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LOMBARD ODIER
INVESTMENT MANAGERS

Transition materials: enablers and beneficiaries of the technology revolution

09/23

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At a glance

- Significant opportunities in transition materials, or commodities linked to the technology revolution, are being created by transitions in energy and material systems
- We consider the role of metals and biobased materials in building new, more energy-productive technologies with lower operating costs and superior efficiencies. This includes the use of timber as an illustration
- Our conviction, based on our roadmap research, is that the transition will be faster and stronger in character than anticipated, and lead to compelling investment potential in the commodities space
- Demand for the critical materials underpinning the energy transition is expected to increase exponentially over the next decade, while a shortage of supply is projected to increase commensurately following chronic underinvestment in the sector, leading to re-pricing
- We believe we are in the early stages of a potential commodities supercycle driven by demand for transition-aligned materials, geopolitics and the post-COVID fracturing of supply chains
- These convictions guide us to identify specific commodities in the investment universe that are either: driven specifically by the transition; or are positively exposed to the transition and provide diversification and liquidity; or are negatively exposed to the transition and excluded
- A systematic investment process driven by risk-diversification principles provides additional advantages to implementing these investment convictions

Transition materials – the investment case

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Industrial and battery metals are among the clearest beneficiaries of the transition to an electrified economy.

1. Systems change at the heart of the transition

At Lombard Odier, we believe that a new innovation cycle – focused on energy, land and oceans, and materials – is emerging, driving systemic change

Rather than dampening growth, we believe this transition revolution is akin in scale and nature to that of past industrial revolutions, and ultimately will unlock increased energy, material and wider resource productivity.

Three systems changes are at the heart of this transition:

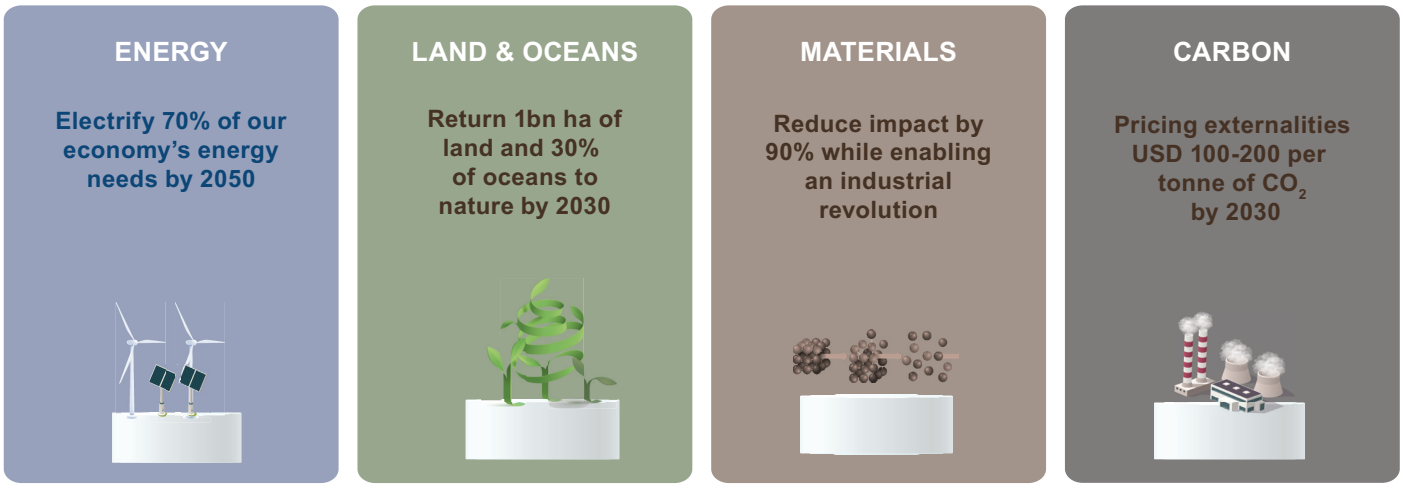
- The rapid electrification of our economy – or expanding the share of electricity as a carrier of energy from less than 20% to more than 70% by 2050 – with much of this being front-loaded during the current decade
- The restoration of land and its return to nature, driven by changes in our food systems, the shift towards regenerative agriculture and re-investment in forest systems, alongside with the conservation of 30% of our oceans
- An evolution in our use of materials brought about by technology (changing the types of materials needed) and the flows of those materials through our economy

Policy action is accelerating this transition. The scale of the EUR 1 trillion EU Green Deal package has now been rivalled by the even more sweeping US Inflation Reduction Act. This piece of legislation is in turn triggering a wider rethink in Europe and elsewhere about how best to incentivise and support technology industries to ensure competitiveness in a rapidly evolving market.

