Quantix COMMODITIES | Commodities Research

Companies, Commodities, and the Energy Transition

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Over 90% of global GDP is committed to an energy transition which will include a massive expansion of renewables over the next 30 years. This will require commodities that the world simply will not have at current production levels and the availability of those materials does not seem to have been factored into any commitments, including those enshrined in law.

In other words, the world is structurally short these commodities and the simple economics of supply and demand argue that this shortfall can only be corrected by incentivizing greater production via higher commodity prices.

Yet, to date, most investors have chosen to express the Energy Transition theme via public or private equity investments in this space. According to Bloomberg[1], in 2021, approx. US$50bn was invested in venture capital and private equity related to energy transition. The universe of equities starts with Commodity Producers, who produce the raw materials, but also includes Renewable Power Manufacturers, who manufacture equipment, and Renewable Power Developers, who use it to generate electricity.

In this paper we demonstrate why direct investments in the commodities can be a more effective and efficient expression of the Energy Transition investment theme. Commodity equities are precisely that: commodities and equities, sharing components of both. In addition to obvious corporate risk factors such as management, producers also have geological and political risks, may have a commodity beta of less than 1, and can also be structurally short other commodities. Furthermore, we show that all of the associated corporate entities involved are effectively short commodities in one way or another. While they may prove worthwhile investments, if an investor desires direct exposure to the commodities that must increase in price to elicit new supply (or incentivize other technologies), the only way to do so is by investing in commodity futures directly.

We believe that **commodity futures should be a core component of any energy transition portfolio.** They are the cleanest, most direct way of gaining exposure to the expected demand increase for the materials essential for the Energy Transition.

There is potential for returns that may come from the higher prices required to incentivize new production or new technologies, or the positive roll yield typically associated with commodities in tight supply.

In addition, and crucially for allocators with existing commodity equity investments which are structurally short commodities, a commodity futures allocation can also act as a diversifying hedge.

[1] Energy Transition Investment Trends 2022, Bloomberg New Energy Finance, January 2022

On the following pages we offer more details on Energy Transition commodity deficits and discuss why commodity futures exposure is more appropriate manner to invest in this opportunity than equities.

Today, the data shows a looming mismatch between the world's strengthened climate ambitions and the availability of critical minerals that are essential to realising those ambitions.
- Dr. Fatih Birol, IEA Executive Director

The Energy Transition

Countries representing **80% of global population and 91% of global GDP** have committed to "net zero" emissions targets, according to the Net Zero Tracker[2], an increase from just 16% of global GDP since 2019. National net zero targets covering two-thirds of all greenhouse gas emissions ("GHG") are now enshrined in legislation or policy documents.

In a net zero world, two-thirds of the global energy supply will need to come from renewable sources, such as wind, solar, bioenergy, geothermal and hydro energy. The share from fossil fuels will fall to only 20% from nearly 80% today.

Accomplishing this energy transition will require a massive expansion of the renewable energy sector, the scale of which cannot be understated. As just one example, if the world is to grow solar capacity 20-fold to supply 20% of world energy by 2050[3], this requires installing the equivalent of the largest existing solar park *every day* by 2030.

Figure 1: Most of the world is committed to "net zero" emissions targets[1]

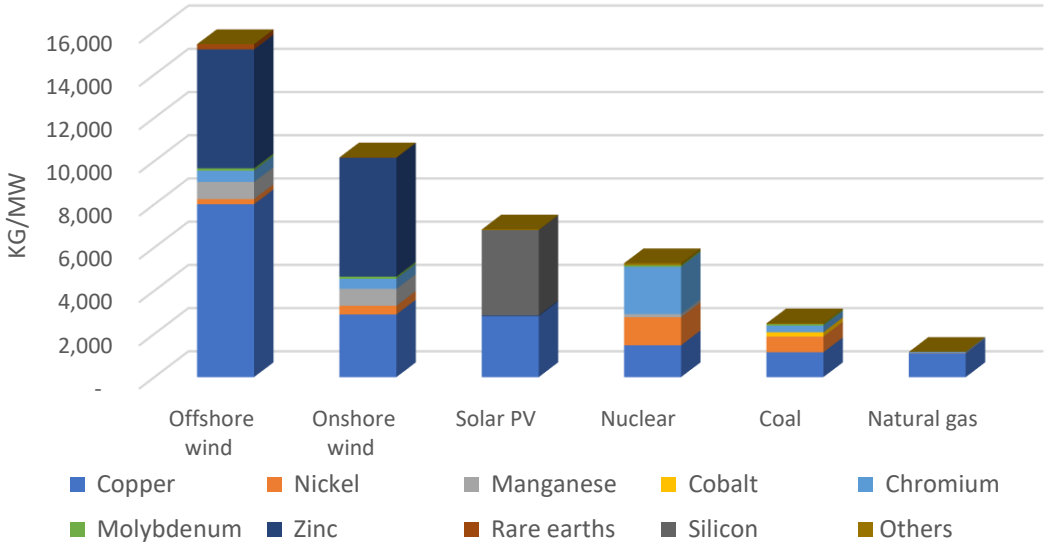
Source: Net Zero Tracker

[2] https://zerotracker.net/
[3] https://iea.blob.core.windows.net/assets/deebef5d-0c34-4539-9d0c-10b13d840027/NetZeroby2050-ARoadmapfortheGlobalEnergySector_CORR.pdf

The Role of Metals and Minerals in the Energy Transition

This new energy landscape is fundamentally different from the one we have known since the early 20th Century when electrification and the internal combustion engine became common. For example, harnessing wind and solar energy requires far more metals and minerals than fossil fuel plants; for the equivalent MW of generation capacity, offshore wind plants require approx. 8 tons of copper while natural gas needs just 1.1 tons.[4]

Figure 2: Wind and Solar require significantly more metals and minerals

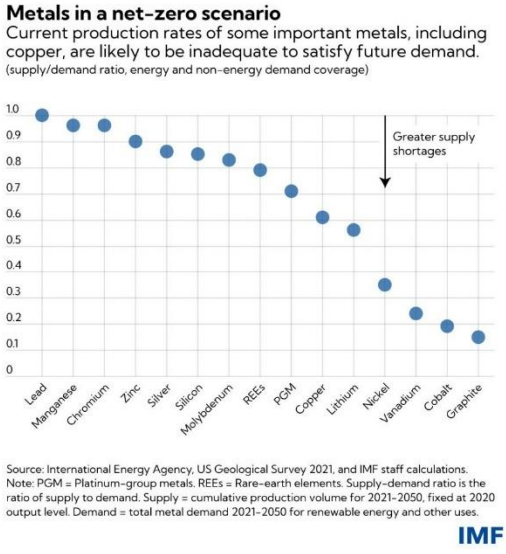


Source: IEA, The Role of Critical World Energy Outlook Special Report

When setting net zero targets, policymakers do not seem to have taken this radical difference into account. Even the World Bank noted in 2020 that "*…while the analysis estimates mineral demand from energy storage as well as geothermal, solar, wind, and conventional energy technologies, it does not take into account the global supply of minerals available to date to meet demand, nor the new mineral demand.*"[5]

That is apparent when one looks at the sheer amount of these commodities needed, not just in exotic materials such as graphite but even more common metals such as nickel or copper. According to the IMF, at current production rates, the world will have less than 40% of the nickel it will need to "fuel" this transition.

