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Global Metals Weekly

Metals are heroes in Net Zero

08 November 2021 | Commodities | Global

Key takeaways

- A few deliverables from COP26 are key to tackling climate change. Road to Net Zero provides challenges, also in investment
- Metals demand from EVs, power storage and renewables to increase rapidly to achieve Net Zero. CAGR could be as high as 25%.
- Miners need to increase CAPEX to prevent bottlenecks, but spending is running well below what is needed.

COP26 and road to Net Zero

Over the last three decades, climate change has become a focus, leading to a series of agreements. Yet, since the Montreal Protocol in 1987, seen as one of the most successful multilateral treaties in history, it appears that the journey towards a sustainable low carbon future is still far from approaching the finish line. Indeed, there is a divergence between the first Nationally Determined Contributions (NDCs) submitted by the parties convening in Paris and what scientists and experts deem necessary to limit global warming to 'well below' 2 degrees, never mind 1.5 degrees. For the COP26 summit, a few key deliverables would be desirable, including new and more ambitious NDCs, climate financing and a finalisation of the Paris Rulebook.

Metals demand from EVs, power storage and renewables

Decarbonisation effectively means an electrification of the global economy through renewables, power storage and EVs. To show some of the operational challenges, the IEA assumes that installed power generation capacity in metals-intensive renewables and electric vehicle car sales need to rise by factors of 4 and 18 respectively by 2030 to achieving Net Zero. Working some of the IEA's Net Zero assumptions into our metals demand models, we calculate CAGR in consumption of 3.6%, 24.6%, 7.6%, 18%, 2.5% and 3.3% for copper, lithium, nickel, cobalt, silver and platinum respectively. Highlighting the potential growth in market size, lithium supply in 2020 was 387Kt, but demand could rise to 3Mt and 5Mt by 2030 and 2050 under Net Zero respectively.

Miners need to increase CAPEX

What does mean for the mining industry? To facilitate that demand growth, producers need to boost production capacity. True, recycling can help, but ultimately, some primary capacity is also needed. Linked to that, we estimate that the industry needs to spend $72B annually out to 2030 just to prevent bottlenecks towards achieving Net Zero; this CAPEX requirement does not include any demand growth from traditional consumer segments. To put this number into context, global mining CAPEX averaged around $99.5B in the past decade; this number includes outlays on iron ore, as well as coal and is more of a steady state spend. Hence, it does not necessarily factor in all the additional investment required to support decarbonisation. As such, operators are underspending massively, suggesting that CAPEX may need to almost double going forward for the world to hit Net Zero by 2050.

Metals are heroes in Net Zero

The roadmap to COP26

Over the last three decades, climate change has become a focus, leading to a series agreements. Yet, since the Montreal Protocol in 1987 (Exhibit 1), seen as the most successful multilateral treaties in history, it appears that the journey towards a sustainable low carbon future is still far from approaching the finish line. After Montreal, an important milestone was achieved through the UN Framework Convention on Climate Change (UNFCCC) in 1992, the first ever global treaty to explicitly address climate change and to formally set up a forum for debate and negotiations as the 'Conference of the Parties' (COP). After the Kyoto Protocol came into force in 2005, many argued that more ambitious goals are needed, especially considering the numerous climate-related natural catastrophes that occurred in recent years. Indeed, even the "well below 2°C" (or "preferably" 1.5 °C) target of the Paris Agreement in 2015 is being questioned as out of reach on the basis of the current national pledges.

Exhibit 1: Outcomes from previous summits
Tackling climate change has been a focus since 1987

Agreement	Main goal	Outcome
Montreal Protocol on Substances that Deplete the Ozone Layer, 1987	Reduce the harmful impact that certain substances (e.g. chlorofluorocarbons and hydrofluorocarbons) have on the stratospheric ozone layer	Parties successfully phased out 98% of ozone-depleting substances compared to 1990 levels.98% of ozone-depleting substances compared to 1990 levels
UN Framework Convention on Climate Change (UNFCCC), 1992	Stabilize greenhouse gas concentration in the atmosphere with the ultimate aim of preventing the "dangerous anthropogenic interference with the climate system"	Conference of The Parties (COP), the Kyoto Protocol and the Paris Agreement
Kyoto Protocol, 2005	First commitment period (2008-2012): average 5% reduction of CO2 emissions compared to 1990 levels (equivalent to a 1 $GtCO_2$ per year) Second commitment period (2013-2020): at least 18% reduction of CO2 emissions compared to 1990	The average annual aggregated GHG emissions of Annex B-2012 countries were 24% below the base-year emissions during the first commitment period
Paris Agreement, 2015	Limit global warming to well below 2 degrees Celsius, preferably to 1.5, compared to pre-industrial levels	Parties are currently falling short of their original pledges

Source: IEA< IPCC, UNEP, BofA Global Research

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Is the Paris Agreement enough?

There seems to be a divergence between the first Nationally Determined Contributions[2] (NDCs) submitted by the parties convening in Paris and what scientists and experts deem necessary to limit global warming to 'well below' 2 degrees, never mind 1.5 degrees. To that point, according to the International Energy Agency report[3] even if successfully fulfilled, the pledges to date would still leave around 22 billion tonnes of CO_2 emissions worldwide in 2050. The continuation of that trend would be consistent with a temperature rise in 2100 of around 2.1 °C. On a more positive note, the Intergovernmental Panel on Climate Change (IPCC) believes that *t*he Paris Agreement target is achievable, but only if unparalleled action is taken immediately[4]. In this regard, the Glasgow COP is seen as the ultimate deadline for countries to come forward with new and more ambitious NDCs. A similar narrative emerges from the UN Environment Programme's (UNEP) latest *Emissions Gap Report 2021: The Heat Is On*[5], which shows that the new NDCs, combined with other mitigation pledges, put the world on course for a global temperature rise of 2.7% by the end of the century.

This assessment raises the stakes for the Glasgow summit even further, especially considering that such an outcome refers to the best-case scenario where the new unconditional commitments are assumed to be met. For global warming to be capped to 1.5 °C, an additional 28 GtCO2 of CO_2e need to be taken off annual emissions in the next eight years, the equivalent of almost half of current GHG emissions (for the upper end target of 2 °C the figure drops to 13 GtCO2e).

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What is net zero?

