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**Fossil fuel divestment:
a \$5 trillion challenge**

Oil & gas and coal companies form one of the world’s largest asset classes, worth nearly \$5trn at current stock market values. In the past two years, dozens of public and private institutions have announced plans to divest fossil fuels from their portfolios – a movement one executive described as “one of the fastest-moving debates I think I’ve seen in my 30 years in markets”.

Fossil fuels are investor favourites for a reason. Few sectors offer the scale, liquidity, growth, and yield of these century-old businesses vital to today’s economy. This White Paper explores the motivations behind fossil fuel divestment, the scale of existing fossil fuel investments, and potential alternatives for investment re-allocated from oil, gas, and coal stocks.

- **“Fossil fuel divestment” is a concept that can reflect various societal or practical considerations.** Environmental concerns, moral and ethical stances, concerns about asset stranding, and portfolio diversification are all potential rationales.
- **Fossil fuel investment meets numerous institutional investor imperatives.** Fossil fuels offer four attributes (overall scale, liquidity, value growth, and dividend yield), a more complete investment package than that provided by most other sectors.
- **Fossil fuels are an enormous asset class.** The current value of the 1,469 listed oil and gas firms is \$4.65trn; 275 coal firms are worth \$233bn. ExxonMobil, the largest oil and gas firm, has a market cap of \$425bn.
- **The world’s largest investors – and many governments – are the key shareholders in fossil fuel companies.** BlackRock, the largest investor in oil and gas equities, controls \$140bn via just its largest 25 holdings. Governments of many countries, including China, Russia, and India, are strategic investors in public companies as well.
- **Divesting from fossil fuels does not equate to investing in renewables.** Clean energy will attract \$5.5trn in investment between now and 2030, according to Bloomberg New Energy Finance, but not every dollar will be suitable for every institution. Projects, public equities, YieldCos and green bonds offer stability, growth, and yield, but not all in one package.
- **Other major sectors offer some of the attributes of oil and gas companies, but not all of them.** Information technology is significantly larger than oil & gas as a sector – \$7trn – but pays low dividends as a proportion of post-tax profits. Real estate investment trusts are only \$1.4trn in total market cap, but currently have average dividend yields of more than 4%.
- **Significant divestment from coal would be much easier than significant divestment from oil and gas.** Listed coal companies are small enough in aggregate that investors could divest and re-invest without unbalancing portfolios. Oil and gas companies are too large, and too widely held, for divestment to be easy or fast.
- **A robust architecture for fossil fuel divestment will require alternative investment structures or asset classes, not just “alternative energy”.** In order to attract trillions of re-invested institutional dollars, clean energy will need a vast expansion of its YieldCo and green bond structures, or indeed, new, as-yet-unbuilt instruments.

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A FTSE managing director describes divestment as “one of the fastest-moving debates I think I’ve seen in my 30 years in markets”

The Go Fossil Free movement states that “Fossil fuel investments are a risk for both investors and the planet”

1. BACKGROUND AND PURPOSE OF THIS WHITE PAPER

“Fossil fuel divestment” covers a range of approaches to companies either exclusively active in hydrocarbons (such as oil, gas, and coal firms) or with high ‘carbon reserves’ in their portfolios (such as miners). It calls on investors to remove stocks, bonds, and other instruments from their portfolios – with an obvious need to reinvest elsewhere. The movement is young, rapid, and fast-evolving. Kevin Bourne, a managing director of London-based stock market indices provider FTSE, [described divestment](#) as “one of the fastest-moving debates I think I’ve seen in my 30 years in markets.”

[Fossil Free](#), a project of the non-profit organization 350.org led by the author and activist Bill McKibben, is the movement’s most vocal presence. Divestment has analogues in earlier endowment campaigns to divest from Apartheid South Africa, tobacco advertising, and regions affected by violence. What distinguishes it from those earlier campaigns is its rapid growth and quick scaling.

McKibben’s activism and the organisation have spawned numerous groups targeting specific investment portfolios, particularly university endowments. At first, divested portfolios were quite small (one university committing to divest had an endowment of \$960,000 at the time). The movement has momentum however, with Stanford University recently announcing that it will divest coal stocks from its \$18.7bn endowment, and the World Council of Churches ring-fencing fossil fuels from its portfolio guidance. At the moment, however, divestment calls are not enough to move a needle calibrated in the trillions of dollars. But if divestment were to achieve trillion-dollar scale, what would it look like?

This paper is a thought experiment on that question. It addresses potential re-investment strategies for ex-fossil fuel dollars. It analyses clean energy as an asset class and destination for capital. It also examines other multi-trillion dollar sectors as potential destinations for reinvestment.

2. INSTRUMENTS ADDRESSING DIVESTMENT

Fossil Free says “Fossil fuel investments are a risk for both investors and the planet.” Investors have begun to examine fossil fuels as an investment risk, in various forms ranging from quantification of risk factors to ring-fencing fossil fuel investment from equity portfolios. These risks take two primary forms: asset stranding and underperformance against benchmarks. Addressing them requires quantifying the value of assets at risk of stranding, and creating investment vehicles ringfencing fossil fuels from broader portfolios.

2.1. Stranded assets

“Stranded asset” analysis seeks to quantify the risk of write-downs to asset portfolios due to changing values or investment paradigms. A number of institutions quantify stranded assets:

- [Carbon Disclosure Project](#) and its reporting on company greenhouse gas emissions and “strategies for managing climate change, water and deforestation risks”
- [Carbon Tracker Initiative](#) and its “Unburnable Carbon” tracking of the ‘carbon reserves’ on corporate balance sheets
- The [Stranded Assets Programme](#) of the Smith School of Enterprise and the Environment at Oxford