In parallel, carbon markets are acting as an accelerator. At least 70 carbon pricing regimes have been implemented around the world, with prices in Europe having exceeded EUR 100 per tonne of CO_2 for the first time. The impact of carbon prices will progressively shift the economics in favour of new and lower-emitting technologies: from regular vehicles to electric vehicles, from blast furnaces to electric arc furnaces, and from cement to timber.

The transition is creating significant opportunities for growth, disruptive business models and innovative solutions. Profit pools are shifting as markets change and new technologies take hold. And amid this transformation, materials remain a vital building block of the global economy and will be particularly affected.

FIG. 1 TRANSFORMING THREE SYSTEMS: ENERGY, LAND AND OCEANS, AND MATERIALS, ACCELERATED BY THE PRICING IN OF CARBON



Source: LOIM. For illustrative purposes only.

1.1 The pace of the transition

Past transitions – from the rollout of railroads and canals to the adoption of coal, oil and gas, and the embrace of products as diverse as automobiles, dishwashers and microwaves – have followed a familiar pattern.

Transitions generally start slowly at first, as new technologies and business models lack acceptance, scale or cost-competitiveness. With innovation, adoption rates and economies of scale improve, until an inflection point is reached: the point at which functionality, accessibility and affordability of the new technology or business model allow it to break into mass markets. From there, transitions progress extremely fast. Technological revolutions unfold exponentially, not linearly.

Today, at Lombard Odier we see this familiar pattern emerging yet again. The costs of key technologies have fallen and, accordingly, adoption rates are rising. The use of some technology (such as LEDs) is already widespread. Other areas, such as renewables, now dominate new installations and it is only a matter of time before existing capacity is transformed. Solar energy is currently the cheapest source of energy on the planet.[1] Electric vehicles are at an inflection point, with costs having fallen rapidly to bring them into parity with regular vehicles. Large-scale batteries, heat pumps and a plethora of other technologies are following (figure 2).

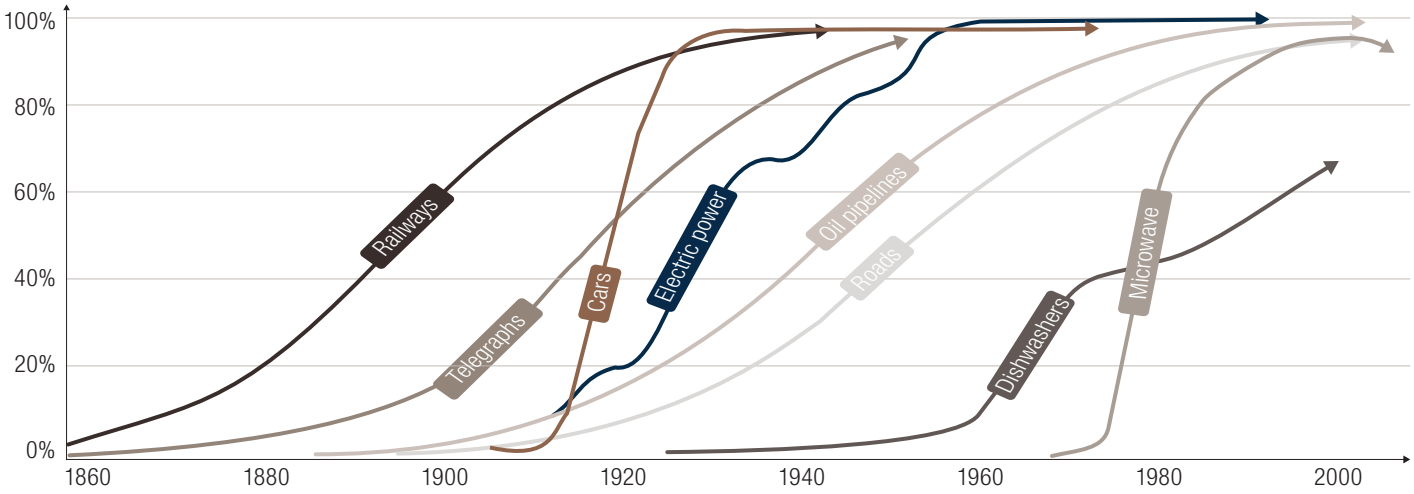
The energy transition will bring a substantial shift in value and impact investment portfolios in myriad ways. Much of the focus may be on equity markets, where the bulk of the destruction and gain of value may occur. The scale and nature of the transition, however, will reverberate throughout the economy, affecting all asset classes.