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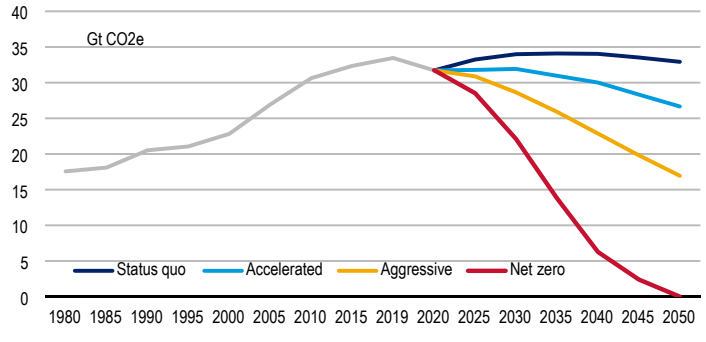
What is Net Zero? The balance of reducing *and* removing emissions

We recently published our Net Zero Primer (see Thematic Investing: "Transwarming" World: Net Zero Primer 21 October 2021 (https://rsch.baml.com/r?q=cXumYlUzQ6sNn!FV74h5oA)), outlining potential pathways to keeping global warming within 1.5°C. All require rapid reduction in greenhouse gas emissions, notably reaching "***net zero***" by 2050. Net Zero is a measure of carbon neutrality through a balance of eliminating and removing carbon emissions from the atmosphere. Exhibit 2, first published in Global Energy Weekly: When oil and gas collide 29 October 2021 (https://rsch.baml.com/r?q=betqbtVDZPQNn!FV74h5oA) shows emission profiles out to 2050, including Net Zero; see also (Global Energy Weekly: Takes a lot of zero$ to zero in on carbon 28 May 2021 (https://rsch.baml.com/r?q=YhvYgZNl6XINn!FV74h5oA)).

Exhibit 2: Different emission profiles out to 2050, including Net Zero
The Net Zero Emission is an onerous strategy



Source: IEA, BofA Global Research

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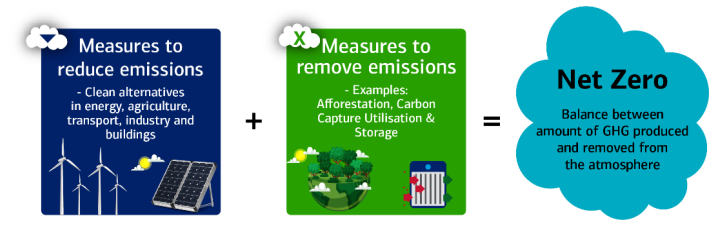
The word "net" is the key. This means that whilst eliminating emissions to zero would be ideal, not every activity has to be zero emission to be compliant in a net zero economy. However, those that continue to emit greenhouse gases would need to be captured and removed from the atmosphere (Exhibit 3).

Exhibit 3: Net Zero: a measure of carbon neutrality by reducing *and* removing emissions
To achieve net zero requires a combination of reducing direct emissions and/or removing them from industrial activity or atmospheric emissions with nature or technology based solutions



Source: Green Match, BofA Global Research

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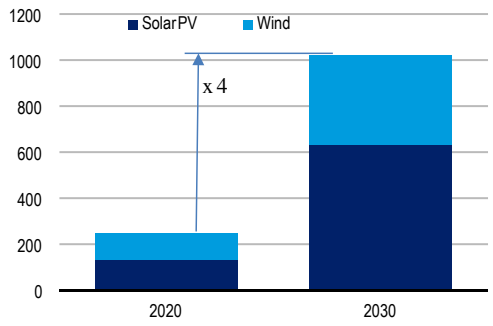
Exhibit 4 and Exhibit 5 taken an initial stab at the challenges of achieving Net Zero, highlighting some of the IEA's assumptions over capacity additions in metals-intensive renewables, along electric vehicle car sales, required over the coming years.

Exhibit 4: Capacity additions, GW
Renewables capacity installations need to grow by a factor of 4



Source: IEA, BofA Global Research

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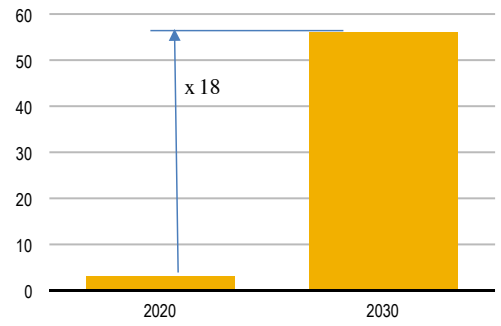
Exhibit 5: Electric car sales, millions
EV sales should rise 18 times by 2030



Source: IEA, BofA Global Research

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Good COP / Bad COP? What is COP26, and what is expected?

The United Nations hold a Climate Change Conference every year attended by the ~200 country members of the UN's Framework Convention on Climate Change. Countries negotiate and commit to levels of emissions reductions, and how they'll be financed and implemented. The country emissions reduction pledges ("Nationally Determined Contributions", or NDCs) were launched in 2015 at COP21 in Paris, where countries agreed to review and update them every five years, with COP26 being the first such update due. In the run-up to this year's Conference of the Parties, the urge to operationalize the Paris Agreement has been steadily increasing. Devastating weather events and the recent energy crisis, which unveiled the still severe fossil fuel dependency of Asia and Europe, highlighted how challenging a successful conclusion of the COP climate talks are.

Thus, the success of COP26 will be determined by the levels of country commitments to reach net zero, the specific policies and finance that will be mobilised to achieve it. What's expected from COP26 (per the official COP26 website):

- The What: Net Zero: Countries are due to submit 2030 emissions reductions targets to remain on track to achieve net zero by 2050. Several nations have already pre-announced their targets such as China (committing to peak emissions by 2030 and net zero by 2060, announced September 2020), and the most recent pledge from the UAE to reach net zero by 2050 (October 2021).
- The How: Climate Action: To deliver the mid-long dated targets, specific policies and actions are expected, many of which are due to be announced and publicised at or ahead of COP26, specifically accelerating the phase out of coal, curtailing deforestation, speeding up the transition to electric vehicles, and encouraging investment in renewable energy.
- Climate Finance: In addition to funding their own targets, developed nations committed in 2009 to mobilise $100bn per year to emerging markets on climate action by 2020; per the OECD's latest figures (2019), $80bn was spent, with COP26 expected for nations to increase the figure to bridge the gap, as well as begin negotiations for the next financing milestone and how it can be delivered (e.g. via aid, grants and trade). The UN's Environment Programme estimate adaptation costs alone in developing countries will reach $140-300bn by 2030, and $280-500bn by 2050. Africa alone could require $3tn climate action investment by 2030 (source: Climate Policy Initiative).