The world currently produces *nowhere near* enough of the critical commodities necessary to achieve its net zero goals



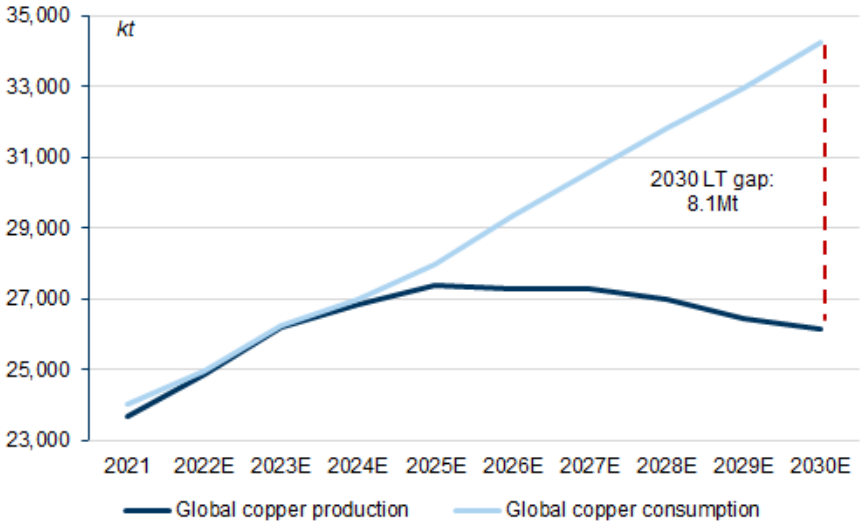
[4] https://iea.blob.core.windows.net/assets/ffd2a83b-8c30-4e9d-980a-52b6d9a86fdc/TheRoleofCriticalMineralsinCleanEnergyTransitions.pdf

[5] https://pubdocs.worldbank.org/en/961711588875536384/Minerals-for-Climate-Action-The-Mineral-Intensity-of-the-Clean-Energy-Transition.pdf

If the world is net short a large quantity of metals and minerals, we will have to dramatically increase our production thereof. That will require higher prices as the current price levels are too low even for the existing universe of projects. According to Goldman Sachs[6], "*…under current spot prices, c.60% of [copper] projects are not economically viable including sunk costs, and c.40% excluding sunk costs*".

One reason for this is cost inflation; the average incentive price for *current* production is projected to be $9k in 2022, having increased 30% in 4 years. Copper prices are therefore too low to maintain *current* production, much less incentivize the new production that is necessary to meet the projected additional demand.

Figure 3: Price implications of the supply gap



Source: Goldman Sachs Global Investment Research, "Copper Top Projects 2022: A Deficit on the Horizon", 1 September 2022

Importantly, due to lengthy investment cycles, the impact of lower prices *today* can last well into the future by delaying production in existing projects and reducing capex investment into new projects. According to Daniel Yergin[7,8]: "*The IEA says that it is 16 years on average from discovering the resource to first production. But they left out the next 15 years of litigation as it works its way through the courts in the United States.*"

Combined with an emphasis on shareholder returns, these factors result in project delays (50% of the projects analyzed by Goldman Sachs[6] have had their production start delayed vs 2018) and falling capex (projected to be 40% lower over the next 5 years vs 2010-2021).

Due to their physical nature, these problems cannot be reversed quickly and so the net result is stagnating production. For Copper, this would mean a shortfall in a vital element for the electricity infrastructure.

Not only does the world not produce enough of the commodities it will need, we do not seem to be on a path to do so

[6] Goldman Sachs Global Investment Research, "Copper Top Projects 2022: A Deficit on the Horizon", 1 September 2022
[7] Daniel Yergin is Vice Chairman of S&P Global and author of the Pulitzer Prize-winning book *The Prize*.
[8] https://www.smartermarketspod.com/winter-is-coming-episode-2-daniel-yergin/

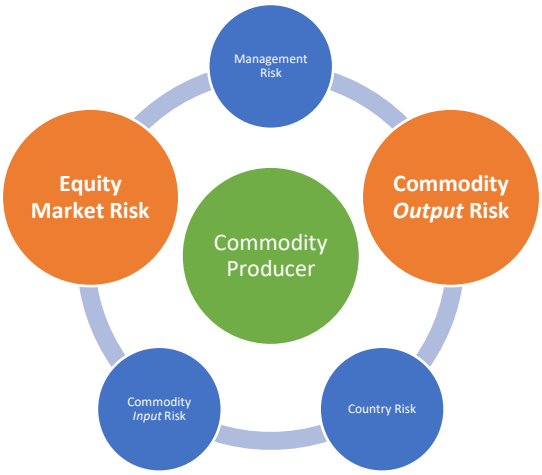
Commodity Equities

Historically, a common way for investors to express a view on commodity themes is through commodity equities rather than directly through commodity futures. In doing so, they can apply a common framework from other parts of their portfolio.

These investments are best understood by treating the two words separately: *commodity* and *equity* as they share characteristics of both, and this exposes some weaknesses in employing an equity approach to the Energy Transition.

For commodity equities generally, we can break them down into 5 component risks that can affect potential returns:

1. **Equity market risk** arises from sentiment and investment flows more broadly in equity markets
2. **Commodity output risk** due to changes in the price of the commodity being produced by the company
3. **Management risk** includes financial risk, as well as reputational or legal, relating to management
4. **Commodity input risk** if input costs rise for raw materials or labor
5. **Country risks** arise from the geographic area in which a company operates



The two largest risks are generally **Equity Market** and **Commodity Output** risk. To illustrate this, 63% of the returns of the Energy Select SPDR fund (XLE) have historically been explained by the combination of the S&P 500 and Brent Crude Oil, with roughly equal contributions from both on a volatility adjusted basis.

A regression[9] of the weekly returns of XLE over the past 10 years with an R^2 of 0.63. Note that the volatility of Brent is roughly twice that of the S&P 500.