2.2. Ring-fencing and indexing

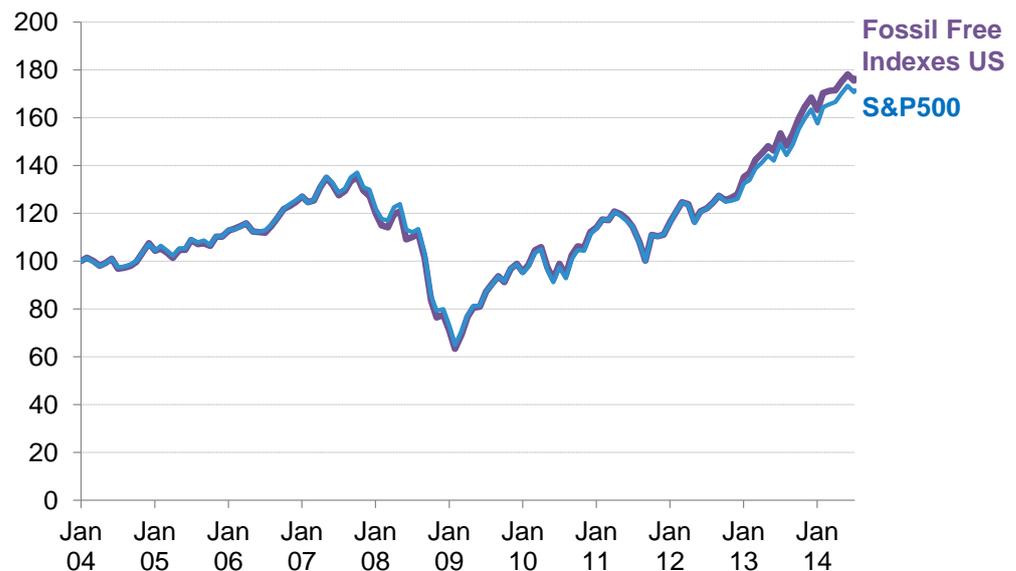
“Ring-fencing” involves excluding fossil fuels from equity portfolios that are otherwise diversified, allowing investors to select against fossil fuels as a discrete risk distinct from others.

- [Fossil Free Indexes](#) benchmark index screening the S&P500 of the top 200 oil, gas, and coal companies by carbon reserves
- [FTSE Developed Ex Fossil Fuels Index Series](#) representing the performance of the FTSE Developed Index after excluding companies with certain revenue exposure to fossil fuels, or high carbon reserves

FTSE’s index has attracted the attention of BlackRock, the world’s largest fund manager with \$4.6trn under management as of July 2014. BlackRock “intends to launch a solution that tracks FTSE’s new benchmark” according to FTSE’s April press release.

Initial analysis of ring-fencing and indexing shows that ex-fossil fuel portfolios have performed on par with those including oil, gas, and coal producers and those companies with high carbon reserves (Figure 1).

Figure 1: Fossil Free Indexes US Index and S&P500, 2004 – July 2014



Source: Fossil Free Indexes, Bloomberg

Note: rebased to 100 on 2 January 2004

3. FOSSIL FUELS AND INVESTOR IMPERATIVES

In analysing fossil fuel divestment as a potentially meaningful movement for institutional investors, it is important first to analyse fossil fuel *investment* and what it offers in a portfolio.

Different individuals and institutions will view fossil fuel companies in different ways. A geologist may view them as a series of reserve-to-production ratios; a petroleum engineer, as an aggregation of property, plant, and equipment; a portfolio manager, as a component of a diversified equity portfolio; a grandmother, as a source of dividends for her descendants; a college student, as a basket of noxious gases and environmental liabilities.

For an institutional investor, a fossil fuel firm is all of these things to some degree, and at the same time none of them. An oil, gas, or coal producer is ultimately financial data: supply and demand; cost and price; margins and reserves; price-to-equity and cash flow. And, it is ultimately data in the service of investors who allocate capital in multi-billion dollar chunks. For those investors, fossil fuels satisfy four imperatives:

1. **Scale** a very large pool of total investable assets and securities
2. **Liquidity** an asset pool which investors can enter and exit at will
3. **Growth** the opportunity for a consistent increase in value over time
4. **Yield** a source of stable, predictable cash flows in the form of dividends

The subsections below analyse oil & gas and coal firms through these four imperatives.

3.1. Scale

Fossil fuel firms are a very large asset pool: \$4.9trn in nearly 1,500 listed oil and gas companies, and a further \$230bn in 275 coal companies. In addition to their public equity, these firms have issued hundreds of billions of dollars of debt¹.

This massive scale is no surprise given that oil and gas firms are among the world's largest companies by equity value (Figure 2). ExxonMobil is the second-largest corporation in the world, after Apple, and nine of the 10 largest oil and gas firms are worth more than \$100bn each. Coal companies are significantly smaller, however, and the largest quoted coal company would barely break into the ranks of the top 20 oil and gas firms.

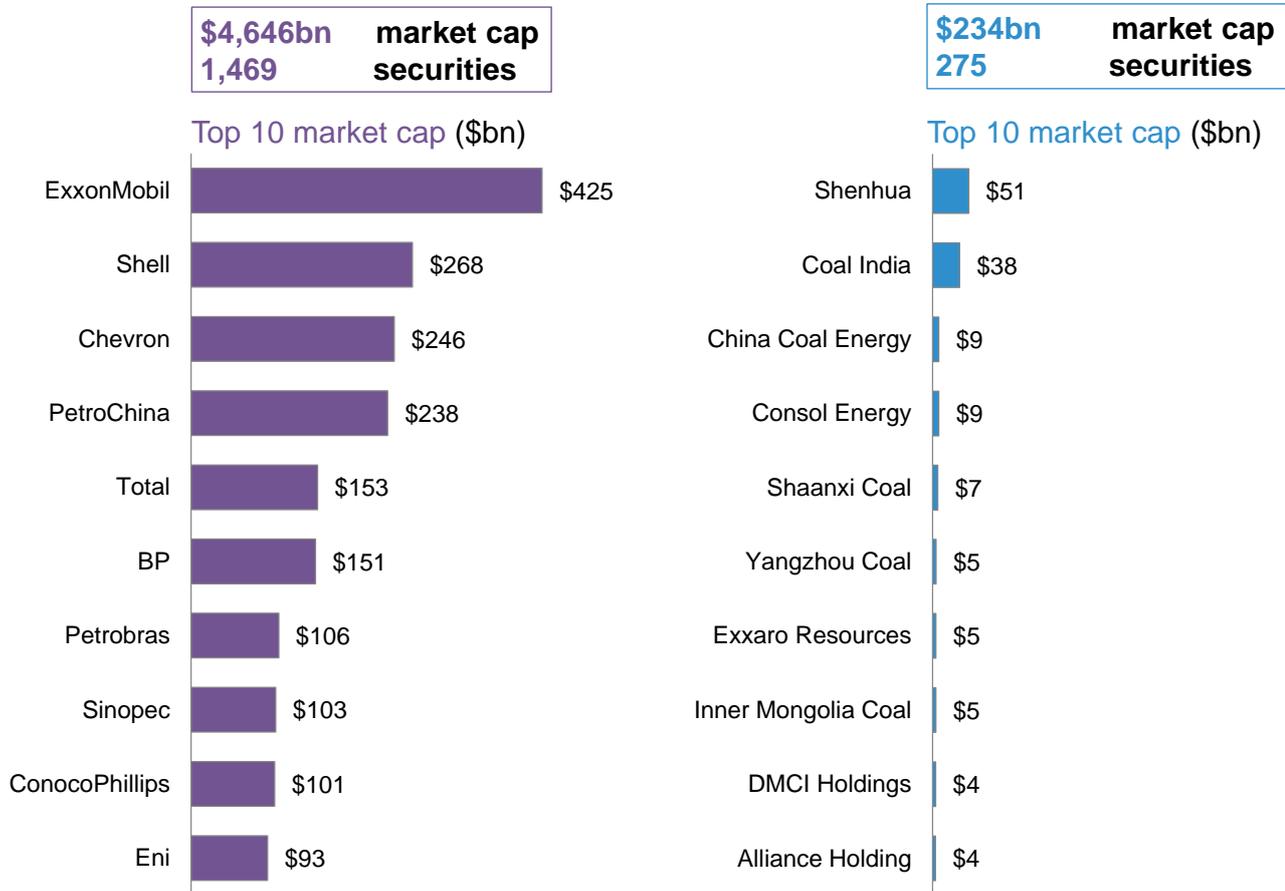
While oil and gas firms are certainly global, the publicly-listed companies skew heavily towards US and European stock exchanges. While China's oil giants PetroChina, Sinopec, and China National Offshore Oil Corporation (CNOOC) are listed, many of the world's largest state-owned firms, such as Saudi Aramco and Petroliaam Nasional Berhad (Petronas), are not listed.