COP26: What does success look like?

Although apparently straightforward, evaluating the outcome of any type of negotiation or agreement thereof - in the case of COP26, all Parties committing to or, even better, improving the original targets set up in Paris - always leaves room for debate, depending on which perspective one chooses to take on. Furthermore, projections of future GHG emissions based on announced new NDCs, forecasts on the future developments in the renewable space and the speed of transition to clean vehicles, are just a few of the potential discussion points. However, given the general consensus around the current status quo with respect to the Paris Agreement targets - it is widely agreed that these are most likely to be missed - the following list could be a good starting benchmark for evaluation:

- New and more ambitious NDCs: as many governments as possible need to submit new and more ambitious NDCs by the end of the two-week climate talks. China and India are now among the world's top emitters, along with the United States. Developed countries have argued that those countries should take on a greater responsibility in addressing climate change. Also, simply updating the previous targets is not enough. It is believed that the Parties should commit to unprecedented goals as well as actions with the aim of gearing towards the lower target in terms of

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global warming, embedded by the Paris Agreement. The difference between 1.5 °C and 2 °C is substantial and could make the difference in the combat to prevent further catastrophic events. Indeed, the UK's all-encompassing aim for the Glasgow summit is to "keep 1.5 degrees alive".

- **Climate financing**. Developed nations to honour the pledge they put forth in 2009 of mobilizing $100 billion per year by 2020 to support developing countries in their clean energy transition. The official figures for 2020 will not be finalized until 2022, but it is rather evident that the goal was missed last year. Indeed, as a prelude to COP26 the OECD published a report[6] showing that rich countries fell short of their promises and that developing countries will have to wait until 2023 to see the pledged funds delivered. So far, the climate finances effectively put on the table by developed countries totalled USD 79.6B in 2019. Missing these targets not only hinders the path to climate abatement ambitions, but also the credibility of any type of pledge or commitment brought forward by developed nations.

- **Finalize the Paris Rulebook.** If the COP21 in Paris was all about the 'What', COP26 has to be the final step for finalizing the 'How', i.e. determining the implementation plan, the so-called "Paris Rulebook". This includes:

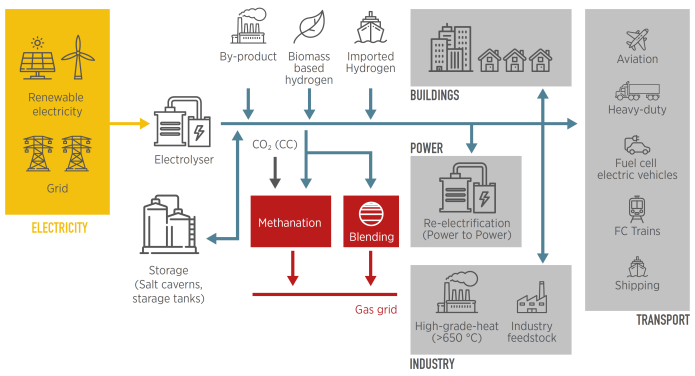
1. Defining a solution on carbon markets by designing an appropriate and robust system of carbon credits consistent with the "Net-Zero" policy. A great focus is placed on international carbon markets which currently require more clarity around its system of rules. Further scrutiny is also needed to guarantee fairness and to prevent countries from unlawfully benefit from trading carbon credits without actually contributing to mitigate climate change;

2. Resolving the issues of transparency and reporting, by establishing an effective system that encourages the Parties to stay on track with their commitments.

Net zero means electrification

Decarbonisation effectively means an electrification of the global economy. Exhibit 6 picks up on this, highlighting how a new infrastructure could look like; granted, the chart is a simplification because it references for instance electrolysis/ hydrogen to tackle intermittency issues and that function that could also be performed by other technologies, including batteries.

Exhibit 6: Integration of Variable Renewable Energy into end uses by means of hydrogen
Renewables, power storage and electricity usage to create a new energy infrastructure



Source: IRENA (2018) Hydrogen from renewable power technology outlook for the energy transition

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Table 1 revisits the implications of de-carbonisation on demand for the MIFTs (metals important for future technologies).

Table 1: Applications helping to decarbonise the economy, along the commodities required
Many mined commodities are critical in technologies required to reducing emissions

	Power applications			Automotive	Others		
	Wind	Solar photovoltaic	Energy storage	Electric vehicles	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
Lithium				X			
Molybdenum	X	X				X	X
Neodymium (proxy for rare earths)	X			X			
Nickel	X	X	X	X		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

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Meanwhile, Exhibit 5 makes the transitions into the metals space, summarising the impact different Net Zero scenarios have on demand for some of the key metals. The last two columns are perhaps the most notable, suggesting compound annual growth rates of up to 25% YoY out to 2030.

Exhibit 7: Metals demand from selected technologies required to achieving Net Zero
Compound annual growth rates of up to 25% YoY are required out to 2030

	Supply	Demand											
		Batteries		Transportation		Energy		Hydrogen		Total		CAGR	
	2020	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050	2030	2050
Copper	23,389,096			5,870,114	7,921,539	4,117,691	4,470,435			9,987,806	12,391,974	3.5%	1.4%
Lithium	386,947	3,141,497	5,410,475							3,141,497	5,410,475	24.7%	9.4%
Nickel	2,615,340	2,838,432	4,737,969							2,838,432	4,737,969	7.6%	3.5%
Cobalt	142,883	607,720	1,024,626							607,720	1,024,626	18.0%	7.3%
Silver	30,687					8,554	10,477			8,554	10,477	2.5%	1.0%
Platinum	6,415,424			1,755,551	4,820,573			747,964	1,120,786	2,503,515	5,941,359	3.3%	2.2%

Source: IEA, BofA Global Research

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Miners need to increase CAPEX

What does mean for the mining industry? To facilitate that demand growth, miners need to boost CAPEX. Exhibit 8 picks up on this, suggesting that the industry needs to spend $72B annually out to 2030 just to prevent bottleneck towards achieving Net Zero; this CAPEX requirement does not include any demand growth from traditional consumers.