Figure 4: Regression of XLE vs US Equities & Oil

	Coefficients	*t Stat*	*Volatility*
Intercept	(0.00)	(0.79)	
SPX Index	0.79	16.15	16.4%
CO1 Comdty	0.41	17.86	34.8%

Source: Data from Bloomberg, Calculations by Quantix Commodities.

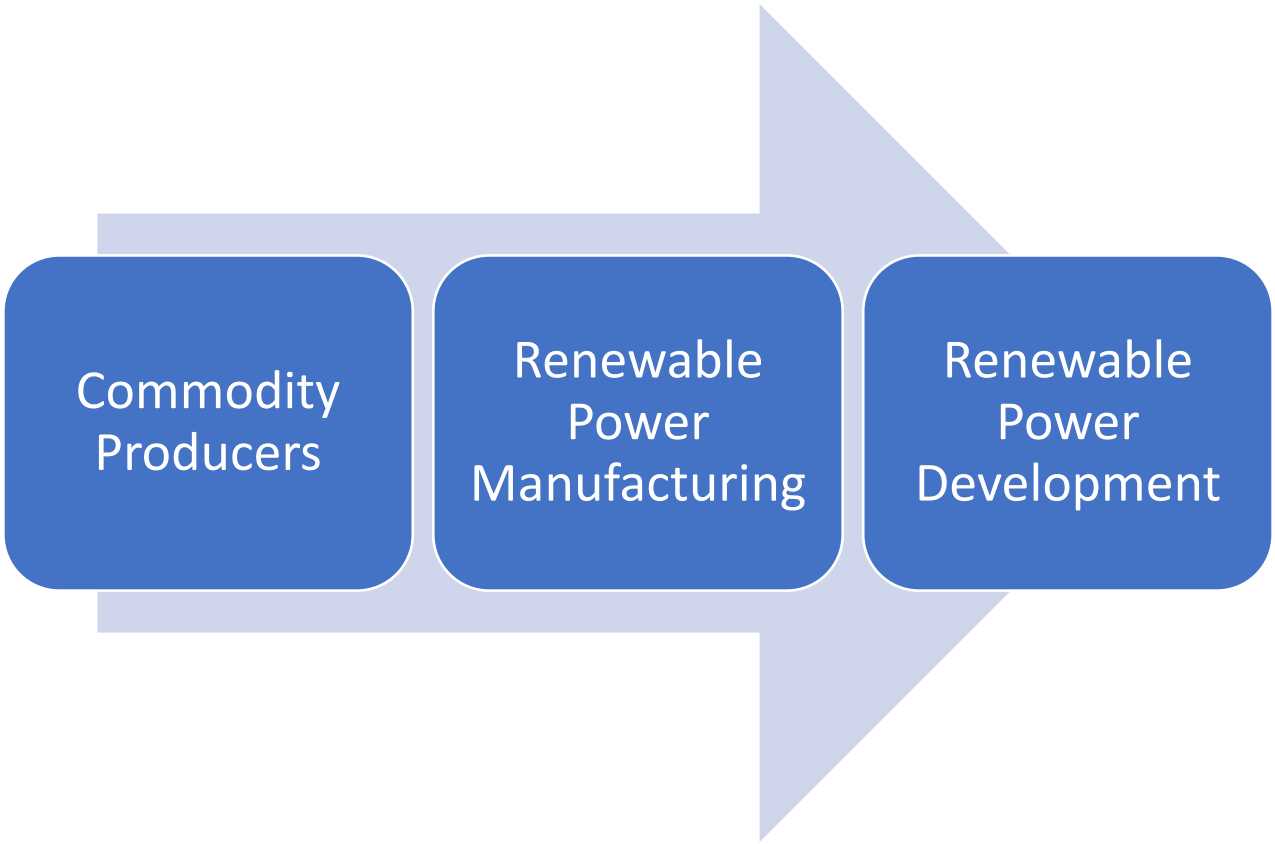
Commodity producers tend to have large equity market risks and are best thought of as a basket of equities and commodities

[9] Source: Quantix Commodities, data from Bloomberg, calculations by Quantix Commodities. Date range: Nov-12 to Nov-22. Please contact Quantix Commodities for a detailed description of the regression methodology.

The Clean Energy Ecosystem

Within this ecosystem, there are three main categories[10]:

- **Commodity Producers** produce the raw materials (eg copper) used to manufacture the infrastructure for renewable power generation (eg turbines)
    - Examples include Albemarle in Lithium or Codelco in Copper
- **Renewable Power Manufacturers** manufacture the infrastructure using the raw materials
    - Examples include Vestas in wind or First Solar in solar
- **Renewable Power Developers** use the infrastructure to generate renewable electricity
    - Examples include NextEra or Iberdrola



Below, we take a detailed look at each category.

[10] Collectively Renewable Power Manufacturing and Development represent 63% of paid in capital into "Clean Tech" via venture capital and private equity according to Cambridge Associates. The other categories are Energy Optimization (e.g. energy efficiency) and Resource Solutions (e.g. waste and recycling). https://www.cambridgeassociates.com/wp-content/uploads/2022/10/Cambridge-Associates-Clean-Tech-Company-Performance-Statistics-1Q22.pdf

Commodity Producers

This type of company has long been a common way for equity investors to invest in commodity themes. In the context of the energy transition, one would expect these companies to benefit both from the rising demand and the rising prices of the commodities they produce. Is this long-held belief true?

Freeport-McMoRan (FCX) is the third largest copper producer in the world[11] and derives more than 80% of its revenues from copper production in the US, Chile, Peru, and Indonesia[12]. To understand the effect on returns of commodity and non-commodity risks, we regress[13] weekly changes in the share price over the past 10 years against the S&P 500 (to represent general equities risks), Chilean 1 year CDS (to represent country risk) and Copper (commodity risk).

We find that a weighted combination of these factors explain 55% of weekly FCX returns (R^2 of 0.55).

Figure 4: A Regression of FCX vs US Equities, Chilean CDS and Copper

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.00	0.00	0.00	1.00
SPX Index	0.91	0.13	6.91	0.00
HG1 Commodity	1.39	0.08	16.83	0.00
Chilean 5 year CDS	(0.00)	0.00	(2.98)	0.00

Source: Data from Bloomberg, Calculations by Quantix Commodities.

What does this mean for investors? While Freeport offers leveraged exposure to copper prices (with a coefficient or beta of 1.40), it also clearly has significant equity exposure (beta of 1.02) as well as a statistically significant but small exposure to Chilean risk.