Coal firms are also global but have relatively little diversity for their scale. With some exceptions, national boundaries define a company's resource base and its economic exposure. Coal companies have much smaller scale than oil and gas; within that smaller scale, there is also less intra-company diversity.

The largest coal firm by market cap would barely break into the ranks of the top 20 oil and gas firms

¹ This analysis concerns equities only, the main focus of fossil fuel divestment movements today.

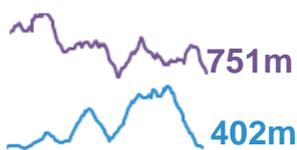
Figure 2: Oil & gas and coal equities



Source: Bloomberg

Note: Data as at 31 July

Figure 3: Oil & gas and coal equities traded volume, July 2009 – June 2014



Source: Bloomberg

Note: 15-day moving average

3.2. Liquidity

Institutional investors require liquidity in their public equities, even if they are buy-and-hold or long-only investors. Oil and gas and coal equities are certainly liquid, with a combined trading volume of more than a billion shares a day over the past five years (Figure 3).

Trends are visible in fossil fuel equities. Oil and gas equities have declined in total traded volume over the past five years, with a noticeable buying spike in the beginning of the shale gas boom. Coal equities traded in much higher volumes at the same time as holders sold down due to lower growth prospects (on which more below).

3.3. Growth

Fossil fuel equities do display growth over the last five years, but not in equal measure. Oil, gas, and coal all traded up from mid-2009 before dipping in 2010 below their starting position. Demand for fossil fuels is closely linked to general economic growth, so some recovery alongside the broader equity markets is expected and did occur with the first green shoots of recovery from the global financial crisis. Though oil and gas and coal companies traded on the same trend, coal was peakier - higher, and lower, at its extremes than oil and gas.

By 2012, growth diverged substantially (Figure 4). By July 2012, both sectors again traded at par - but from there, oil and gas stocks grew 25% in two years, while coal stocks lost almost half of their indexed value. In the US, some stocks are now down 95% since 2011, and even in China, which consumes as much coal as the rest of the world combined, growth has been nil or negative.

Oil and gas stocks have outperformed other major sectors over the past five years (see Section 5 below). Coal stocks, on the other hand, have been striking underperformers, reflecting a fall in international coal prices as the US shale boom caused generators to switch into gas-firing.

Figure 4: Oil & gas and coal stock performance, July 2009 – June 2014



Source: Bloomberg

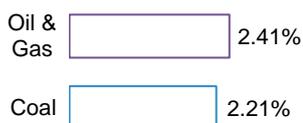
Note: Bloomberg World Oil & Gas Index and Bloomberg World Coal Index, rebased to 100 on 1 July 2009.

3.4. Yield

Institutional investors value cash flow in the form of dividends, as well as growth from increasing stock prices. Oil, gas, and coal firms are historically high-yield companies compared to other equities, with the top 100 companies in each sector having average dividend yields of more than 2% (Figure 5). This reflects the fact that fossil fuel firms tend to distribute a high proportion of post-tax profits, and that their profitability is protected against competition by their ownership of mineral extraction rights.

A yield of 2%-plus is not enormous, but it is enough to attract income-hungry investors with long-term portfolios. Only one other major sector analysed in this white paper – real estate – has a higher yield amongst its largest companies.