This paper focuses on the compelling **investment opportunities in commodities linked to the technology revolution** and associated transitions in energy and material systems, and carbon markets. After outlining how the transition will unfold in key systems changes, we highlight the massive increase in expected capital expenditure on electrification and look at the role of metals and biobased materials in building new technologies. Timber provides a good example of how the substitution of transition-aligned materials will also come into play.

We then address why we believe the transition will be faster and stronger in character than anticipated by policy, and lead to compelling investment potential in the commodities space. For instance, the outlook is favourable for the likes of copper and lithium due to supply gaps. Other factors – such as geopolitics and the post-COVID fracturing of supply chains – lead us to believe that we are in the early stages of a potential commodities supercycle, with the re-opening of China exerting a positive influence on commodity markets.

How do we turn these convictions into an investment strategy? The paper then explores how our convictions inform the creation of an investment universe and transition materials portfolio, using our transition research to identify and capture the favourable investment opportunities. We conclude by highlighting the benefits of our systematic and active approach, as well as how commodities can offer diversification within a multi-asset portfolio.

FIG. 2 S-CURVE ADOPTION RATE PATTERN OF NEW TECHNOLOGY



Source: Systemiq (2023), The Breakthrough Effect.

[1] Source: International Energy Agency, World Energy Outlook 2020. Solar is now 'cheapest electricity in history', confirms IEA (carbonbrief.org).

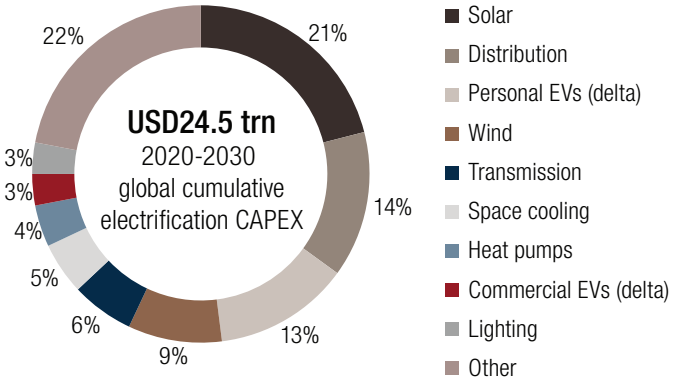
2. Transition materials – the investment case

2.1 Massive capital expenditure

Past industrial revolutions have, historically, been a core driver of shifts in commodity markets. Successive industrial revolutions have transformed our economy from a dependence on traditional biomass (wood), to coal and new fossil fuels like oil and gas. At the same time, innovation in material markets has shifted our economy from relying on iron to depending on steel, aluminium, cement, and other materials.

The technology revolution continues this long-standing pattern of shifting markets and an evolution in the commodities driving their growth in the future. We estimate as much as USD 24.5 in trillion in capital expenditure may be deployed this decade in the energy transition alone (figure 3). Wider investments in nature systems and the circular economy potentially increase this figure to USD 30-40 trn.

FIG. 3 FORECAST OF USD 24.5 TRILLION CAPEX SPENDING ON ELECTRIFICATION THIS DECADE



Source: LOIM research.

Although these figures still represent a minority share of global gross capital formation, they are roughly comparable to aggregate spending on IT in the past decade: approximately USD 2.5 trn per year on the energy transition and as much as 50% more when including broader transitions in the material system and spending related to food systems, water and nature.[2] The scale of disruption, too, we believe will rival the tech revolution that has unfolded in past decades.

2.2 The materials powering the energy transition

The energy transition involves high upfront capital intensity, but generally involves a move towards more energy-productive technologies with lower operating costs and superior efficiencies. The greater upfront cost of key products (ranging from electric vehicles to renewable installations or large-scale batteries) is in part driven by the higher value of the raw materials embedded in them.

