect the EV heat management market will rise at a CAGR of over 35% for the next four years which is significant growth (Exhibit 14). In terms of global thermal management, the market is fairly concentrated with the top four participants representing 64% of the market (Exhibit 15). The consolidation in the market is likely to continue and, as a result, we would expect some of these larger players to be key beneficiaries of increased production of electric vehicles. We want exposure to those companies who have the best-in-class technology and will not only grow with the market but will also gain market share from other companies.

Exhibit 14: EV heat management: market revenue to rise at a 37% CAGR 2019-25e



Source: Bloomberg, HSBC Global Research. Data as at December, 2019.

Exhibit 15: Global market share in thermal management systems

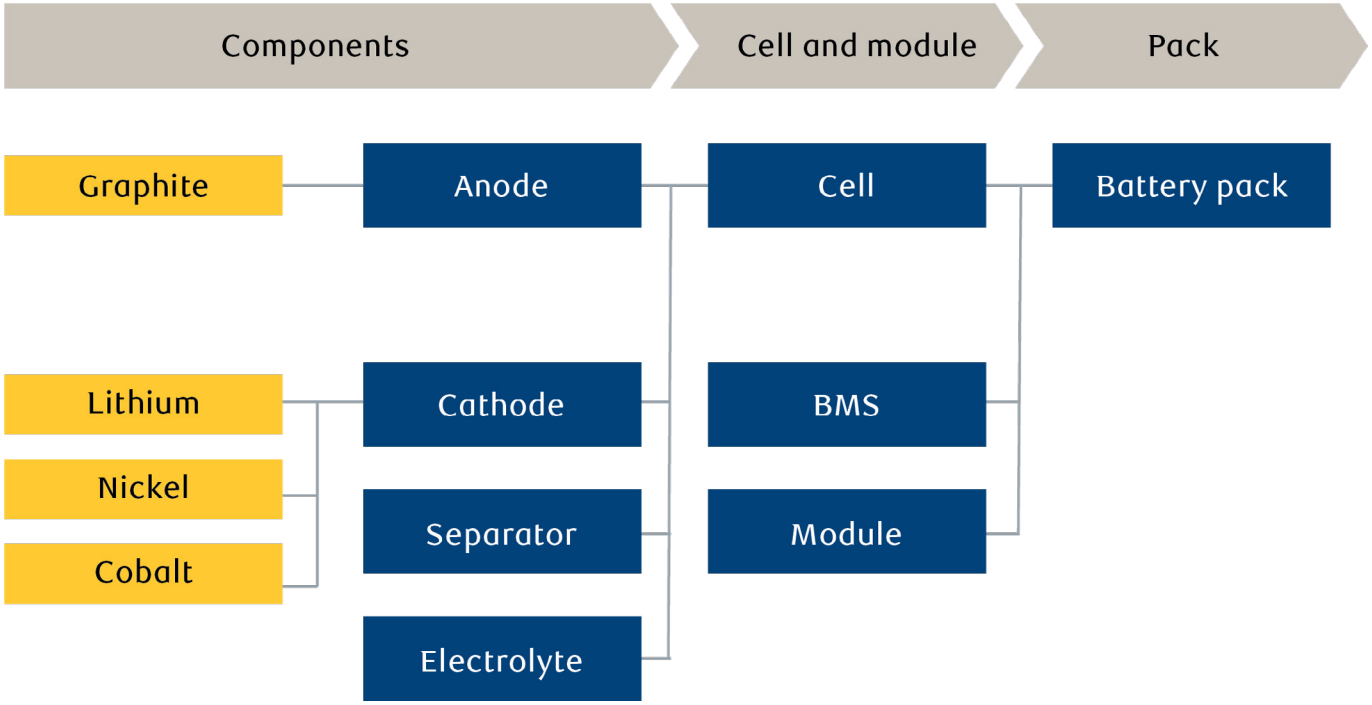


Source: Bloomberg, HSBC Global Research. Data as at December, 2019.

b) Battery manufacturers

The supply and development of the battery cell has been vital to the establishment of the EV industry and there are multiple parts of the value chain to produce battery packs that are required for EV (Exhibit 16).

Exhibit 16: Battery pack components

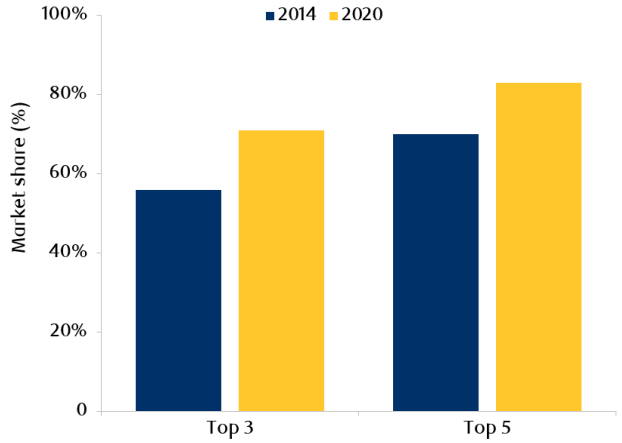


Source: Macquarie Research. Data as at December, 2020.