- The exposure to copper prices is obvious – the company produces copper! As is the fact that it is *leveraged* exposure: in the second quarter of 2022, Freeport produced copper at an average price of $2.35[14] and sold it for an average price of $3.50[15] for a margin of $1.15. If copper prices doubled while costs stayed the same, their margin would increase to $4.65, an increase of 300%.
- As a component of equity indices such as the S&P 500, FCX has exposure to equity markets as shares will move in line with flows in and out of those indices. Specifically, between the end of Q1 2020 and the end of Q1 2021, the SPDR S&P 500 ETF (SPY) was a net seller of FCX as it saw outflows of $7.8bn even as copper prices rose from $2.23/lb to $3.99/lb.
- FCX also has political and geographic risk associated with the location of its production, as reflected by a small Chilean CDS exposure. The recent proposal to increase taxes (imposition of a 1% ad valorem tax) and royalties (between 8% and 26%) on copper by Chile is one example of these risks.

[11] The largest is Codelco (Corporacion Nacional de Cobre) which is owned by the Chilean government and the second largest is BHP which is a diversified miner which derives roughly twice as much of its revenues from Iron Ore than from copper (which is roughly the same as from coal). This highlights a common problem – many metals producers produce a wide range of metals making it difficult to isolate specific exposures.
[12] Source: Company website
[13] Source: Quantix Commodities, data from Bloomberg, calculations by Quantix Commodities. Date range: Nov-12 to Nov-22. Please contact Quantix Commodities for a detailed description of the regression methodology.
[14] "Site Production & Delivery Costs" as defined by Freeport McMoRan. Excludes by-product credits, treatment charges, royalties & export duties
[15] "Average Realization (per lb)" as defined by Freeport McMoRan

Commodity specific risks generally fall into two categories: inputs and outputs.

Inputs are the price of other commodities that are consumed in the production process, most commonly energy.

In the FCX example, their production costs were up in the third quarter of 2022 to $2.35/lb from $1.88 (in 2021) and $1.77 (in 2020) respectively. In other words, over the past two years *costs have increased by more than revenues*. While this can happen for a variety of reasons, in the case of FCX this has to do with fuel costs. According to the company, FCX consumes 220 million gallons of diesel in their copper production and diesel prices have risen far more than copper – nearly doubling from Q3 2020 to Q3 2022. **In other words, commodity producers are long some commodities and short other commodities.**

Outputs are the price received by the company for the commodities that it produces. In many cases these prices are related to the underlying spot price but may not be depending on the company's sales agreements.

In the FCX example, copper revenues were $3.50/lb in the third quarter of 2022, down from $4.20/lb in the third quarter of 2021 but up from $3.01/lb in the third quarter of 2020. These prices are fairly close to the COMEX averages of $3.49, $4.30, and $2.94 respectively.

However, Copper is a large and mature market even if demand is growing dramatically. Lithium, on the other hand, is currently a much smaller market with illiquid futures contracts. This means that longer term contracts are often negotiated between producers and consumers at a mix of fixed and floating prices and therefore changes in the spot price may not pass through to revenues for some time. What does this mean for Output risk?

Albemarle Corporation (ALB) is the largest lithium producer in the world with resources, production and conversion facilities in 11 countries. Their contract prices vary: only 15% are priced at the time of purchase, nearly 65% are being indexed to longer term averages (some with floors and ceilings) and the balance are a long-term fixed price[16]. In the third quarter of 2022, prices received rose an impressive 298% over the third quarter of 2021[17]. However, Lithium Hydroxide prices *rose 380%* over the period, meaning that ALB has a lithium beta of only ~0.8.

The impact on the type of investor returns is profound: ALB's share price has a (statistically insignificant) *negative* beta to lithium prices with a (statistically significant) *positive* one to the Russell 1000. It also has a strong positive correlation (66%) to its main competitor, Sociedad Quimica y Minera de Chile SA (SQM).

It is important to note that this mix of fixed and floating prices is a function of the liquidity in the underlying market and therefore applies whether a given producer is a public or a private equity. Indeed, smaller projects, whether public or private (or greenfields), will likely have a higher percentage of fixed price contracts due to the need to secure bank financing.

Commodity producers have different betas to the commodities they produce, varying related to how they sell those commodities

[16] https://s201.q4cdn.com/960975307/files/doc_presentations/2022/10/2022_10-(Oct)-Investor-Presentation-ALB_Web.pdf
[17] https://s201.q4cdn.com/960975307/files/doc_financials/2022/q3/Q32022_ALB_Earnings_Presentation_FINAL_Web.pdf

Renewable Power Manufacturers

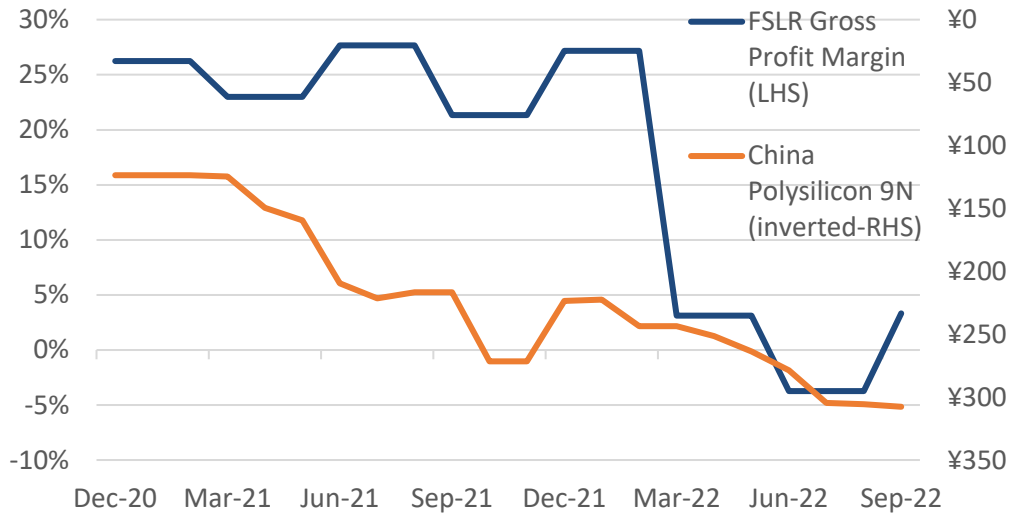
This type of company, such as those manufacturing wind turbines or solar panels, is another common way that equity investors invest in the energy transition. In this context, one would expect increasing demand for their products to result in increased prices for them and thus increased revenues. Although these companies operate in a relatively new sector, they are economically like any other manufacturer – they consume raw materials which they turn into manufactured products. As such they are effectively *short* the raw materials that they use to produce their end product.

First Solar (FSLR) is the third largest company within the solar industry and the only company within the 10 largest solar manufacturers to be headquartered in the United States with no manufacturing in China[18].