Exhibit 8: CAPEX requirements across the MIFTs
Miners need to spend $72B just to facilitate demand growth for the MIFTs; this figure does not include consumption increase from traditional sectors not directly related to de-carbonisation

	Demand		Capex intensity	Growth capex and depreciation, total	
	2030	2050	US$/t	2030	2050
Copper	9987.8	12392.0	20000	390	501
Lithium	3141.5	5410.5	3000	19	33
Nickel	2838.4	4738.0	50000	287	479
Cobalt	607.7	1024.6	4000	5	8
Silver	8.6	10.5	30	9	3

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Platinum	2503.5	5941.4	1800	9	22
Total capex, US$ BN				719	1,045
Annual average, US$ BN				72	35

Source: BofA Global Research

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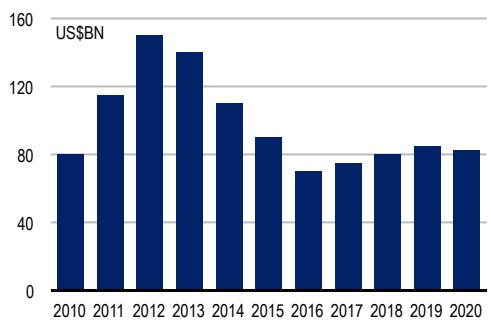
To put this number into context, global mining CAPEX averaged around $99.5B in the past decade (Exhibit 9); this number includes outlays on iron ore, as well as coal and is more of a steady state spend. Hence, it does not necessarily factor in all the additional investment required to support decarbonisation. As such, operators are underspending massively, suggesting that CAPEX may need to almost double going forward for the world to hit Net Zero by 2050.

Exhibit 9: Global Metals and Mining Capex
Global Capex has averaged around $99.5B in the past decade



Source: S&P, BofA Global Research

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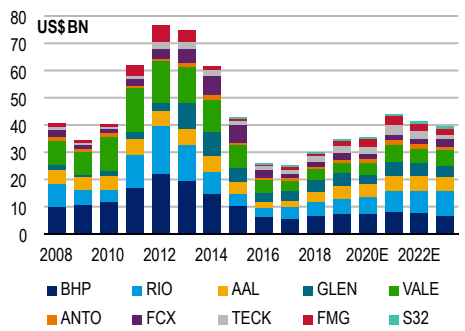
Exhibit 10: Capex among selected miners
Miners remain cautious in their Capex outlays



Source: company reports, BofA Global Research

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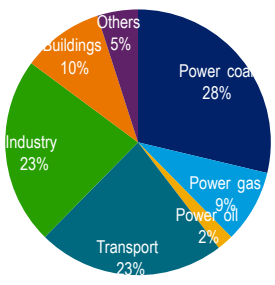
Net Zero and demand from renewables, storage and EVs,

Electricity generation, storage and transportation key for metals demand

Revisiting the breakdown of global emissions, Exhibit 11 shows the contribution individual sectors are making, with that power and transportation among heavyweight GHG generators. Hence, it is perhaps not surprising that those sectors are remain the focus in tackling climate change.

Exhibit 11: Global CO2 emissions by sector
Power and transport are among the key emitters



Source: IEA

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Renewables: installations of solar and wind keep accelerating

Exhibit 12 picks up on power generation, outlining that installed capacity of renewables needs to increase gradually in the coming years to achieve Net Zero. Indeed, according to the IEAs calculations, the share of solar PV and wind in total generation should reach 40% and 68% in 2030 and 2050 respectively.

Exhibit 12: Key development milestones for renewables
Solar PV and wind are set to account for 40% and 68% of in 2030 and 2050

Power generation capacity	**2020**	**2030**	**2050**
Total installed capacity (GW)	10,000	16,885	30,227
Renewables			
Installed capacity (GW)	2,900	10,300	26,600
Share in total generation	29%	61%	88%
Total solar PV	1,450	6,867	17,733
Total wind	1,450	3,433	8,867
Other	7,100	6,585	3,627

Source: IEA< BofA Global Research

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This has implications for a range of MIFTs, especially copper and silver. Exhibit 13 picks up on this, outlining that copper demand could increase by 4Mt annually from investment into renewables generation, not factoring in power generation capacity.

Exhibit 13: Copper demand, tonnes
Renewables could support copper demand at +4Mt

	2020	**2030**	**2050**
From solar	7,975,000	37,766,667	97,533,333
From Wind	8,700,000	20,600,000	53,200,000
From others	7,100,000	6,585,246	3,627,273
Total, cumulative	23,775,000	64,951,913	154,360,606
Copper demand annually, tonnes		4,117,691	4,470,435

Source: IEA, BofA Global Research

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Similarly, demand for silver, which is used in solar panels, could also be materially higher in the coming years; to put the annual demand figures into context, demand from solar panels was around 3,000 tonnes in 2019/20.

Exhibit 14: Silver demand in ounces and tonnes
Silver demand could rise rapidly, if more solar panels are installed

	2020	**2030**	**2050**
Solar capacity installed, GW	1,450	6,867	17,733
Watt/ cells	3.51	4.15	4.15
# of cells	413,477,789,816	1,655,042,735,043	4,274,188,034,188
Oz/W	0.003644	0.002572	0.002572
Ounces	1,506,608,043	4,256,862,597	10,993,450,978
Silver demand cumulative, tonnes	46,861	132,403	341,935
Silver demand annually, tonnes		8,554	10,477

Source: IEA, BofA Global Research

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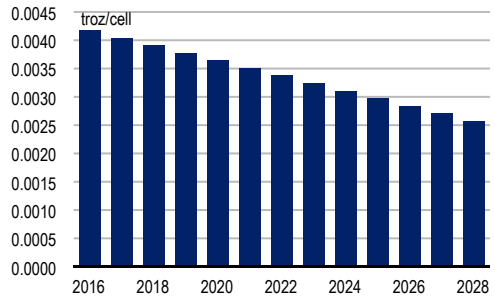
Rising silver usage is remarkable also when keeping in mind that PV producers are reducing the silver content per cell (Exhibit 15), while boosting the watts each cell can generate (Exhibit 16).

Exhibit 15: Silver loadings per cell in solar panel
PV manufacturers are reducing silver loadings in solar panels...



Source: Silver Institute, BofA Global Research

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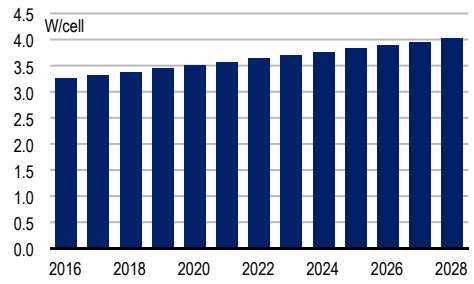
Exhibit 16: Watts per cell in solar panels
... while at the same time boosting wattage per cell



Source: Silver Institute, BofA Global Research

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Energy storage: batteries and hydrogen

Battery storage to boost lithium demand

While renewables have a lower carbon footprint, intermittency, ie the imbalance between periods of electricity generation and when power is needed, is an issue. To mitigate these risk, electricity storage is needed and two hydrogen, as well as batteries are among the technological solutions discussed to accomplish that.