Figure 5: Oil & Gas and Coal dividend yields



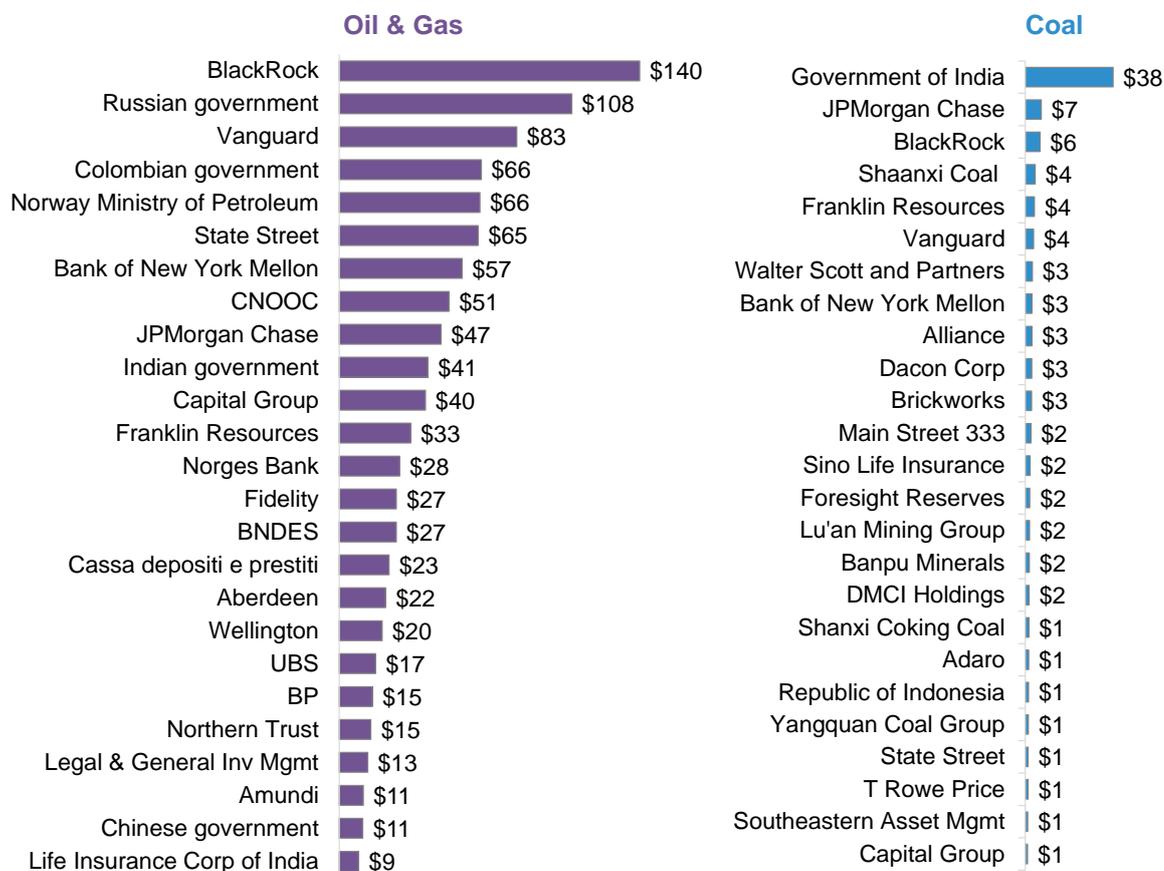
Source: Bloomberg

Note: Top 100 company average

4. KEY INVESTORS IN OIL & GAS AND COAL

The largest shareholders in oil, gas, and coal consist of the largest institutional funds in the world, alongside governments and strategic investors from within the sectors themselves. The largest 25 holders of only the largest 25 oil and gas firms control more than \$1trn worth of shares (Figure 6). Any large-scale divestment movement beyond campuses, churches, and municipalities will require engaging and persuading firms such as BlackRock, Vanguard, State Street, and Capital Group – each with more \$1trn of assets under management – to reconsider their portfolios. Divestment movements are less likely to impact the strategies of the Russian, Indian, Chinese, Colombian and Norwegian governments and their more than \$250bn of strategic holdings.

Figure 6: Top 25 investors in quoted oil & gas and coal sectors, Q2 2014 (\$bn)



Source: Bloomberg

Note: Includes top 25 holders of the 25 largest firms in each sector. Data as at 18 July

The top 25 oil and gas firms are 61% of total market cap, and the top 25 coal firms are 77% of market cap

While there is a large universe of oil, gas, and coal firms, both sectors are actually quite concentrated in terms of equity valuation. The top 25 oil and gas firms account for 61% of total market capitalisation for that sector, and the top 25 coal firms are 77% of sector market cap.

This combination of concentrations – in terms of both investors and the value of companies invested in – indicates certain necessities for large-scale divestment strategy. Targeting thousands or millions of small investors will have little impact on capital available for oil, gas, and coal firms (at least in the early stages). Likewise, depriving hundreds of small firms of capital will have little impact on total fossil fuel valuations and their ability to further explore for and extract hydrocarbons.

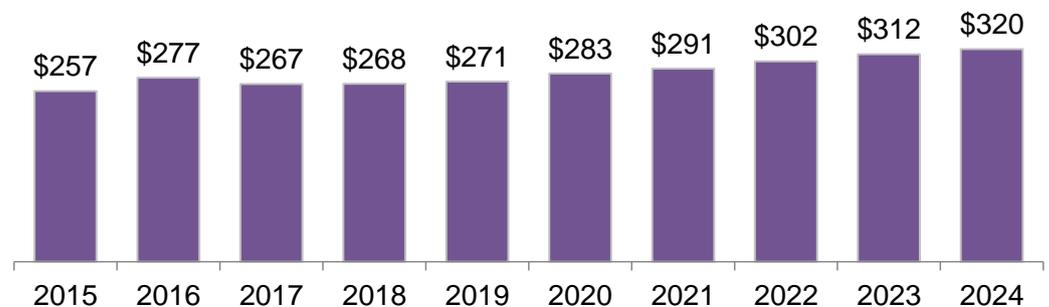
5. CLEAN ENERGY INVESTMENT OPTIONS

Clean energy is a trillion-dollar investment opportunity for institutional investors. We forecast [\\$5.5trn of investment in renewable energy](#) power generation investment from today through 2030, half of which will happen in the next decade. As this capacity is being built, new financial instruments are emerging to recycle capital and allow institutional investors easier access to the sector.

5.1. Direct investment in clean energy generation assets

Generation capacity has always made up the majority of all new dollars invested in clean energy, and will continue to be so. Bloomberg New Energy Finance forecasts more than \$2.8trn in new generation capacity investment in the next 10 years, more half the total market cap of oil, gas, and coal equities (Figure 7).

Figure 7: Renewable energy generation capacity investment, 2015 – 2024 (\$bn)



Clean energy capacity investment will top \$2.8trn in the next 10 years

Source: Bloomberg New Energy Finance 2030 Market Outlook

This capacity will be globally distributed, and an increasing proportion of it will be investment-grade, owned or sponsored by creditworthy utilities or governments, or securitized and sold into the public markets.

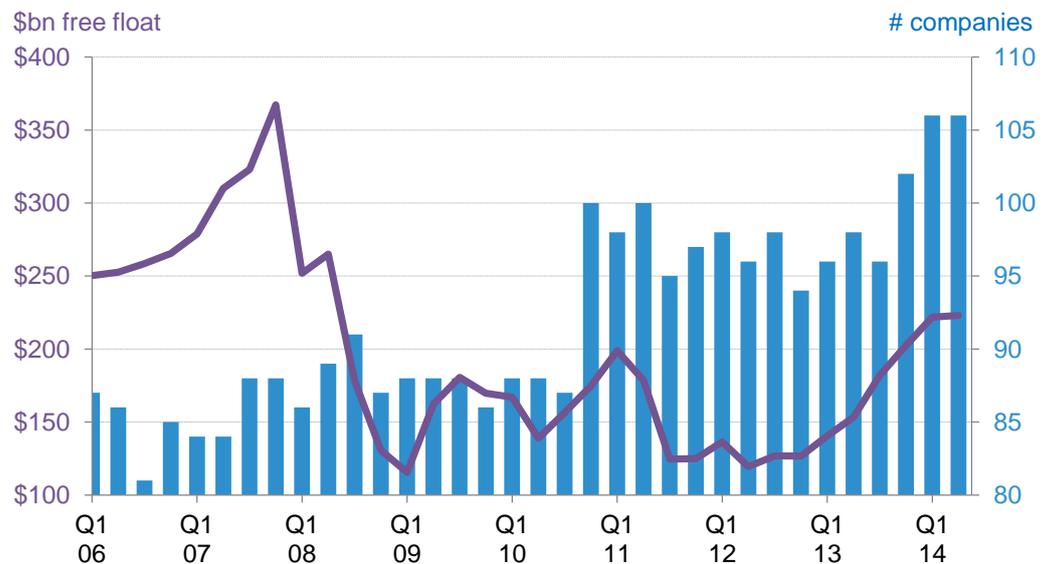
Direct asset investment, however, is relatively illiquid and rates of return are highly dependent upon technology, market, and contract structure. Many investors, chary of retroactive changes to tariffs in markets like Spain or the Czech Republic, may not be interested in clean energy assets. Others will find investment-grade returns to be decent for yield, but may require growth as well, which assets do not offer. Regardless of location or size, asset investment requires a granular assessment of project and market context, and many institutional investors may not find assets worth the effort.