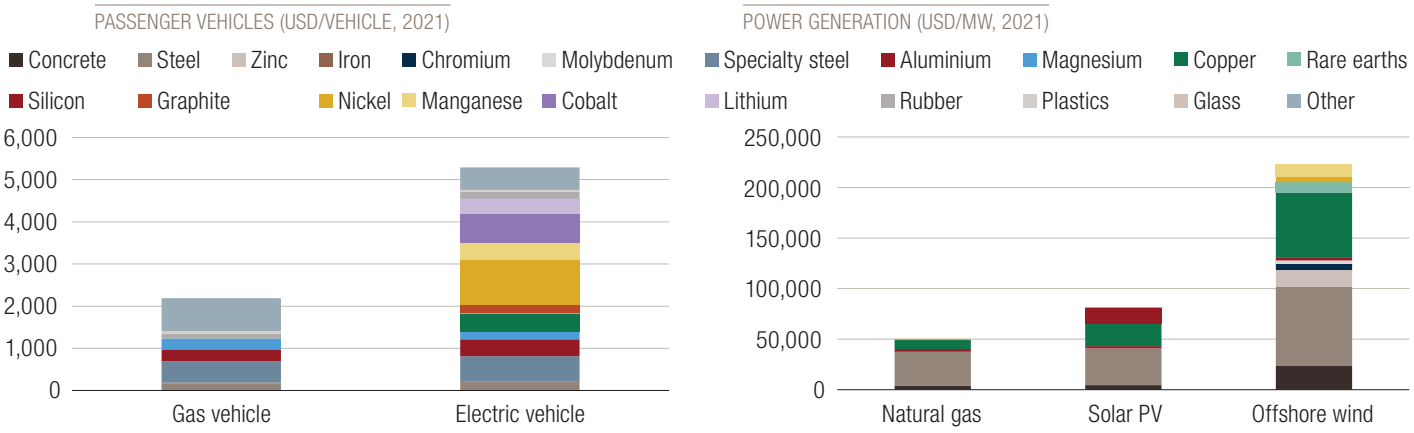
Metals and biobased materials are heavily used in the applications, products and processes that enable the energy transition from fossil fuels to green energy sources and technologies. A typical electric vehicle requires about 6kg of lithium, 29kg of nickel, 10kg of manganese, and 8kg of cobalt, while charging stations require a consequential amount of copper.[3] As for green electricity production, photovoltaic panels use large quantities of copper, silicon, silver, and zinc. Wind turbines require iron ore, copper, and aluminium.

In general, these technologies typically require both different materials as well as a higher aggregate value of these materials (figure 4). The higher cost is recuperated by the lower energy expense during the use-phase of these products, making materials a key beneficiary of a value shift from operating-stage consumables to production-stage capital goods and inputs.

[2] Source: LOIM Roadmap Research.

[3] Source: The Visual Capitalist, The Key Minerals in an EV Battery, May 2, 2022.

FIG. 4 NEW TECHNOLOGIES RELY ON DIFFERENT TRANSITION MATERIALS



Source: IAE, Fitch Ratings, CRU Group, World Nuclear Association, LOIM. For illustrative purposes only.

2.3 The transition-aligned universe looks metallic… but not only

Industrial and battery metals are among the clearest beneficiaries of the transition to an electrified economy, but other materials are positively exposed too.

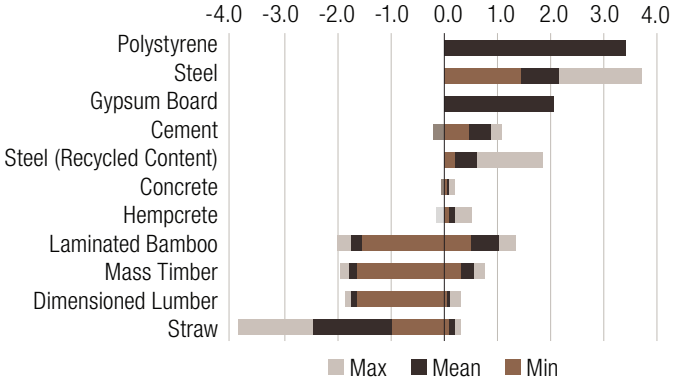
Rising carbon prices and an increased focus on embedded emissions in our built environment will put an increased premium on these metals and materials. This will unlock investment opportunities around recycling, re-use and recovery, product lifetime extension and improved design, but will also drive the further substitution of other materials, including biobased materials.

In construction markets, where the lifecycle emissions of buildings is emerging as a core policy focus, this will drive demand for lower-carbon materials including timber.

Innovation in timber products and construction is enabling the increased use of timber, including in multi-story construction, with timber products posing strong growth in leading markets (figure 5). In some leading markets (including in Scandinavia), timber-based construction is already commonplace, and other regions are following suit.

A similar pattern is taking place in packaging markets, where increased awareness and focus on the plastics crisis is creating a growth story around paper and cardboard packaging – another biobased material benefiting from many of the same attributes as timber and biodegradability.

FIG. 5 THE INCREASED USE OF WOOD DRIVES CARBON-NEUTRAL CONSTRUCTION



Source: RMI (2021), Reducing Embodied Carbon in Buildings Low-Cost, High-Value Opportunities, based on Galina Churkina et al. 2020. For illustrative purposes only.

Ethanol – a biofuel – may also be positively exposed to the transition. Although the electrification of new vehicle sales will be a key theme in the coming decade, vehicle fleets will remain largely based on combustion engines until well into the 2030s. De-carbonising the emissions of this legacy fleet has few remedies other than the use of biofuels, with regulators having gradually increased requirements on the use of biofuels in automotive, shipping and airline fleets.