Batteries are relatively straightforward as power storage. Exhibit 17 picks up on this, outlining that battery storage is set to increase under the IEA's Net Zero scenarios; in our calculations, we assume that lithium-ion batteries are the technology of choice.

Exhibit 17: Lithium demand in tonnes
Battery storage could add to lithium demand

	2020	2030	2050
Battery storage (GW)	18	590	3100
Lithium demand	1,336	43,778	230,020

Source: IEA, BofA Global Research

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The hydrogen economy is bullish platinum

Meanwhile, the hydrogen economy could potentially have profound implications for the global economy. Indeed, electrolysis can be used to store power generated from renewables as hydrogen, before the gas is being re-converted into electricity as the needs arise. At the same time, green hydrogen, ie hydrogen generated from renewables, can also be used in eg steel mills and to power vehicles. Exhibit 18 picks up on this, outlining the IEA's expectations over low-carbon hydrogen production.

Exhibit 18: Platinum demand from electrolysis
Electrolysis could be a major boost to platinum offtake

	2020	2030	2050
Total production hydrogen–based fuels (Mt)	87	212	528
Low–carbon hydrogen production	9	150	520
share of fossil–based with CCUS	95%	46%	38%
share of electrolysis–based	5%	54%	62%
Low carbon hydrogen, electrolysis-based	0.45	81	322.4
Platinum installed at 3oz	19,286	3,471,429	13,817,143
Average annual demand		345,214	517,286
Platinum installed at 10oz	64,286	11,571,429	46,057,143
Average annual demand		1,150,714	1,724,286

Source: IEA, BofA Global Research

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Batteries and FCEVs to reduce emissions in transportation

Shifting to transportation, Exhibit 19 outlines that electrified vehicles should account for 64% of car sales by 2030. This is well above our assumption of a 31% penetration rate that we currently factor into our supply and demand models. Beyond passenger vehicles, the IEA's scenarios also incorporate targets on commercial vehicles. This matters especially for platinum as we believe that heavier vehicles will predominantly run on fuel cells, rather than batteries.

Exhibit 19: Key development milestones in transforming the global transport sector
By 2050, virtually no ICE vehicles will be sold under IEA Net Zero

Road transport	**2020**	**2030**	**2050**
Share of PHEV, BEV and FCEV in sales:			
cars	5%	64%	100%
two/three–wheelers	40%	85%	100%
bus	3%	60%	100%
vans	0%	72%	100%
heavy trucks	0%	30%	99%
Biofuel blending in oil products	5%	13%	41%
Infrastructure			
EV public charging (million units)	1.3	40	200
Hydrogen refuelling units	0	90	0
Share of electrified rail lines	34%	47%	65%

Source: IEA, BofA Global Research

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Error! Reference source not found. makes the transition towards metals demand, suggesting that demand is set to increase significantly across the battery raw materials lithium, cobalt and nickel.

Exhibit 20: Lithium, cobalt and nickel demand from EVs
Demand is set to increase form both BEVs and PHEVs

	2020	2030	2050
LITHIUM			
BEV	109,258	2,978,627	5,105,920
PHEV	15,558	119,092	74,534
Total	124,816	3,097,719	5,180,455
COBALT			
BEV	43,896	584,356	1,009,884
PHEV	6,251	23,364	14,742
Total	50,147	607,720	1,024,626
NICKEL			
BEV	83,144	2,729,308	4,669,801
PHEV	11,839	109,124	68,168
Total	94,983	2,838,432	4,737,969

Source: IEA, BofA Global Research

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Meanwhile, platinum offtake should rise as more fuel cell electric vehicles are being put into the road.

Exhibit 21: Platinum demand in ounces
FCEVs could add to platinum demand

	2020	2030	2050
Two/three–wheelers	40%	85%	100%
Bus	3%	60%	100%
Vans	0%	72%	100%
Heavy trucks	0%	30%	99%
Demand, oz			
Bus	6,147	125,469	209,114
Vans		401,762	558,003
Trucks		1,228,320	4,053,456
Total	6,147	1,755,551	4,820,573

Source: IEA, BofA Global Research

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All along, electrified vehicles tend to have more copper-intensive wiring, with Exhibit 22 showing that copper demand will likely increase in the coming years.

Exhibit 22: Copper demand in tonnes
Copper demand from automotive is set to increase going forward

	2020	2030	2050
ICE	**2,480,158**	**1,280,950**	**0**
EV	204,709	4,572,268	7,836,614
PHEV	507	7,051	64,574
Sub-total vehicles	*2,685,373*	*5,860,270*	*7,901,189*
Sub-total charging stations	*0*	*10*	*20*
Total	2,685,373	5,860,280	7,901,209

Source: IEA, BofA Global Research

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Appendix

Table 2: Price forecasts, fundamental drivers and risks
We are bullish a range of cyclical commodities