5.2. Clean energy equities

Clean energy equities are already available to institutional investors and are components of many major portfolios. They offer growth potential and sufficient liquidity for institutional investment (with the possible exception of some small listed companies which trade over the counter). Clean energy equities offer global reach into diverse value chains including manufacturing, project development, and asset ownership. As an asset class, clean energy equities are a small fraction of the size of oil and gas equities.

The universe of clean energy equities, as measured by the WilderHill New Energy Global Innovation Index, is 106 companies, with a total value of \$220bn (Figure 8).² It includes pure-play wind and solar firms; industrial firms with a large interest in the clean energy value chain, and major project developers from around the world.

Figure 8: NEX Index free float and number of companies, 2006 – Q2 2014



Source: Bloomberg

Clean energy share prices grew dramatically from 2004 to 2007, outpacing the US major benchmarks, the Nasdaq and the S&P500, before collapsing equally dramatically during the global financial crisis and years of manufacturing overcapacity.

On a five-year timeline, clean energy stocks have traded flat – though in ‘trading flat’ they have declined by 50% before rebounding 100% with substantial trading volume in the underlying equities (Figure 9).

² The total value of companies in the NEX exceeds \$2trn; however, few of these companies are pure-play clean energy firms. The NEX is an established proxy for the value of the clean energy universe.

Figure 9: NEX Index value and daily trading volume, July 2009 – June 2014



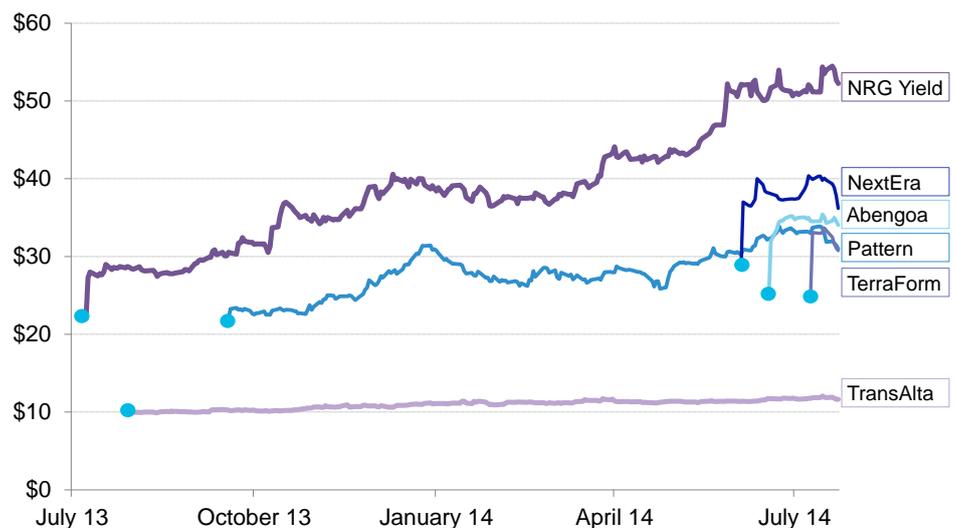
Source: Bloomberg

Four of six YieldCos had first-day trading pops, indicating significant demand

5.3. YieldCos

In 2013, project developers and asset owners created the first clean energy “YieldCos”: publicly-traded corporations the main purpose of which is to buy and hold operational assets, while passing the majority of cash flows to investors as dividends. Bloomberg New Energy Finance clients can read comprehensive analysis of YieldCos in the [Demystifying the YieldCo model](#) Research Note.

Figure 10: US energy YieldCos since listing



Source: Bloomberg

Note: “NextEra” is NextEra Energy Partners. “Abengoa” is Abengoa Yield. “TransAlta” is TransAlta Renewables. Data as at 31 July.

The largest YieldCo's market cap is \$3.9bn; total YieldCo market cap is \$16.4bn

The largest MLP's market cap is \$68.5bn; total MLP market cap is \$415bn

Green bonds issued in 2014 will equal the value of all green bonds issued from 1995 to 2013

2013 green bond issuance equals only 1% of the 1.4trn in corporate bonds issued last year

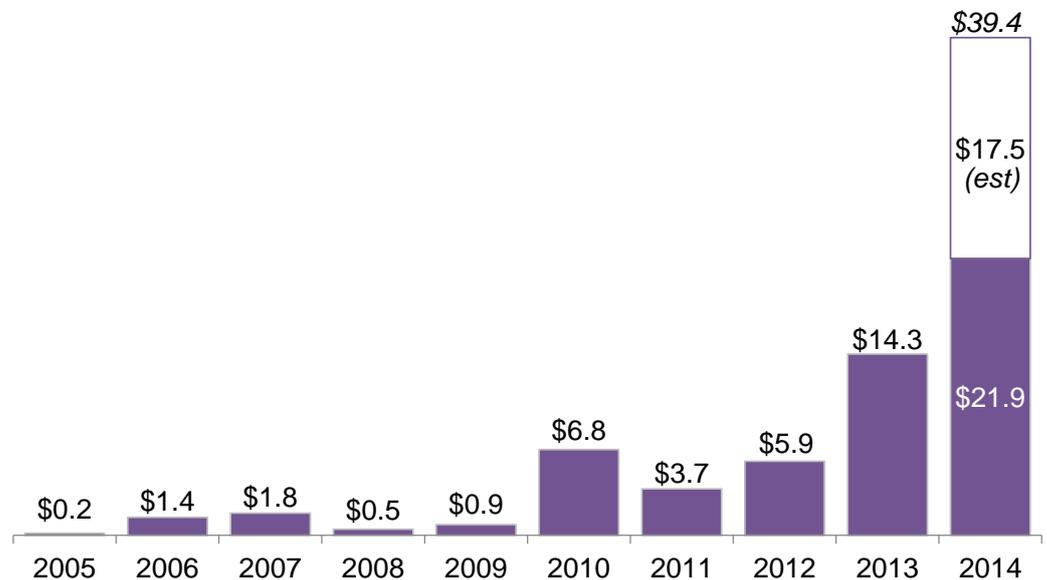
YieldCos offer a potential mix of growth from appreciating stock prices, and yield from dividend payments. Investor appetite for the six YieldCos listed since 2013 has been robust, with four having significant first-day trading pops (Figure 10).