2.4 Our conviction: a faster and more profound transition

We believe that the energy transition will offer substantial opportunities in the commodities space. While many investors see the structural surge in demand for transition-aligned materials, the true impact on fundamentals remains underappreciated, in our opinion.

Indeed, the broad market consensus assumes a slow transition. Government policies are aligned to an approximately 2.6-2.9 °C trajectory of warming.[4] Broker consensus assumes electrification (EVs, buildings etc), but at conservative rates. Underlying assumptions are generally based on outdated or stagnant information about cost, failing to take into account demonstrable cost reductions and learning curves.

Our conviction is that **we will witness a faster transition.**

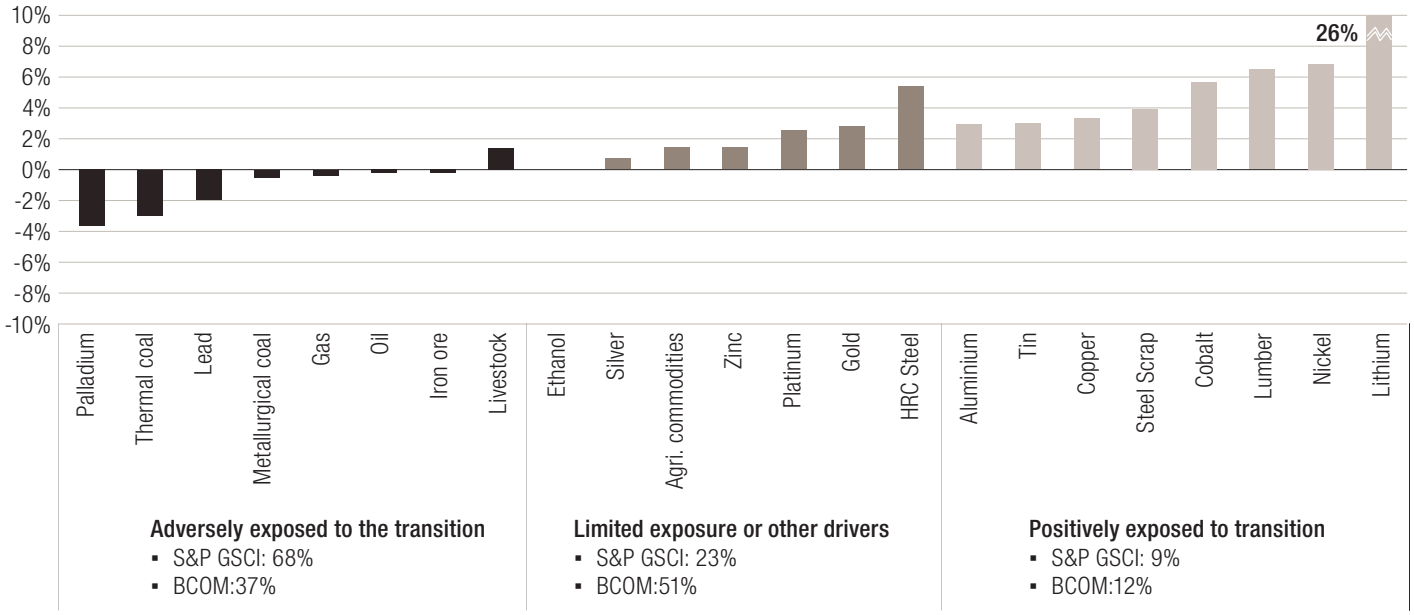
The transition is driven, primarily, by exponential adoption of more energy-productive technologies whose economics have rapidly improved. Reductions in cost (in solar energy, wind, batteries and electric vehicles) have consistently beaten expectations, leading rather than lagging policy.

Adoption rates of renewables and electric vehicles have, accordingly, continued to surpass forecasts. Accordingly, ambitions of key industry players – who recognise the opportunity – already often exceed stated policy targets with some leading car manufacturers, some of whom are targeting full electrification as early as 2030, are significantly ahead of targets set by policymakers.

Progressive expansion of coverage of carbon prices will further accelerate these trends. Finally, positive feedback mechanisms – whereby one technology improves the economics of another – are a further source of acceleration.

Taking into account the impact of technological innovation, policy, the pricing of externalities and consumer pressure, we then form views on the outlook for commodity markets (figure 6).

FIG. 6 PROJECTED GROWTH IN MARKET VOLUMES AND EXPOSURE TO TRANSITION (% CAGR, 2019-2030)



Source: LOIM research. For illustrative purposes only.