As the solar industry has grown, FSLR has seen explosive growth: solar module production has more than quadrupled since the end of 2017, from 530MW in Q3 2017 to 2,380 MW in Q3 2022. Quarterly gross revenues have similarly grown, from $339m to $629m.

However, after peaking at $334m in Q4 2019, gross profit has fallen to $21m in Q3 2022[19]. The reason for this is that polysilicon prices have risen dramatically and as FSLR is **short** polysilicon, its revenues have suffered despite likely improvements in productivity.

Figure 5: First Solar Gross Profit Margin has fallen, in part due to rising polysilicon prices



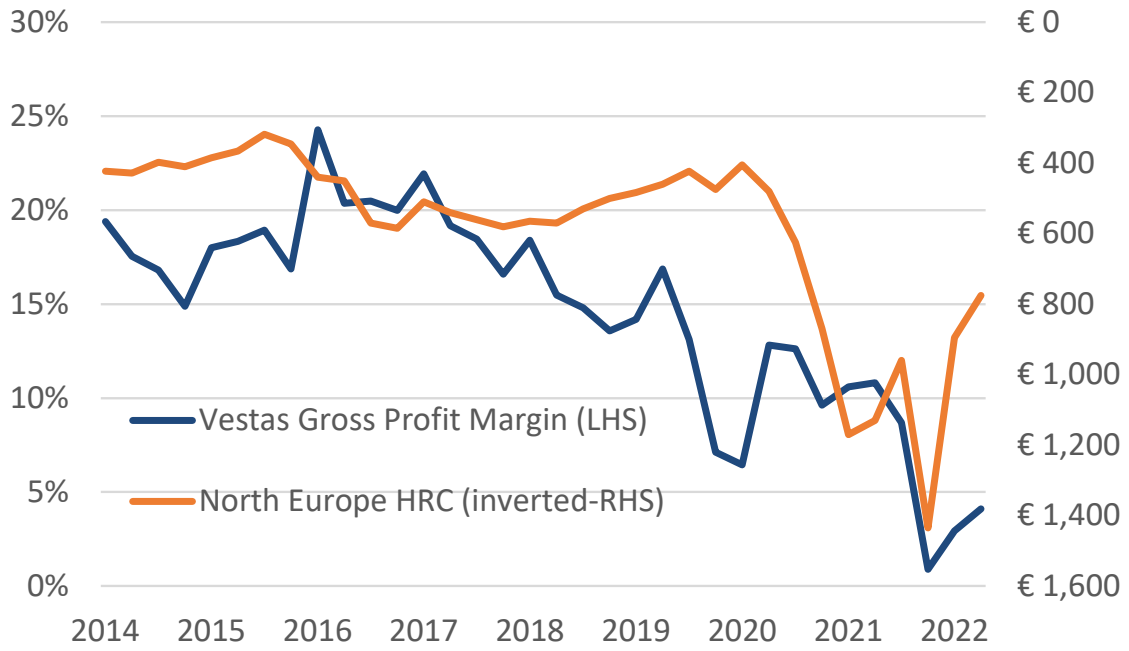
Source: Bloomberg. FSLR Quarterly Basic EPS, GAAP, Q4 2020 to Q3 2022

[18] https://www.firstsolar.com/en/About-Us/Overview

[19] Source: Bloomberg

A similar effect can be seen in the returns of Vestas Wind Systems A/S, the largest manufacturer of wind turbines in the world. Despite growing turbine production (and order backlog) by almost over 150% since the end of Q4 2012, Vestas' profit margin has fallen sharply over the past few years, at least partially due to rising steel prices.

Figure 6: Vestas Gross Profit Margin has fallen, in part due to rising steel prices



Source: Bloomberg. Vestas Quarterly Basic EPS, GAAP, Q2 2013 to Q3 2022

As the IEA put it:

"*Since the beginning of 2020 the price of PV-grade polysilicon has more than quadrupled, steel has increased by 50%, copper by 60% and aluminium by 80%...the reversal of the long-term trend of decreasing costs is already visible in the prices of wind turbines and PV modules, which have increased by 10-25% depending on country and region, erasing two to three years of cost reductions since 2018 from technology improvements*."[20]

Indeed this may be one of the reasons why, according to Cambridge Associates[21], **private equity investments in Renewable Power Manufacturing had an IRR of *negative* 5.9% from 2000 to 2020**.

Both Commodity Producers and Renewable Power Manufacturers are *short* the commodities they consume to produce their output

[20] https://www.iea.org/articles/what-is-the-impact-of-increasing-commodity-and-energy-prices-on-solar-pv-wind-and-biofuels

[21] Clean Tech Company Performance Statistics – Cambridge Associates March 31, 2022

Renewable Power Developers

This type of company, typically in the public markets, is another way investors can get exposure to the energy transition. These companies generate energy using the renewable energy products (e.g. solar panels) of the Renewable Power Manufacturers. They are directly short the output of those manufacturers and thus *indirectly* short the commodity inputs into those outputs.

Like other utilities, these companies are typically partially insulated against overall inflation as their offtake agreements are usually indexed. However, they are exposed to the extent that the cost of their inputs (e.g. solar panels, wind turbines) increases faster than overall inflation.

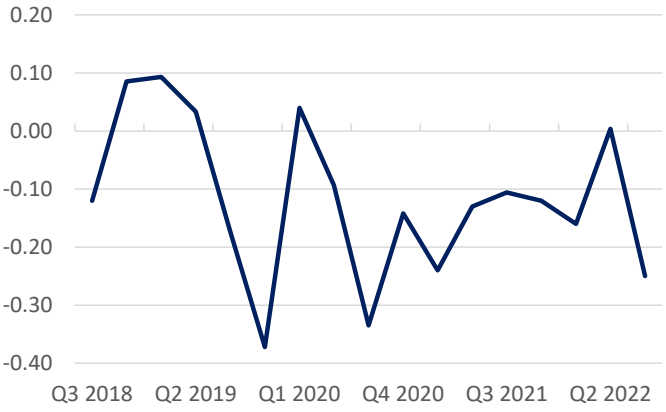
Most public companies which produce clean energy do so as part of a larger portfolio, so it is difficult to analyze specific risk factors. For example, NextEra Energy (NEE) is one of the largest clean energy producers in the world but only 4% of its energy is generated by solar production. This is marginally higher than the 3% produced by burning coal but significantly smaller than the two-thirds generated through burning natural gas.