Metal	2021E	2022E	Fundamental drivers	
Aluminium	$2,465/t 112c/lb	$3,250/t 147c/lb	• Capacity growth in China is slowing and ex-China is reluctant to invest in new capacity • China has exported 4.5-5mt annualised of aluminium units. While these shipments are not strictly unwrought aluminium, they have nonetheless subdued fundamentals in World ex-China. Falling exports are bullish. • We expect a **deficit** from 2021.	• D: M • D: C • U: S • U: S
Copper	$9,345/t 424c/lb	$9, 875/t 448c/lb	• Demand in China rebounded impressively in 2020, but has been slowing; property and auto are the key concerns • Inventories are low, which is supportive • Supply additions are set to be limited at the same time • We expect a small **deficit** for 2021.	• D: C • D: g • U: S • U: C
Lead	$2,133t 97c/lb	$2,251/t 102c/lb	• There are no immediate scrap and concentrates shortages, suggesting the market could flip back into surplus • China's demand has slowed structurally, as the ebike market has matured.	• D: D • U: S
Nickel	$18, 366/t 833c/lb	$22,125/t 1004c/lb	• Nickel demand from electric vehicle producers should rise in the coming years, yet, more NPI being converted to nickel sulphate • Indonesia is still flooding the global nickel market with nickel units, which should keep prices in check • We expect a **surplus** for 2021, but deficits towards 2023	• D: M Phi • D: I • D: S
Zinc	$2,914/t 132c/lb	$2,750/t 125c/lb	• The market has rebalanced on significant production curtailments over Covid-19. • Supply is set to come back in 2021, but demand should also rebound, limiting any supply overhang • Zinc may remain an underperformer, but immediate downside more limited	• D: D • D: T fur
Gold	$1,803/oz	$1,875/oz	• Gold has been a trade on US rates and the volume of negative yielding assets. • Stronger inflation would be bearish gold through rising nominal rates, unless CBs cap rates; more aggressive Fed would help • A weaker USD could also push gold higher.	• D: D • D: D
Silver	$25.83/oz	$30/oz	• The silver market has rebalanced on production discipline and demand from new applications including solar panels • Industrial demand to rebound post COVID-19. • If more spending on solar panels come through, silver should rally above $31/oz.	•
Platinum Palladium	$1,093/oz $2,402/oz	$1,313/oz $2,063/oz	• Chip shortages cap the upside to prices, but a normalisation of dislocations should ultimately boost demand • Palladium remains in deficit, so prices should overall remain well supported • While platinum is set to remain in surplus in 2021, the hydrogen economy and substitution should increasingly stabilise prices.	•
Iron Ore	$157/t CIF	$91/t CIF	• Vale's issues have been defining the iron ore market for a whole and the company is set to increase production further in 2021. • These units are hitting the market as steel mills in China are cutting production and output increases slow ex-China • Fundamentals are weakening, so prices should decline further	•
HCC Thermal coal	$207/t $129t	$240/t $130/t	• Thermal coal prices should rebound as economies open; energy/ gas markets remain extremely tight • Supply issues are keeping the met coal market tight.	•
Brent and WTI crude oil	$68/bbl $65/bbl	$75/bbl $71/bbl	We project Brent and WTI to average $68/bbl and $65/bbl, respectively, in 2021 and $75 and $71 in 2022. Our supply and demand forecasts suggest a 1.4mn b/d deficit in 2021 followed by a 400k b/d deficit in 2022. We forecast global demand will rebound nearly 6mn b/d YoY in 2021 after falling 8.7mn b/d in 2020. During 2021-23, we forecast demand will grow by more than 9mn b/d, the fastest pace since the 1970s. Non-OPEC supply should grow roughly 700k b/d YoY in 2021 and an additional 2mn b/d+ in 2022. We project total US supply will remain flattish in 2021 and rise more than 1.5mn b/d in 2022. • OPEC supplies are set to rise 600k b/d in 2021 and 2.1mn b/d in 2022 as OPEC+ adds back supply and as Iran re	

Colours indicate our stance on each commodity: Green = bullish, Yellow = neutral, Red = cautious. **Source:** BofA Global Research estimates

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Supply and demand balances

Table 3: Aluminium supply and demand balance
The aluminium market is expected to tighten 2018-2022E

'000 tonnes	2018	2019	2020	2021E	2022E
Global production	64041	64069	65674	68903	72444
YoY change	1.4%	0.0%	2.5%	4.9%	5.1%
Global consumption	64956	65357	63979	70501	74469
YoY change	3.0%	0.6%	-2.1%	10.2%	5.6%
Balance	-916	-1288	1695	-1598	-2025
Market inventories	11163	10037	12390	0	0
Weeks of world demand	8.9	8.0	10.1	0.0	0.0
LME Cash ($/t)	2110	1813	1704	2465	3250
LME Cash (c/lb)	96	82	77	112	147

Source: SNL, Woodmac, CRU, Bloomberg, company reports, IAI, BofA Global Research

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Table 4: Copper supply and demand balance
Copper will likely be in deficit this year 2018-2022E

'000 tonnes	2018	2019	2020	2021E	2022E
Global production	23507	23444	23389	24624	25647
YoY change	2.0%	-0.3%	-0.2%	5.3%	4.2%
Global consumption	23654	23681	23528	24866	26084
YoY change	2.5%	0.1%	-0.6%	5.7%	4.9%
Balance	-147	-237	-139	-241	-437
Market inventories	1583	1351	1212	971	534
Weeks of world demand	3.5	3.0	2.7	2.0	1.1
LME Cash ($/t)	6532	5995	6175	9345	9875
LME Cash (c/lb)	296	272	280	424	448

Source: SNL, Woodmac, CRU, Bloomberg, company reports, ICSG, BofA Global Research

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Table 5: Lead supply and demand balance
There should be no lead shortages 2018-2022E

'000 tonnes	2018	2019	2020	2021E	2022E
Global production	12807	13191	12677	13160	14054
YoY change	0.7%	3.0%	-3.9%	3.8%	6.8%
Global consumption	12771	12847	12388	13340	13880
YoY change	1.5%	0.6%	-3.6%	7.7%	4.0%
Balance	35	344	290	-180	174
Market inventories	489	833	1123	943	1117
Weeks of world demand	2.0	3.4	4.7	3.7	4.2
LME Cash ($/t)	2241	1954	1824	2133	2251
LME Cash (c/lb)	102	89	83	97	102

Source: SNL, Woodmac, CRU, Bloomberg, company reports, ILZSG, BofA Global Research

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Table 6: Nickel supply and demand balance
The nickel market is bifurcated

'000 tonnes	2018	2019	2020	2021E	2022E
Global production	2235	2409	2615	2789	3197
YoY change	5.6%	7.8%	8.6%	6.6%	14.6%
Global consumption	2289	2379	2423	2814	2915
YoY change	7.4%	4.0%	1.8%	16.1%	3.6%
Balance, incl. NPI oversupply	-54	30	192	-25	282
Balance, excl. NPI oversupply	-54	30	52	-131	54
Market inventories	328	307	377	392	446
Weeks of world demand	7.5	6.7	8.1	7.2	8.0
LME price ($/t)	13130	13165	13783	18366	22125
LME price (c/lb)	596	597	625	833	1021

Source: SNL, Woodmac, CRU, Bloomberg, company reports, INSG, BofA Global Research

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Table 7: Zinc supply and demand balance
Zinc surpluses will likely remain small 2018-2022E