[4] See Climate Action Tracker (accessed May 2023).

2.5 Emerging commodity supply gaps

Prices of commodities are driven by myriad factors, but the current expected balance between supply and demand is their core impetus. We base our demand projections for commodities on our core conviction that the transition is unfolding at an accelerating pace. Added to this, our investment conviction recognises that the projects pipeline and present supply may prove inadequate to fully meet demand.

In mining terminology, resources refer to quantities of ores and minerals with reasonable prospects for extraction – at the right price, while reserves refer to quantities identified with higher levels of confidence, where extraction is not only feasible but also economically viable at or around present prices.

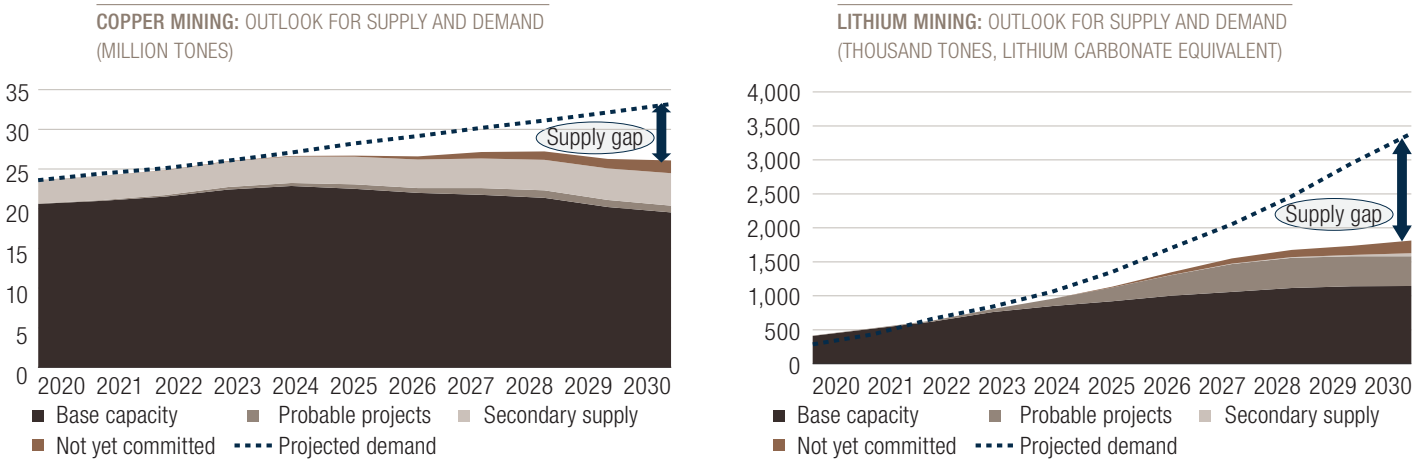
Resources for the materials necessary for the transition are, by and large, far in excess even of cumulative, projected demand, even through to 2050. Resources for copper, nickel, lithium, cobalt, silicon, and other metals are comparatively abundant. We therefore do not believe that resource scarcity will hamper the transition, but believe that prices will nonetheless need to adjust to encourage the upgrade resources into reserves, incentivise the development of new and existing mining projects, and rationalise demand.

Figure 7 illustrates our analysis of copper and lithium markets today. Even taking into account present base capacity and new and probable projects as well as recycled sources of supply, a supply gap remains.

Such imbalances are common in commodity markets – yet rarely lead to technological transitions being derailed. Rather, prices act as a balancing mechanism, with higher prices driving (a) improved investment in resource efficiency: for instance in more efficient battery technologies; (b) a degree of substitution, driven by the higher price of the substituted material; (c) higher rates of collection and recycling, again incentivised by higher prices; and (d) an expanded pipeline or development of new projects.

Higher prices of raw materials may be seen as a supply-chain risk by some, potentially impacting margins and end-product prices. **The core investment conviction for our commodity strategies is that the transition – both the energy transition and wider transitions in nature and material systems – will drive up the prices of specific materials.**

FIG. 7 SUPPLY AND DEMAND OUTLOOK FOR COPPER AND LITHIUM MINING



Source: LOIM. For illustrative purposes only.

2.6 Deglobalisation and geopolitical tensions

Wider geopolitical factors and disruptions may further impact commodity markets, beyond underlying technological drivers.