This concept is not new; Canadian companies have adopted it for energy assets and master limited partnerships (MLPs) and real estate investment trusts (REITs) have existed for decades. This pedigree, and history, is a hopeful sign for clean energy YieldCos. Today, YieldCos are growing, but are not yet large enough to constitute a true asset class. NRG Yield is the largest YieldCo with a value of nearly \$4bn; the total market cap of the six YieldCos is \$16.4bn. By comparison, Enterprise Products is the largest master limited partnership, with a market cap of \$68.5bn; US MLPs are worth \$415bn in aggregate.

5.4. Green Bonds

Green bonds are an emerging source for clean energy capital. Green bonds have been in circulation for two decades, though have only recently achieved lift-off as an investment outside the walled garden of project-specific bonds, international organisations, and governments. Some \$23.4bn of green bonds were issued from 1995 to 2012; but \$14.4bn were issued last year alone. Bloomberg New Energy Finance forecasts \$40bn in issuance this year – as much as issued in the past two decades combined (Figure 11). Bloomberg New Energy Finance clients can read comprehensive analysis of green bonds in the [Green Bonds Market Outlook](#) White Paper.

Figure 11: Green bonds raised, 2004 – 2014 (\$bn)



Source: Bloomberg New Energy Finance

Note: full-year estimate as at 22 July 2014

Green bonds were once the almost-exclusive province of specifically ringfenced physical assets or supranational banks such as the World Bank. Last year, SolarCity issued its first bond for a large portfolio of distributed assets, and this year, corporations including Toyota, GDF-Suez, and Vornado Realty Trust have issued green bonds for diverse portfolios of assets.

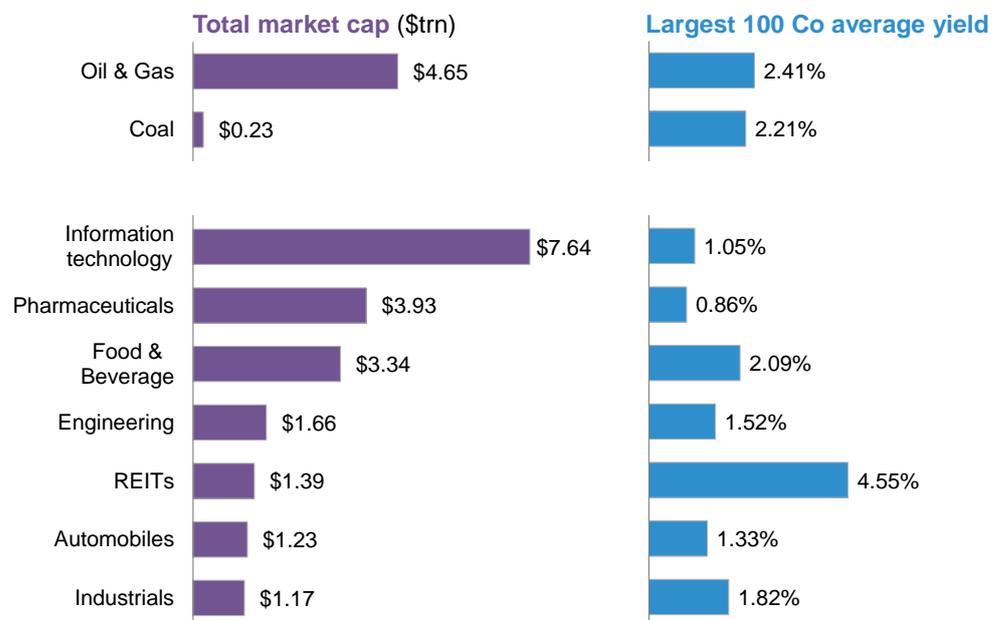
Green bonds are a promising asset class for investors interested in clean energy assets but with a low risk appetite or a desire for yield over growth. Green bonds still require greater definition as

a sector, and perhaps standardisation to allow investors to make a like-for-like comparison between a portfolio of US distributed solar projects, a bundle of Toyota Prius financings, and a community of new LEED-certified buildings. Growth is likely, but for now, green bonds are still small in the scheme of fixed income markets. Last year's \$14bn in green bonds were only 1% of the \$1.4trn in corporate bond issuance in 2013.

6. INVESTMENT IN OTHER SECTORS

Today, clean energy as an asset class is simply not large enough to absorb substantial amounts of capital divested from fossil fuels. There are, however, a number of trillion dollar-plus sectors that could absorb divested dollars. The seven sectors below are highlighted to absorb fossil fuel divested capital not just because of scale, but because each also includes companies where minimizing fossil fuel use, creating greater energy efficiency, or manufacturing and servicing a lower-carbon energy system is part of the growth strategy.³

Figure 12: Oil & gas and coal companies compared to other sectors (market cap and yield)