'000 tonnes	2018	2019	2020	2021E	2022E
Global production	13252	13372	13754	14400	14600
YoY change	-2.1%	0.9%	2.9%	4.7%	1.4%
Global consumption	14144	13861	13271	14291	14773
YoY change	-0.7%	-2.0%	-4.3%	7.7%	3.4%
Balance	-892	-489	484	109	-173
Market inventories	644	589	758	867	693
Weeks of world demand	2.4	2.2	3.0	3.2	2.4
LME Cash ($/t)	2923	2404	2265	2914	2750
LME Cash (c/lb)	133	109	103	132	125

Source: SNL, Woodmac, CRU, Bloomberg, company reports, ILZSG, BofA Global Research

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Table 8: Platinum supply and demand balance
Platinum set to be balanced 2018-2022E

'000 ounces	2018	2019	2020	2021E	2022E
Global production	7929	7826	6415	8113	8599
YoY change	-1.2%	-1.3%	-18.0%	26.5%	6.0%
Global consumption	8059	8540	7409	7975	8627
YoY change	0.3%	6.0%	-13.3%	7.7%	8.2%
Balance	-130	-715	-993	137	-27
Spot ($/oz)	880	865	886	1093	1313

Source: Matthey, company reports, BofA Global Research

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Table 9: Palladium supply and demand balance
Palladium should remain undersupplied 2018-2022E

'000 ounces	2018	2019	2020	2021E	2022E
Global production	9,753	10,233	9,011	10,386	11,072
YoY change	4.0%	4.9%	-11.9%	15.3%	6.6%
Global consumption	10,324	11,418	10,007	9,132	9,540
YoY change	2.6%	10.6%	-12.4%	-8.7%	4.5%
Balance	-571	-1,185	-996	1,254	1,532
Spot ($/oz)	1,030	1,540	2,201	2,402	2,063

Source: Matthey, company reports, BofA Global Research

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Table 10: Iron ore supply and demand balance
Iron ore is flipping back into surplus

Wet Mt	2018	2019	2020	2021E	2022E
Global production	2,216	2,211	2,244	2,297	2,365
YoY change	0.5%	-0.2%	1.5%	2.4%	2.9%
Global consumption	2,210	2,264	2,291	2,313	2,324
YoY change	2.4%	2.4%	1.2%	0.9%	0.5%
Balance	6	-53	-48	-15	40
Iron ore price (US$/t)	70	93	109	157	91

Source: company reports, CRU, BofA Global Research

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Table 11: Cobalt supply and demand balance
Cobalt set to move back into surplus

tonnes	2018	2019	2020	2021E	2022E
Global production	162,284	132,466	142,883	189,672	227,938
YoY change	400.0%	500.0%	600.0%	700.0%	800.0%
Global consumption	143,813	150,170	153,063	193,410	213,774
YoY change	21.5%	4.4%	1.9%	26.4%	10.5%
Balance	18,471	-17,704	-10,179	-3,738	14,164
Spot ($/lb)	37.1	16.4	15.2	20.0	20.5

Source: company reports, CRU, BofA Global Research

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Table 12: Lithium supply and demand balance
Supply discipline essential

tonnes, LCE	2018	2019	2020	2021E	2022E
Total Supply	330,024	367,959	386,947	431,314	594,416
YoY change	20.2%	11.5%	5.2%	11.5%	37.8%
Total Demand	272,319	296,680	327,702	457,229	574,019
YoY change	26.9%	8.9%	10.5%	39.5%	25.5%
Balance	57,705	71,279	59,244	-25,915	20,397

Source: company reports, CRU, BofA Global Research

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Table 13: Commodity price forecasts
BofA's quarterly and annual forecasts for base metals, precious metals, bulk materials, minor metals, steel and energy

		Current	4Q21E	1Q22E	2Q22E	3Q22E	4Q22E	1Q23E	2020	2021	2022	2023	2024	2025	LT price
Base metals															
Aluminium	US$/t	2,555	2,750	3,000	3,250	3,250	3,500	3,500	1,704	2,465	3,250	3,375	2,989	2,093	2,199
	USc/lb	116	125	136	147	147	159	159	77	112	147	153	136	95	100

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Copper	US$/t	9,439	9,750	10,500	10,500	9,500	9,000	9,500	6,175	9,345	9,875	9,500	8,906	8,313	7,719
	USc/lb	428	442	476	476	431	408	431	280	424	448	431	404	377	350
Lead	US$/t	2,348	2,000	2,251	2,251	2,251	2,251	2,297	1,824	2,133	2,251	2,297	2,348	2,398	2,448
	USc/lb	107	91	102	102	102	102	104	83	97	102	104	106	109	111
Nickel	US$/t	19,141	18,500	19,000	22,000	22,500	25,000	20,000	13,783	18,366	22,125	20,000	18,367	16,734	15,101
	USc/lb	868	839	862	998	1,021	1,134	907	625	833	1,004	907	833	759	685
NPI, 8-12%	CNY/t	1,495	1,400	1,300	1,250	1,200	1,100	1,000	1,010	1,260	1,213	1,000	1,032	1,064	1,096
Zinc	US$/t	3,241	3,000	3,000	2,750	2,750	2,500	2,500	2,265	2,914	2,750	2,500	2,546	2,591	2,637
	USc/lb	147	136	136	125	125	113	113	103	132	125	113	115	118	120
Precious metals															
Gold, nominal	US$/oz	1,794	1,800	1,900	1,800	1,900	1,900	1,900	1,771	1,803	1,875	1,950	1,961	1,971	1,980
Gold, real	US$/oz		1,800	1,854	1,756	1,854	1,854	1,808	1,771	1,803	1,829	1,856	1,821	1,785	1,750
Silver, nominal	US$/oz	23.79	25.00	27.50	31.00	31.00	31.00	32.50	20.52	25.83	30.13	32.50	31.18	29.78	28.29
Silver, real	US$/oz		25.00	26.83	30.24	30.24	30.24	30.93	20.52	25.83	29.39	30.93	28.96	26.98	25.00
Platinum	US$/oz	1,033	1,000	1,000	1,250	1,500	1,500	1,500	886	1,093	1,313	1,500	1,465	1,430	1,395
Palladium	US$/oz	2,022	2,000	2,000	2,250	2,000	2,000	1,750	2,201	2,402	2,063	1,750	1,632	1,513	1,395