Prior to 2020, the demand surge for critical materials for the energy transition was already well underway due to accelerating climate action. In 2020, the COVID pandemic led to unprecedented fiscal and monetary stimulus that far outpaced the response to the 2008 Global Financial Crisis. In February 2022, Russia invaded and occupied parts of Ukraine in a major escalation of the Russo-Ukrainian war which began in 2014. This further fractured global supply chains, upended the geopolitical order and ultimately led to global hyperinflation. Ever since, we have witnessed greater fragmentation of a multi-polar world that will be increasingly shaped by competition for strategic resources.

The need to accelerate the global energy transition and secure critical materials supplies has increased commensurately. Coming after a decade of chronic underinvestment in the sector, the need for capital investment is now magnified. **From an investment cycle perspective, we believe we are potentially in the early stages of a new commodity supercycle for transition materials.**

2.7 China

China is particularly relevant to the commodity markets because it is a top producer and consumer of a number of industrial materials, and a key consumer of oil. We expect China to resume exerting a positive influence on commodity market performance in 2023, with the end of its zero-COVID policy and the rebound of its real-estate market from an extremely low entry point.

Furthermore, China has also committed to a very ambitious process of de-carbonising its economy. We expect this to translate into the general promotion of electrification (of transport, networks and renewable infrastructure). China alone accounts for roughly half of global renewable new capacity installation,[5] **once again affecting the markets for metals enabling the transition**. The impact is significant – in 2022, the growth in demand for copper entirely offset the drag from the slowdown in property in China.

[5] Soure: Lombard Odier Mobility Roadmap.

3. A commodity transition materials portfolio

3.1 Defining the investment universe

This paper has outlined how investment convictions about the shape, nature and pace of transitions in energy and other economic systems may, in turn, drive investable convictions in commodity markets.

We believe that these fundamental investment insights are the first, key drivers informing a transition-aligned investment portfolio. Specifically, these insights guide the identification of specific commodities in the investment universe that are positively exposed to the transition. Based on our understanding of the transition and the summary shown in figure 6 we find:

- Some materials, such as copper, nickel or lithium, are specifically driven by the transition
- Others, such as zinc or silver, are positively exposed to the transition, albeit less so than other materials; they could also be advantageous for diversification and liquidity purposes
- Finally, some materials – such as coal, oil and gas, but also lead and palladium – may be negatively exposed, and could be excluded from a portfolio

Part of this resulting investment universe could be found in traditional benchmarks, including for industrial metals such as copper, nickel, aluminium or zinc; but exposure to these metals will generally be slight, compared to greater exposure to oil, gas, livestock and agricultural commodities.

More niche commodities (such as cobalt), recycled materials (like steel scrap) or biobased resources (such as lumber and ethanol) generally do not feature in traditional benchmarks at all, which hence do not provide investors with full and diversified exposure to the transition opportunity.

Fundamental investment insights from our research on transition roadmaps also provide a forward-looking assessment of the likely supply-demand imbalances. This provides actionable insights at the allocation process level, which allows us to forecast which commodities within the universe may be most positively impacted and offer the most attractive investment opportunities.

An investment universe of positively exposed transition materials is expected to be dynamic and to evolve over time. New commodities can be included, depending on opportunities and the evolution of market access (as in the case of lithium or other biobased materials). A component can be removed if the investment opportunity fades, for instance because evolving technology favours other specifications: battery technologies are a good example.

3.2 A systematic investment process

We believe a systematic investment process driven by risk-diversification principles provides additional advantages to implementing these investment convictions in a portfolio.

Systematic investment processes ensure investment discipline while accounting for the numerous constraints that can be inherent in such a portfolio – including UCITS diversification constraints, market liquidity constraints, tail risk diversification and others.

Given the complex nature of the topic and the specificities of the asset class, we believe investors are better served by active managers who are experts in the field. That is why at Lombard Odier, we leverage our dedicated transition research team, with sector specific analysts, to support an experienced investment team with decades of experience in commodity trading.