That said, some broader observations can be made:

- According to Cambridge Associates, the IRR of **Renewable Power Developer** projects was 12.6% (gross of fees) from 2005 to 2020[22] (no data was available for the 2000-2004 period). Despite explosive growth in new energy generation over the period, this represents an outperformance of only 3.2% p.a. (gross of fees) compared to the Russell 2000 Utilities Value Index[23] over the period.
- **Brookfield Renewable Partners** (BEP) operates "one of the world's largest publicly traded, pure-play renewable power platforms"[24] with over 23,600 MW of operating and 102,000 MW of development capacity[25].
    - Over the past 10 years, BEP has outperformed the S&P 500 Utilities index by ~6.3% p.a. but mostly due to its higher volatility; on a risk adjusted basis it is essentially in line.
    - Over the past 5 years, B*EP has grown clean energy operating capacity almost 50% from 16,400 MW*, and yet it has remained unprofitable, largely due to interest expenses.

Renewable Power Developers are utilities and, like other utilities, offer regulated cashflows but, unlike other utilities, often have higher volatility

Figure 7: BEP remains unprofitable (Qly EPS)



Source: Bloomberg. BEP-U Quarterly Basic EPS, GAAP, Q! 2018 to Q3 2022

[22] https://www.cambridgeassociates.com/wp-content/uploads/2022/10/Cambridge-Associates-Clean-Tech-Company-Performance-Statistics-1Q22.pdf

[23] Russell 2000 chosen to reflect relative liquidity. Outperformance vs. the S&P 500 was 3.2% over the period.

[24] https://bep.brookfield.com/

[25] https://bep.brookfield.com/sites/bep-brookfield-ir/files/2022-11/bep-q3-2022-interim-report-v1.pdf

Summary

The universe of equities which provide exposure to the new energy transition starts with **Commodity Producers,** who produce the raw materials used by **Renewable Power Manufacturers,** who manufacture equipment sold to **Renewable Power Developers,** who use it to generate electricity.

Although **Commodity Producers** will most directly benefit from rising demand for their output, they have all of the risks associated with any other equity and are also short other commodities that they use in production. In addition, and particularly for smaller and illiquid commodities, they may have a beta of less than 1 to their output because of fixed price (or capped) sales contracts.

Renewable Power Manufacturers are, like any other manufacturer, exposed to rising costs for their inputs which they may or may not be able to pass on to consumers, in this case **Renewable Power Developers**. The latter, like the former, are effectively short the commodity inputs used to manufacture the renewable energy equipment.

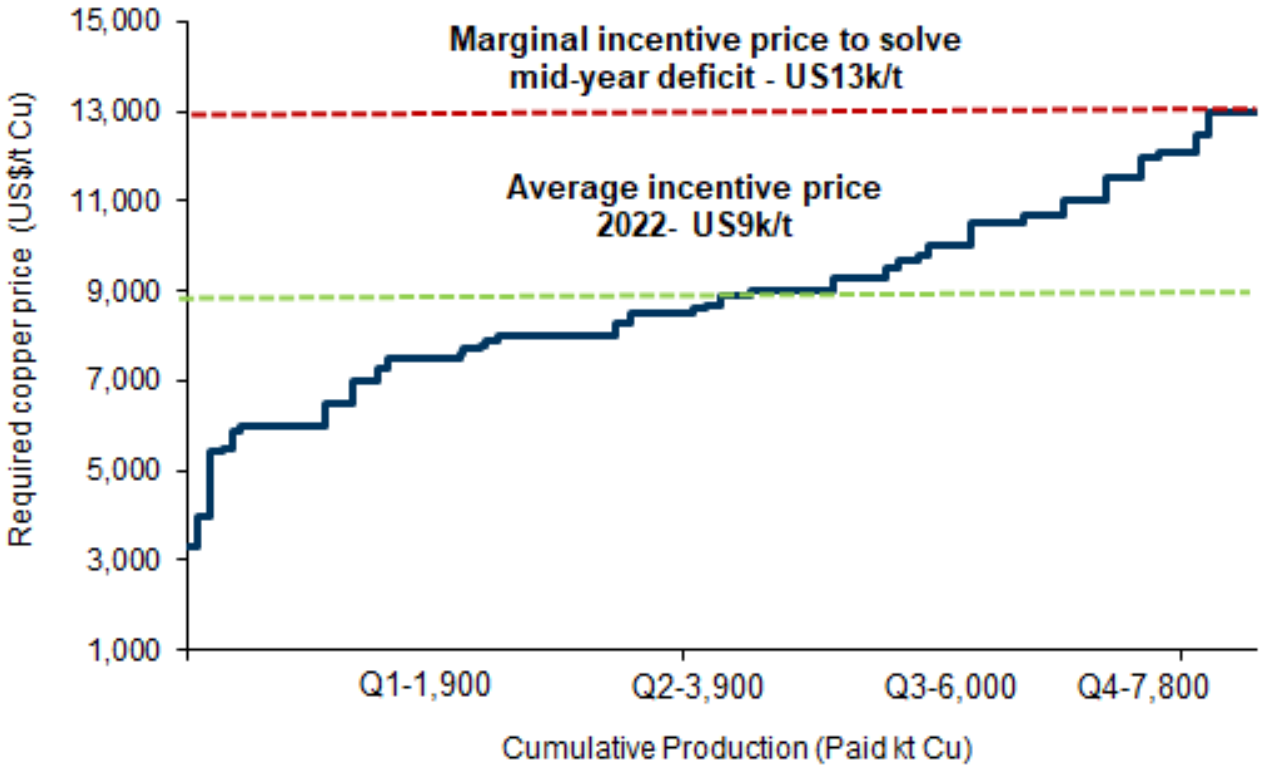
In other words, *all* of these companies are effectively *short* commodities in one way or another. While they may prove worthwhile investments, if an investor wants direct exposure to the commodities that *must* increase in price to elicit new supply (or incentivize other technologies), the only way to do so is by investing in commodity futures directly.

Commodity Futures

As we have seen, the world simply doesn't have enough supply of the commodities we will need to build the new energy economy. Ultimately rising commodity prices will be the only way that either new supply or new technologies will become available.