In terms of the cost breakdown, currently the cell accounts for about 76% of the total cost of the battery pack with the module cost estimated to be around 10%.[11]

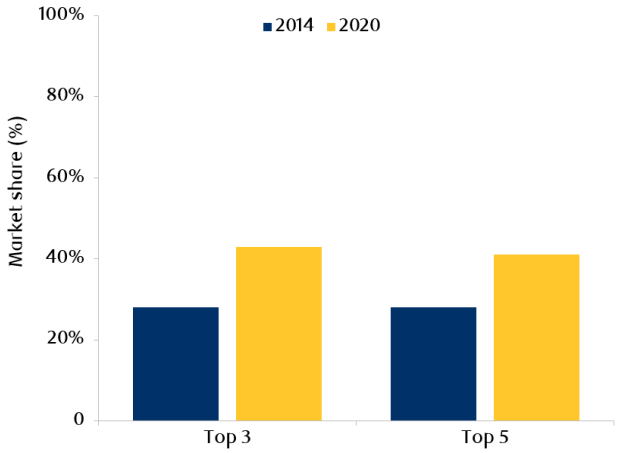
Significant economies of scale in battery cell production mean that the sector is largely dominated by several large players (Exhibits 17 and 18). In 2014, the top three battery manufacturers represented 56% of the total and that increased to 70% in 2020.

Exhibit 17: Battery manufacturers' market share concentration



Source: IHS Global Insight, Goldman Sachs Global Investment Research. Data as at December, 2020.

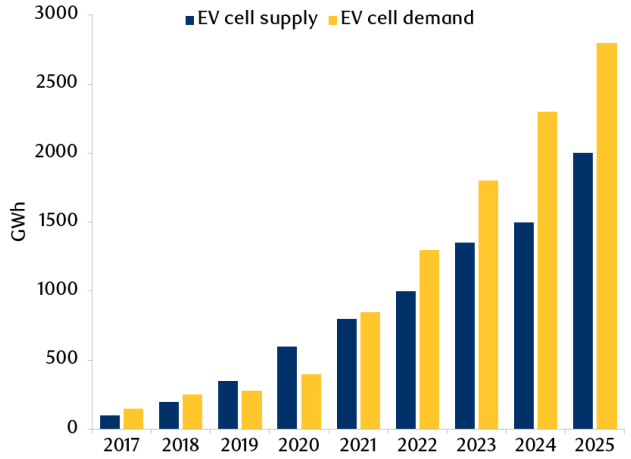
Exhibit 18: Auto manufacturers' market share concentration



Source: IHS Global Insight, Goldman Sachs Global Investment Research. Data as at December, 2020.

When analysing the supply/demand dynamics, research by Citi suggests that global EV cell demand could grow to 2,800GWh in 2025 but that the industry supply is broadly keeping pace with demand (Exhibit 19). The key concern that we have is that capacity expansion could exceed supply and impact the profitability of this area. Return on invested capital (ROIC) has fallen in this area, and although the ROIC is higher than other parts of EV value chain, this is something that we need to monitor closely. We have found that South Korean battery manufacturers have the highest market share with the scope to increase that share and are the most technologically advanced with good OEM diversification.

Exhibit 19: Global cell supply/demand



Source: Citi Research, BMI. Data as at December, 2020.

c) Auto manufacturers

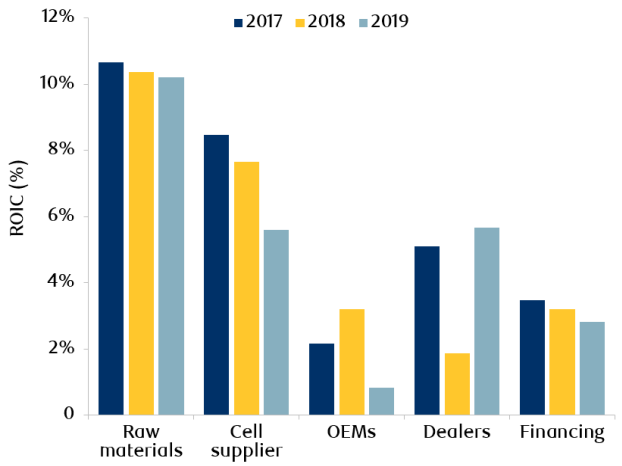
Auto manufacturers are the final way to play the accelerating EV growth theme. Government policy support for EV is a key contributor to the growth of the industry. In November 2020, the Chinese government announced its New Electric Vehicle Industry Development Plan 2021-2035 which sets out the long-term development framework of EV in China. In Europe, subsidies and new carbon emissions rules are likely to accelerate adoption with consumers more willing to buy EV models. A CRR survey of 1,600 Chinese consumers showed that more than half of those planning to purchase a new car would prefer an EV.