		Current	4Q21E	1Q22E	2Q22E	3Q22E	4Q22E	1Q23E	2020	2021	2022	2023	2024	2025	LT price
Bulk Commodities															
Hard coking coal	US$/t fob	403.0	325.0	240.0	240.0	240.0	240.0	217.7	135.5	206.7	240.0	217.7	195.4	173.1	150.8
Semi-soft	US$/t fob	269.3	218.8	147.1	147.1	147.1	147.1	135.7	75.3	158.5	147.1	135.7	124.3	112.9	101.5
Thermal Coal	US$/t fob	153.0	175.0	150.0	130.0	125.0	115.0	117.8	60.3	129.0	130.0	117.8	105.6	93.4	81.2
Iron ore fines	US$/t CIF	99.7	100.0	75.0	90.0	100.0	100.0	76.9	108.6	157.0	91.3	76.9	78.8	80.8	84.9
Other materials															
Lithium spodumene	US$/t	1,300	1,000	1,200	1,200	1,200	1,200	1,100	300	863	1,200	1,050	813	700	
Lithium carbonate	US$/t	30,025	16,400	15,823	15,823	15,823	15,823	17,365	8,067	13,929	15,823	17,365	17,365	17,365	
Lithium hydroxide	US$/t	29,675	18,400	17,540	17,540	17,540	17,540	19,249	6,358	15,440	17,540	19,249	19,249	19,249	
Alumina	$/t	435	350	350	323	323	323	331	271	312	330	331	340	348	357
Uranium	$/lb		50.00	60.00	55.00	50.00	49.00	48.50	29.58	36.29	53.50	48.50	48.00	47.50	47.00
Molybdenum	$/lb	19.10	19.14	19.14	19.14	19.14	19.14	19.14	8.68	16.01	19.14	19.14	16.44	13.74	11.04
Cobalt	$/lb	27.30	24.00	25.00	25.00	27.50	27.50	30.00	15.18	21.61	26.25	30.00	26.13	22.26	18.39
Manganese ore	$/dmtu	5.80	5.23	5.23	5.23	5.23	5.23	5.23	4.64	5.13	5.23	5.23	5.42	5.61	5.80
Steel, HRC															
HRC, Europe	US$/t	1,039	1,179	1,064	947	771	701	674	471	1,158	871				
HRC, US	US$/t	2,072	1,764	1,537	1,367	1,110	1,008	960	632	1,677	1,256				
HRC, China	US$/t	825	699	638	635	631	628		556	704	633				

Energy		Current	4Q21E	1Q22E	2Q22E	3Q22E	4Q22E	1Q23E	2020E	2021E	2022E	2023E	2024E	2025E	LT price
Brent	US$/bbl	81.0	83.0	85.0	95.0	85.0	75.0	60.0	43.8	71.3	85.0	60.0	60.0	60.0	60.0
WTI	US$/bbl	79.6	81.0	82.0	92.0	81.0	71.0	57.0	39.8	68.5	81.5	57.0	57.0	57.0	57.0
Henry Hub	US$/MMBtu	5.59	4.25	3.75	3.25	3.30	3.50	2.60	2.13	3.47	3.45	2.60	2.60	2.60	2.60

Note: quarterly energy forecasts are period-end, rest are period averages; **Source:** BofA Global Research

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Key Market Data

Table 14: Commodity prices, exchange rates, equity indices, yields and inventories
Metals have rebounded

Base metals	Cash, $/t	3-month, $/t	Cash, WoW change	3-month, WoW change
Aluminium	2,532	2,555	-7.4%	-7.0%
Copper	9,699	9,439	-1.6%	-2.4%
Lead	2,374	2,348	-3.5%	-3.1%
Nickel	19,224	19,141	-2.3%	-2.2%
Tin	37,457	36,452	0.3%	1.7%
Zinc	3,286	3,241	-4.2%	-3.9%
LMEX	4,297		-3.0%	
	Cash, c/lb	3-month, c/lb		
Aluminium	115	116		
Copper	440	428		
Lead	108	107		
Nickel	872	868		
Tin	1,699	1,654		
Zinc	149	147		

Other commodities, freight, exchange rates, equities and yields	Spot	WoW change
Gold, $/oz	1,792	-0.4%
Silver, $/oz	23.80	-1.2%
Platinum, $/oz	1,029	0.7%
Palladium, $/oz	2,006	0.7%
Iron ore, China fines cfr $/dmt	96.2	-20.9%
Brent, $/bbl	80.54	-3.7%
Baltic Dry Index	2,769	-23.7%
EUR/USD	1.1554	-1.1%
Dow Jones Industrial Average	36,124	1.1%
10-year US Treasury yield	1.529	-3.3%
ICE BofA Commodity index, ER	349.410	-2.4%
ICE BofA Commodity index Industrial Metals, ER	200.760	-4.2%
ICE BofA Commodity index Precious Metals, ER	211.840	-0.5%
ICE BofA Commodity index Energy, ER	367.650	-2.9%

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Exchange stocks and cancelled warrants	Stocks, tonnes	WoW change	Canc. warrants, tonnes	Canc. warr., of stocks
Aluminium				
LME	1,009,725	-4.0%	387,875	38.4%
Shanghai	287,325	6.6%		
Total aluminium	1,297,050	-1.8%		
Copper				
LME	123,400	-14.1%	84,950	68.8%
Comex	53,627	3.8%		
Shanghai	49,327	23.8%		
Total copper	226,354	-3.7%		
Lead				
LME	54,425	-1.6%	11,750	21.6%
Shanghai	172,503	-2.7%		
Total lead	226,928	-2.4%		
Nickel				
LME	138,096	-3.7%	65,178	47.2%
Shanghai	7,934	10.0%		
Total nickel	146,030	-3.0%		
Tin	670	-30.6%	225	33.6%
Zinc				
LME	193,550	-2.1%	45,875	23.7%
Shanghai	74,842	-1.4%		
Total zinc	268,392	-1.9%		

Source: BofA Global Research

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[2] Nationally determined contributions (NDCs) embody efforts by each country to reduce national emissions and adapt to the impacts of climate change

[3] International Energy Agency, 2021. Net Zero by 2050. A Roadmap for the Global Energy Sector

[4] Intergovernmental Panel on Climate Change IPCC, 2021. Climate Change 2021: The Physical Science Basis

[5] UNEP, 2021. Emissions Gap Report

[6] OECD, 2021. Forward-looking Scenarios of Climate Finance

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Research Investment Committee 2021-Nov-8

Research Summary

Global Research Highlights (http://rsch.baml.com/r?q=SlDSQeBHOkTI1z8yB99Pw&e=mmatos%40agenciacomma...)

Balancing Year End Variables
Derek Harris 2021-Nov-5

Disclosures

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