In the case of copper, according to Goldman Sachs[26], the only way for production to rise sufficiently to meet demand by 2030 is by the copper price increasing from its current ~$8,000 to ~$13,000:

Figure 8: The Copper price needs to increase to enable production to meet demand



Source: Goldman Sachs Global Investment Research, "Copper Top Projects 2022: A Deficit on the Horizon", 1 September 2022

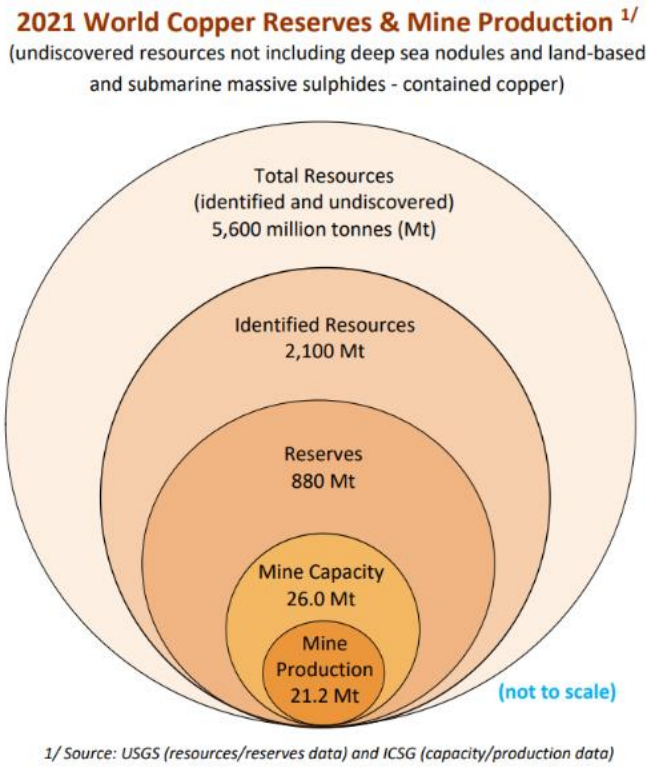
Commodity futures are the most direct way to invest in the energy transition. While the end state is uncertain, some commodities (such as copper) will be necessary irrespective of which technology wins out. Demand for certain commodities (such as the platinum group metals) does depend more on the end state but investing in companies is inherently a bet on which the underlying technologies wins out.

[26] Goldman Sachs Global Investment Research, "Copper Top Projects 2022: A Deficit on the Horizon", 1 September 2022

A key point is that commodity futures also *immediately* benefit from a changing supply and demand balance while companies such as commodity producers can take 10-15 years to respond with new production, especially in metals. This can be best understood by Figure [1] from The World Copper Factbook produced by the International Copper Study Group[27], demonstrating that mine production is only a fraction of copper total resources.

Although the world has proven reserves of 880 million tons of copper it can only produce 26 million tons per year. Due to physical constraints, a demand surge cannot practically be met in the immediate term and therefore must be met by above ground supplies i.e. inventories. This will result in backwardation and a positive carry (more below in the Effect of Carry).

Figure [1]: Copper mine production is significantly smaller than total resources



Source: International Copper Study Group, "World Copper Factbook"

Given this benefit of direct exposure, as well as acting as a "hedge" for some equity-based investments, why have investors so far chosen to allocate to public or private equities instead of commodity futures?

There are generally four categories:

1. **The Effect of Carry in Futures:** most commodities have historically spent most of their time in *contango,* with deferred prices higher than spot prices reflecting dynamics such as the cost of storage (/*backwardation* is where spot prices are higher than deferred, typically when demand is greater than supply). If spot prices remain unchanged this becomes a negative drag (/positive addition) to investor returns.
2. **Leverage:** Commodity Producers are viewed as providing leveraged exposure to the commodity they produce.
3. **Generic "old economy" investment options:** the vast majority of commodity futures investment is into one of two indices, the S&P Goldman Sachs Commodity Index (SPGSCI) or the Bloomberg Commodity Index (BCOM). These indices are largely made up of either traditional energy commodities (e.g. petroleum and petroleum products) or commodities which are irrelevant to the energy transition (e.g. livestock). They also do not include commodities core to the energy transition such as Cobalt or Lithium.
4. **Technological risk:** the concern that, as technology evolves, manufacturing will become more commodity efficient and reduce the amount of commodities needed.

Below we look at each of these in turn.

[27] https://icsg.org/

While **the Effect of Carry** in commodity futures indices has historically been a drag on investor returns, this has varied significantly by both sector and individual commodity reflecting, amongst other things, storage costs and supply & demand balances. For example, the SPGSCI Energy index has had a negative carry of -4.8% annually since 1989 while the SPGSCI Agriculture index has had a negative carry of over -6.0% p.a. In contrast, the SPGSCI Industrial Metals index had a negative carry of only -1.3% while the copper component had a *positive* carry of +1.4%.

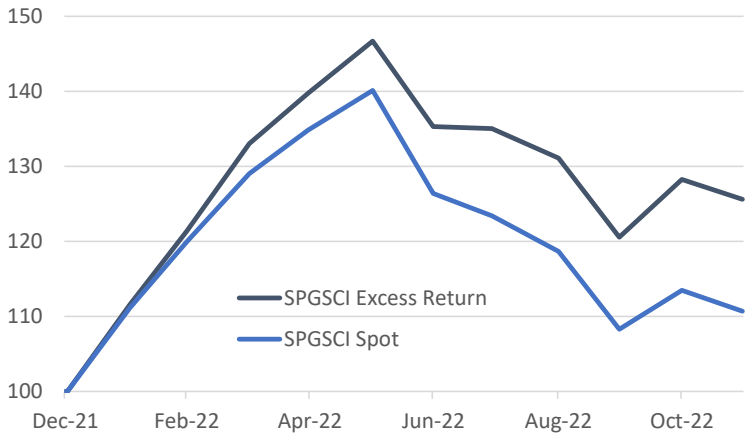
A critical element that most investors are unaware of is that these are *uncollateralized* returns (i.e. returns over cash). On a collateralized, total return basis (assuming 3 month Treasury Bill yields), the SPGSCI Industrial Metals index has had a *positive* carry of +1.3%. If the overall level of interest rates in the medium term are higher than since the GFC, this will provide a tailwind to investor's total returns.

There are good reasons to expect *indices may have a more positive carry going forward*. Tighter supply / demand dynamics may mean that buyers bid up spot prices due to concerns about supply. In the literature this is referred to as the "convenience yield."

This effect can overwhelm storage costs, resulting in backwardation which, in turn, may result in a positive carry for investors. This has been the case in the S&P GSCI in 2022 which has generated significantly greater returns. Excess Returns have outperformed Spot prices by 14.9% year-to-date through 30-Nov-22, as can be seen in Figure 9.

As discussed above, there is an acute shortage of certain commodities relative to the demands of the energy transition which should encourage a more positive carry going forward.