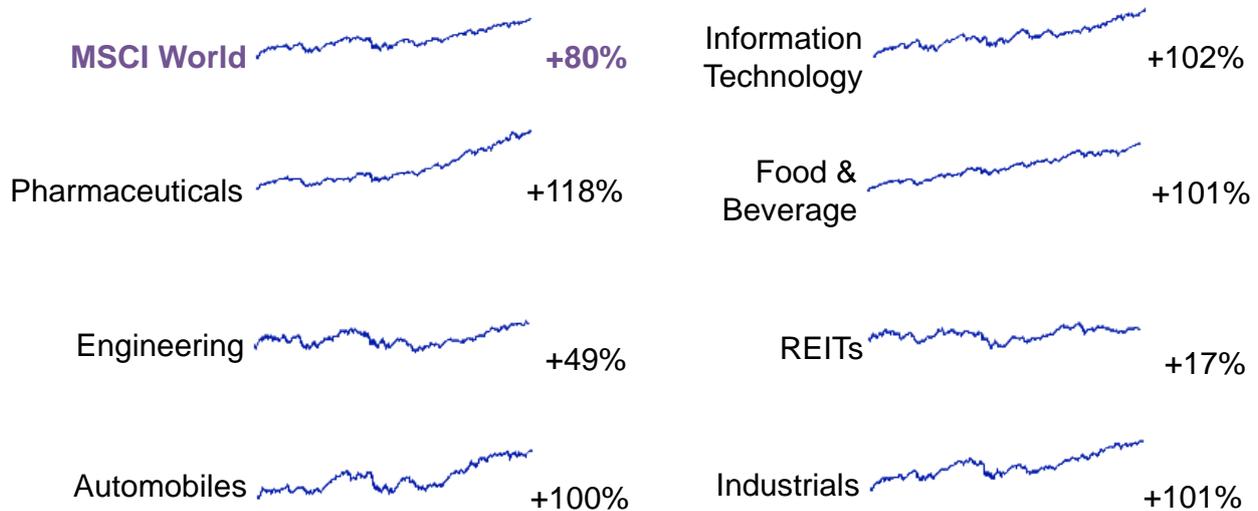
Source: Bloomberg

Note: "average yield" is current average annual dividend yield. Includes the largest 3,000 companies in each sector, or fewer if the sector has less than 3,000 listed firms. Data as at 31 July 2014.

These sectors can equal fossil fuels in scale if not in every attribute (Figure 12). While all have similar liquidity, they have different growth profiles and yield. Only one sector – information technology – has a larger aggregate market capitalisation than fossil fuels; only one sector – real estate investment trusts – has a higher yield among its top 100 companies. Every sector is larger than clean energy today; no single sector has oil & gas' combination of scale, growth, and yield (Figure 13).

³ Obviously, there are other multi-trillion dollar sectors to invest in, such as metals and mining and telecommunications. The sectors analysed here have clear alternative investment rationales for those divesting from fossil fuels – and some alternative investment sectors such as shipping or extractive industries are exposed to many of the same environmental pressures behind divestment movements.

Figure 13: Sector performance, July 2009 – June 2014



Source: Bloomberg

Note: All indexes MSCI except for Bloomberg REIT index

Table 1: Largest IT firms (market cap)

Apple	\$588bn
Google	\$400bn
Microsoft	\$360bn
IBM	\$194bn
Facebook	\$193bn

Source: Bloomberg

Note: As at 31 July 2014

Apple's cash reserve of \$159bn is \$40bn greater than the foreign currency reserves of Malaysia

Table 2: Largest pharmaceutical firms (market cap)

J&J	\$289bn
Roche	\$252bn
Novartis	\$239bn
Pfizer	\$186bn
Merck	\$170bn

Source: Bloomberg

Note: As at 31 July 2014

6.1. Information technology

Information technology is the only major sector that exceeds fossil fuels in total market capitalisation, and it does so by nearly 60%. It includes the world's largest company by market cap, as well as its third and fourth largest, Google and Microsoft (Table 1). It is also a quite diverse sector, including consumer hardware firms such as Apple, pure business firms such as IBM, pure consumer software firms such as Facebook, and pure manufacturers such as Intel. These companies are large, liquid, and generally high-growth. Though they are historically high-earning firms, they do not disburse much cash to equityholders, though Microsoft and Apple have issued extraordinary dividends to reduce their cash piles. Apple now has \$159bn in cash on its books, which is \$40n greater than the foreign currency reserves of Malaysia.

IT firms are increasingly active in energy, with interest not only in reducing their own substantial consumption but also in providing products and services for distributed energy and energy efficiency. Facebook and Apple run their server farms on solar energy and fuel cells; IBM creates software suites for city energy management; Oracle manages utility databases; and Intel, Qualcomm, and ARM make the chips not only for existing hardware but for the "Internet of Things"-enabled energy system of tomorrow.

IT is a growth sector, with indexed stock growth of 100% in the past five years (Figure 13).

6.2. Pharmaceuticals

Pharmaceuticals is a \$4trn sector, high-growth but low-yield, similar to IT. Its largest companies are nearly as large as the biggest IT firms (Table 2).

Pharmaceuticals firms have a potential role in a lower-carbon energy system. Like IT firms, they are substantial consumers of energy via their on-site needs and their global logistics requirements. Their research and development also has applications in biofuels and advanced materials. Pharmaceutical companies can have chunky revenue streams driven by disproportionately lucrative product lines which then lose value dramatically upon patent expiry.

Viagra generated \$2bn in revenue for Pfizer in 2012, for instance, but its patent expires in 2020 at which point generics will greatly reduce cash flow from the drug.

6.3. Food & beverage

Food and beverage companies total \$3.3trn in market cap, after more than 100% growth in the past five years, and have an average yield for the top 100 companies above 2%. Food and beverage firms are perhaps the closest to fossil fuel firms as a sector, by purely financial measures – but the largest is less than half the size of ExxonMobil and a third the size of Apple (Table 3).

As with IT and pharmaceuticals, food and beverage firms have significant exposure to energy, an interest in reducing use and making their supply chains more efficient. With direct exposure to soft commodities, they are also extremely sensitive to climate change and extreme weather events. Food and beverage firms also have existing or potential plays in biochemicals and bioenergy.

Table 3: Largest Food & beverage firms (market cap)

Nestle	\$239bn
Anheuser-Busch	\$174bn
Coca-Cola	\$172bn
PepsiCo	\$133bn
Unilever	\$126bn

Source: Bloomberg

Note: As at 31 July 2014

Table 4: Largest engineering firms (market cap)

Caterpillar	\$65bn
ABB	\$54bn
FANUC	\$42bn
Atlas Copco	\$36bn
Illinois Tool Works	\$35bn

Source: Bloomberg

Note: As at 31 July 2014

6.4. Engineering

Engineering firms are only half the size in aggregate of food and beverage firms, at \$1.7trn, and have significantly underperformed other sectors due to outsized exposure to changes in global economic growth. The sector is also somewhat diverse, including equipment makers such as Caterpillar and Illinois Tool Works, as well electrical and automation specialists like ABB and pure robotics firms such as Japan's FANUC. The largest firm, Caterpillar, would rank only 17th in the list of technology companies (Table 4).

Engineering firms will be an integral part of a lower-carbon future. Some firms, such as Caterpillar or John Deere, have high exposure to extractive industries while others have very little. All of them, however, will be part of building new infrastructure, designing electrical grids, and building and servicing automation systems.

6.5. Real estate investment trusts (REITs)

Real estate investment trusts are publicly-listed collections of property assets; their total market cap is nearly \$1.4trn. REITs have underperformed other sectors in terms of share price growth (only 17% in the past five years) but significantly outperformed in yield (the top 100 REITs yield more than 4.5% on average). The largest REITs are nearly the size of the largest engineering firms (Table 5).