3.3 Diversification benefits

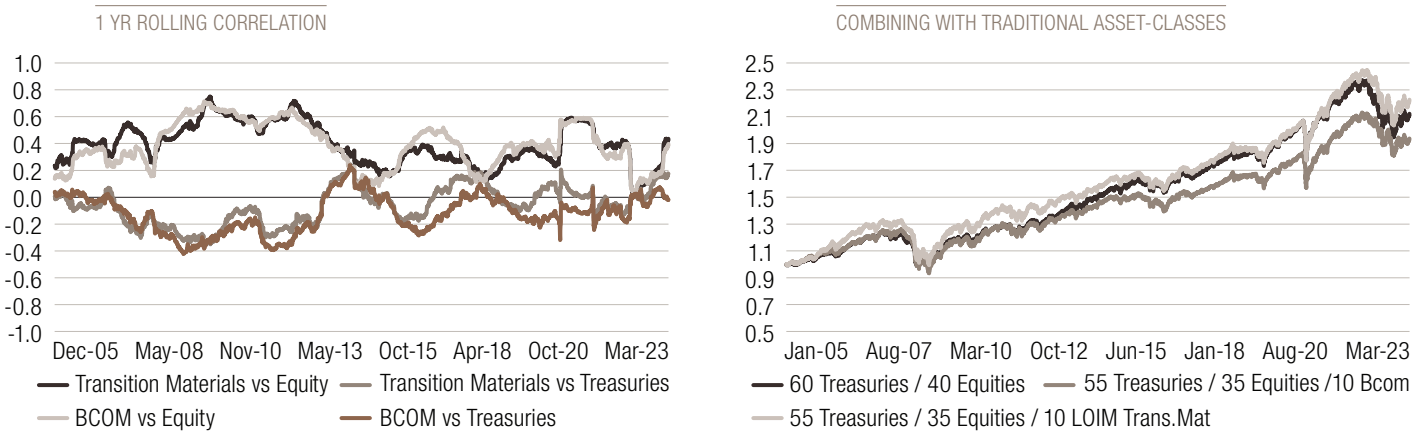
After generating strong results in the previous decade, the traditional 60/40 portfolio has struggled recently amid unfavourable market correlations. We believe that these headwinds are likely to persist as the economy transitions to a new regime resulting from rising inflation and a shift to tightening monetary policy by central banks. In our view, these evolving conditions advocate for greater diversification beyond stocks and bonds.

We believe that commodities bring compelling properties that can help investors navigate the changing market environment. The asset class offers diversification benefits while mitigating the impact of systematically higher inflation.

The transition away from fossil fuels toward cleaner sources of energy is a sound long-term macroeconomic investment theme that can be supportive of those commodities involved in the transition, in our view. Investing in these commodities could offer a **reliable and attractive hedge for transition-related supply chain risk.**

Finally, we believe the impact on the demand for materials will be highly asymmetric (figure 6), and that constrained supply (figure 7) will pressure pricing, generating investment opportunities across the asset class.

FIG. 8 CORRELATION METRICS FOR TRANSITION MATERIALS



Source: LOIM. For illustrative purposes only. As of 31 March 2023.

3.4 Commodities in a multi-asset portfolio

A transition-aligned commodities portfolio nonetheless retains the general properties of the asset class in terms of behaviour, correlations and diversification properties. We expect the typical low correlation of commodities to equities and fixed income to persist, providing interesting diversification features in a multi-asset portfolio.

Moreover, the strategy aims to provide a structural long-term driver of performance potential, to a greater extent than a broad commodity strategy such as the Bloomberg Commodity (BCOM) Index.

A key distinguishing feature is the lack of exposure to the traditional energy sector, which is known to be highly cyclical and more corrosive in terms of negative carry once in contango configuration.

In light of current market conditions and correlation metrics, our view is that commodities in general can offer diversification benefits within a multi-asset portfolio. Commodities linked to the transition can provide potentially compelling long-term opportunities; we believe investors should consider a structural exposure to the asset class.

4. Conclusion

Commodities are tangible assets and play a major role in the global economy and investor portfolios. The transition in energy and materials will reshape the landscape of the asset class, unlocking deep investment opportunities in related commodities.

This transition is unfolding through the fundamental transformation of three systems: energy, land and oceans, and materials; with carbon markets acting as an enabler. The transition is currently at an inflection point.

We base our view of the pace of the transition on the underlying economics, and see the pace accelerating due to policy drivers and carbon markets. Our dedicated research on roadmaps for the transition is at the root of our investment convictions in transition materials in commodities.

Other factors such as the global economy, geopolitical developments or the major role of China will also have an impact on the supply and demand of these materials, and we see this as generally positive. As such, we believe we are at the beginning (rather than the end) of another potential commodities supercycle for transition materials, driven by the technology revolution.

All in all, demand for the critical materials underpinning the energy transition is expected to increase exponentially over the next decade, while a shortage of supply is projected to increase commensurately following the end of a decade of chronic underinvestment in the sector. We believe that the prices of materials, which commodity investors are ultimately exposed to, will readjust to reflect changing market fundamentals.

Commodities have an important role to play in the diversification of traditional equities-bonds portfolios where headwinds such as rising inflation and tightening monetary policy are likely to persist. In addition, we expect exposure to transition commodities to provide an efficient hedge for climate-related supply chain risk, as well as offering long-term return potential.

Investing in transition materials could be a favourable structural fit for investors looking for diversified exposure to the transition by re-aligning their portfolios to supply/demand dynamics in materials and targeting alpha potential.

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