Figure 9: S&P GSCI Excess Returns outperformed spot prices



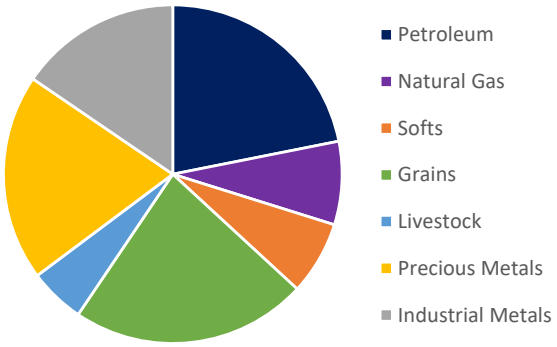
Source: Bloomberg. Date range: Dec-21 to Nov-22

Equity investors typically view Commodity Producers as offering **leveraged exposure** to the commodity they produce. In general, this makes sense; if it costs more than $0 to produce a commodity then a given increase in the price sold should have a larger impact on revenues. As we have seen above in the case of Lithium, in some less liquid commodities this may not be the case.

However, a direct commodity futures exposure is, by definition, a capital efficient investment. If investors are investing directly or using a managed account to gain access, *exchange margins typically allowing for exposure up to 10x the initial margin*, significantly greater than the levered exposure offered through most commodity producer equities.

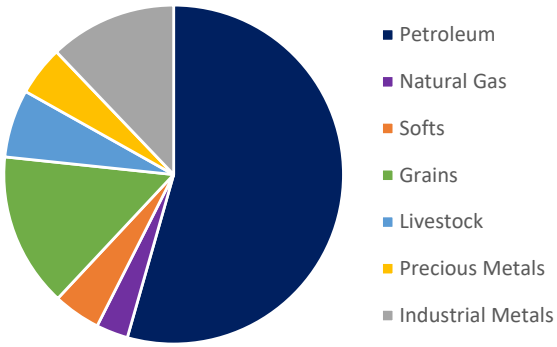
The vast majority of commodity investment tracks one of the **generic "old economy" benchmarks,** either the S&P GSCI or BCOM. These majority of the weight of these indices consist of commodities which have nothing to do with the energy transition as can be seen below:

Figure 10: BCOM Sector Weights



Source: Bloomberg. As of Jun-22.

Figure 11: S&P GSCI Sector Weights



Source: S&P Indices. As of Jun-22

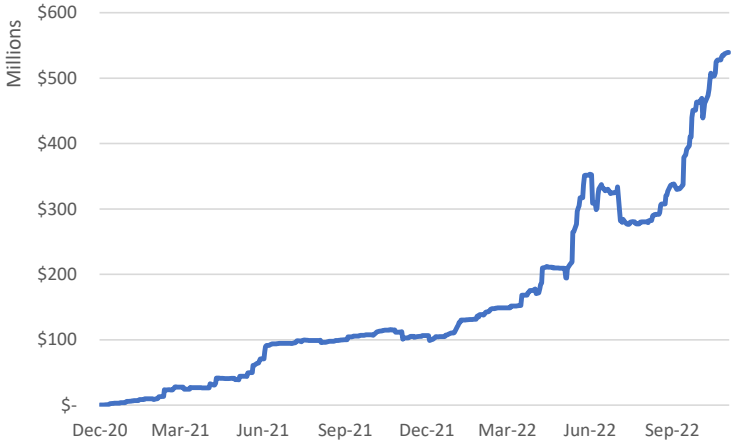
This is akin to only having the S&P 500 or Russell 2000 as options to invest in US equities. While they are both in the right asset class, if an investor is trying to get exposure to technology stocks, neither will be as appropriate as investing in the Nasdaq 100.

There is no reason why this needs to be the case as commodity futures investments can be tailored to meet a specific investment objective in *commodities* the same way they can be in equities.

One of the challenges with the traditional indices for investors in the energy transition is not just the *inclusion* of commodities irrelevant to the energy transition but also the *exclusion*, mostly for liquidity reasons, of commodities which are crucial to the energy transition. These commodities include Cobalt and Lithium, non-traditional commodities which will be part of the "bridge" to a net zero world such as carbon credits, and non-US commodity futures such as European natural gas.

This challenge can be met via skilled managers who may be able to manage these liquidity risks. For example, there are developing futures markets in a number of these commodities such as Cobalt.

Figure 12: COMEX Cobalt Open Interest



Source: Bloomberg. Date range: Dec-20 to Nov-22

Whether included in traditional commodity indices or not, these markets clearly are growing and can be accessed. Indeed these markets **need** to grow, as producers and consumers ultimately need liquid markets in which to hedge. On balance this is more relevant to producers as commercials (including producers and consumers) are, on average, net short in most commodities over time. Producers of commodities are generally large corporations while consumers are ultimately individuals who don't hedge.

Traditionally speculators / investors take the other side of this net producer selling and are paid a risk premium to do so (the Theory of Normal Backwardation), as Keynes argued in A Treatise on Money. Indeed subsequent research has suggested that commodity futures contracts can only survive if speculators / investors earn a positive return: "we find that the spread between the premiums becomes larger: 5.0% for surviving versus 1.6% for the non-surviving commodities.[28]

Finally, the **Technological Risk** that, if there isn't enough "stuff", the world will develop new technologies to reduce the amount of commodities required or find commodity alternatives (as China did with nickel pig iron[29]). While this is a risk, it is one that will take time to work out and will only be incentivized by higher prices.

For example, despite Coal's share in US power generation in 2021 being less than half of what it was in 1950[30], 2021 coal consumption for electricity generation in the US was almost five and a half times what it was in 1950. In other words, any technological change will take time and may well result in continued commodity demand growth.

Conclusion

Countries representing over 90% of the world's GDP have committed themselves to a historic energy transition, moving from fossil fuels to renewable sources of energy. While the end state remains uncertain, this transition requires a *massive* amount of commodities, far beyond current production for almost everything. The only way that this can be resolved is via higher prices.

Investors have a variety of ways to invest in this transition, with many choosing to do so through public or private equity investing. However, the returns of any commodity equity investment are dependent on a number of factors which are not related to the returns of the underlying commodity. Indeed, many such investments may either be short certain other commodities (such as energy) or even the specific commodity that an investor is trying to get exposure to (as is the case with Renewable Power Manufacturers)!

We believe that the cleanest and most direct way of gaining exposure to the expected demand is by investing in commodity futures, serving either as a stand-alone investment or as a "hedge" for existing equity investments against rising commodity prices. As new and fit-for-purpose commodity indices and solutions are developed, the historical reasons why investors have chosen equities over commodity futures become less relevant. In some cases, such as the effect of carry, there is good reason to believe that the historical headwinds to investor returns may become future tailwinds.

It is clear to us that commodity futures have a core role to play in a diversified energy transition portfolio.

[28] https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3452255
[29] https://www.reuters.com/article/none-q1186-idAFSGE6AG05L20101117
[30] https://www.eia.gov/energyexplained/electricity/electricity-in-the-us.php

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