Real estate is highly exposed to energy prices as well as to consumer trends. Many of the largest real estate firms build or retrofit their properties to Leadership in Energy & Environmental Design (LEED) certifications as a way to attract and retain tenants. Those firms that are exposed to operating costs or disruption of grid electricity supply have their own interests in mind as well when pursuing energy efficiency or on-site renewable energy. Some have already accessed the green bond market. In June, US REIT Vornado, which in June priced a five-year, \$450m corporate green bond for new LEED building developments and retrofits.

Table 5: Largest REITs (market cap)

Simon Properties	\$52bn
American Tower	\$37bn
Public Storage	\$30bn
Unibail	\$26bn
Equity Residential	\$23bn

Source: Bloomberg

Note: As at 31 July 2014

Table 6: Largest auto firms (market cap)

Toyota	\$206bn
VW	\$111bn
Daimler	\$91bn
BMW	\$79bn
Ford	\$69bn

Source: Bloomberg

Note: As at 31 July 2014

Table 7: Largest industrial firms (market cap)

GE	\$257bn
Siemens	\$109bn
3M	\$94bn
Honeywell	\$74bn
Hutchison Whampoa	\$59bn

Source: Bloomberg

Note: As at 31 July 2014

6.6. Automobiles

Automobiles are a small sector (only 115 listed companies) but nearly equal the market cap of REITs at \$1.2trn. As a sector, autos have performed on par with technology firms, and the largest auto firm is of the scale of IT and pharmaceuticals (Table 6).

Like engineering or real estate firms, auto manufacturers have multiple exposures to energy. Autos consume the bulk of the world's liquid hydrocarbons and an increasing volume of natural gas; they are energy-intensive manufacturers, and they are both exposed to, and can shape, trends in travel and urban transportation. The five largest auto firms all have active hybrid vehicle and/or purely electric vehicle programmes in place. Toyota has sold more than three million of its hybrid Prius model since introduction.

6.7. Industrials

Industrial firms are the smallest sector analysed here: \$1.2trn across 485 companies. Their indexed performance over the past five years is on par with IT, food and beverage, and autos. The biggest industrial firm, GE, is the world's ninth-largest corporation by market cap (Table 7).

Industrial firms, like engineering firms, are integral to the energy system regardless of its carbon intensity. GE and Siemens, the sector's two duelling giants, are already active in wind and solar energy, natural gas power generation, transmission and distribution, locomotion, and power storage. These two firms, and their peers, are positioned equipment sales, servicing, and vendor finance in a lower-carbon energy system.

7. DIVESTMENT IS A CHALLENGE AND AN OPPORTUNITY

Fossil fuel divestment is a fast-moving idea with a broad reach across civil society and increasingly, the investment community. It is a call to action for some individuals and a potential value preservation strategy for some institutional investors.

If fossil fuel divestment is to expand, the movement requires orders of magnitude more financial commitment. It is easy for an individual to move assets out of one index fund and into another; it is much harder for an institution to move billions of dollars (and the growth and yield that they have enjoyed) out of one company and into another. Fossil fuel divestment is a major challenge for those institutional investors that aim to pursue it, just as it is a challenge to many of the investment vehicles in clean energy that could receive new capital. At the same time, it is an opportunity as well – an opportunity to create new investment opportunities, and to convince holders of trillions of dollars of capital that alternatives to fossil fuels are equally worthy investments.

7.1. Oil and gas divestment will be a challenge

Oil and gas equities are worth nearly \$5trn, and include some of the world's largest companies with (in some cases) more than a century of performance on growth and yield. Oil companies sell a product in near-universal demand that is closely linked to global economic growth, at least in fast-growing economies. Oil may be substitutable in the long run in motor transport, shipping, and aviation, but for now it is indispensable.

Natural gas is a bridge fuel to a lower-carbon power generation system and can also be the least-cost, best-fit option in power systems where it is abundant and cheap. Natural gas is also essential for modern industry, chemicals, and agriculture. With half the emissions of coal in power generation, greater operational flexibility, and a potential major role in motor transport, gas is likely to grow as a proportion of the energy mix. Individual companies may be exposed to boom-and-bust production cycles, but the sector is likely stable on a global scale.

7.2. Coal divestment could be relatively easy

Coal equities are less than 5% of the total value of oil and gas equities, and have already trended down nearly 50% in the past five years. Some US firms have lost more than 90% of their stock value. Overcapacity plagues China's coal sector, despite the country consuming as much coal as the rest of the world combined. Coal is also at the sharp end of any transition to a lower-carbon energy system. Despite its abundance and low cost, it is high in carbon and other emissions and it is relatively inflexible operationally.

Institutional investors are much less exposed to coal than to oil and gas – and as a result, divesting from coal would be much easier than divesting from oil and gas. Other large sectors could absorb coal equity dollars, as could clean energy.

7.3. Re-investment in clean energy requires investor appetite and structures for true scale

As this paper argues, divesting from fossil fuels does not automatically equate to investing in clean energy alternatives. The marginal, disinterested institutional dollar does not automatically flow from an international oil company to a solar manufacturer or a wind project developer. The marginal dollar may find a more logical home in another trillion-dollar equity sector such as information technology or real estate.

Clean energy has come a long way in the past decade – technologically, financially, and in its business models – but it is not yet a like-for-like investment compared to other sectors. Clean energy is a trillion-dollar sector when all of its assets and future growth are factored in; it has positive long-term fundamentals and in many parts of the world, is a first-best option for new power generation capacity. But, it does not have the scale of other multi-trillion dollar sectors; its equities are liquid but volatile; and its yield instruments are still very small.

What could change this paradigm?

Scale can change this paradigm. As clean energy invests hundreds of billions of dollars every year in more and more markets, its asset pool becomes bigger and more diverse. As company champions emerge, individual corporations too may reach the scale to attract hundreds of millions or billions of dollars of investment from a single institutional investor.

Investment vehicles can change this paradigm. YieldCos and green bonds are a start for attracting institutional investment, but reallocating trillions of dollars requires vehicles worthy of that scale. Clean energy will need not a few more YieldCos, but dozens more; not another \$10bn a year in green bonds, but another \$100-200bn.

Perception can change this paradigm. For all of the tools available for financial analysis, institutional investment remains fundamentally human. People choose portfolios, and people assess risk. Clear-headed investors may look at fossil fuel equities and weight them not just against historical return and yield, but also future prospects given new technologies, consumption patterns, regulations, and finally, public perception.

Fossil fuel divestment is neither imminent nor inevitable. But, neither is it impossible for motivated investors.

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