Despite the demand and the potential for growth, we believe that in terms of investment this is the least attractive part of the value chain for the following reasons:

- Returns are low amongst the OEMs. There are marked differences between the main segments in the EV value chain and the OEM manufacturers have much lower returns on capital due to lower margins and likely shorter-than-expected lifecycles on products and R&D investments (Exhibit 20).

[11] BofA Global Research.

Exhibit 20: EV value chain – ROIC



Source: Citi Research, company reports, Datastream. Data as at December, 2020.

- **Competitive pressures are intense.** Historically we have seen companies forsake short-term profitability to grow the EV market and as a result we would expect competitors to continue to invest in market share gains through price competition. We have already seen new EV entrants disrupt the Chinese automobile market with either cheaper or technologically superior products and this has resulted in price cuts from existing manufacturers as they seek to compete; this could continue to be the case globally. Competing with disruptive new players is likely to result in low returns for companies, but failure to do so will jeopardise the long-term outlook for a business.
- **Employee base.** The average age of employees in the European OEMs is around 45 years old and this workforce is focused on producing ICE models. We believe that this is a concern because a large proportion of the workforce would need to be re-trained as EV engineers. Given the differences in technology and the need for fewer employees because EV are less complicated, this could pose problems for workforce dynamics.

Transmission metals

The final way to play the Green Infrastructure theme is through raw materials that allow us to make this transition into a cleaner energy world. The main challenge to moving away from hydrocarbons is that many alternative raw materials will be required to make the transition, with aluminium and copper at the top of the list (Exhibit 21).

Exhibit 21: Applications helping to decarbonise the economy and the commodities

	Wind	"Power applications Solar photovoltaic"	Energy storage	"Automotive BEV and FCEV"	"Other electric motors"	Carbon capture and storage	Light emitting diodes
Aluminium	**X**	**X**	**X**		**X**	**X**	**X**
Chromium	X					X	X
Cobalt			X	X		X	
Copper	X	X		X	X	X	X
Indium		X				X	X
Lead	X	X					X
Lithium				X			
Molybdenum	X	X				X	X
Neodymium (proxy for rare earths)	X			X			
Nickel	X	X	X	X		X	X
Platinum			X	X			
Silver		X		X			X
Steel	X						
Zinc		X					X

Source: World Bank, The Growing Role of Minerals and Metals for a Low Carbon Future, BofA Global research. Note: Several raw materials are needed to replace fossil fuel energy to decarbonise. Cobalt could be in shortage by 2023. Data as at May, 2021.

Over the next decade, this demand is likely to drive the tightest metals imbalances in history (Exhibit 22). On the supply side, investment over the last decade has been muted for global mining companies as a price collapse in the mid-2010s punished those who committed large amounts of capital to their businesses; as a result, capex budgets have remained broadly unchanged. Given the long cycle nature of some of these transition metals (with copper it takes two-to-three years for a brownfield site to become operational and up to eight years for a greenfield), we expect that supply may not be readily available to meet the demand.[12] That said, we could expect a short cycle response in the form of higher scrap supply and some demand substitution to make up the short-fall. Despite this record, supply deficits are still very likely to materialise by 2030.

In terms of specific commodity exposure, we have a preference for Aluminium and Copper as these are generally seen as high quality assets within this space and these companies have a strong focus on ESG factors. The evaluation of ESG practices (for example, water usage, waste management and community relations) is crucial in the metals and mining space and that is something we focus on when looking at the best ways to play this theme.

Exhibit 22: Growth in demand for transition metals

	2020E	2030E	2050E	"CAGR 2020-2030E"	"CAGR 2020-2050E"
Copper (Mt)	23	30.6	52.0	2.9%	2.8%
Nickel (Mt)	2.3	3.6	8.6	4.5%	4.5%
Cobalt (kt)	115	218	375	6.5%	4.0%
Aluminium (Mt)	63	81.1	154	2.5%	3.0%
Zinc (Mt)	12.7	16.3	26.7	2.5%	2.5%

Source: Wood Mackenzie, Copper Alliance, China NBS, Jefferies estimates. Data as December, 2019.

Conclusion

Within the RBC Emerging Markets Equity team, ESG has always been a critical component of our investment philosophy and process since inception. This includes a detailed assessment of climate-related risks and opportunities as part of our stock selection process, company engagement activities, and top-down thematic research.

Because emerging markets are being disproportionately affected by climate change, in terms of both physical risks and financial implications, and the substantial deficits in social infrastructure and investment have been exacerbated by the COVID-19 pandemic, we believe Green Infrastructure is a multi-decade growth story and, as such, we have been increasing our exposure to the theme across our portfolios.

[12] For Greenfield sites, a company will build its own brand new facilities from the ground up. Brownfield investment happens when a company purchases or leases an existing facility.

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For more information, please contact us at:
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