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2020 Vision: The Coming Era of Peak Fossil Fuels

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Carbon Tracker Initiative is an independent financial think tank that analyses the impact of the energy transition on capital markets and the potential investment in high-cost, carbon-intensive fossil fuels. Carbon Tracker has helped to popularise the terms “carbon bubble”, “unburnable carbon” and “stranded assets”.

State Street Global Advisors has co-authored this report on the energy transition with Carbon Tracker. The original Carbon Tracker analyst note can be found here: https://carbontracker.org/reports/2020-vision-why-you-should-see-the-fossil-fuel-peak-coming/.

Climate change has become the defining issue of our time. The threat of global warming driven by fossil fuel use and the dangers of inaction to reduce greenhouse gas emissions are leading to a re-evaluation of how we generate and use energy.

Foreword

Fulfilling the Paris Agreement goal to limit the global temperature rise to 2°C or less has been recognised by practically all countries and governments around the world are committing to decarbonisation. Amid much progress, however, the US is pulling out of the Paris Agreement while China — the world’s largest carbon emitter — continues to build new coal plants.

Despite some setbacks, there has been a sea-change in how we view fossil fuels, driven by greater awareness of the threat of climate change and the increasingly favourable economics of renewable energy. As the paper highlights, we may be only four years away from peak fossil fuels, the moment when total consumption of coal, oil and gas starts to fall.

At State Street Global Advisors, we believe that mitigating climate risks should be a priority for all investors, and climate change has been a key engagement issue of ours since 2014. Investors have various ways to manage these risks, from simply screening out companies with high emissions and fossil fuel reserves to more sophisticated approaches that allow investors to mitigate risks but also benefit from climate change-relate opportunities. The choice of style will ultimately depend on investors' investment objectives and risk tolerance.

Whichever approach investors take, they should not stand still. History shows that change can happen quicker than expected. As an example, cars started to replace horses as a mode of transport in the US in 1920, when there were only 100,000 cars, only 3% of the 4 million horses. And the peaking of global coal demand in 2014 was little anticipated by industries and investors who believed China and India would drive future demand.

The peaking and decline of oil and gas is likely to follow a similar pattern. Investors should therefore be fully prepared for the energy transition and the disruption it will likely cause to geopolitics, countries, sectors and companies.

Introduction

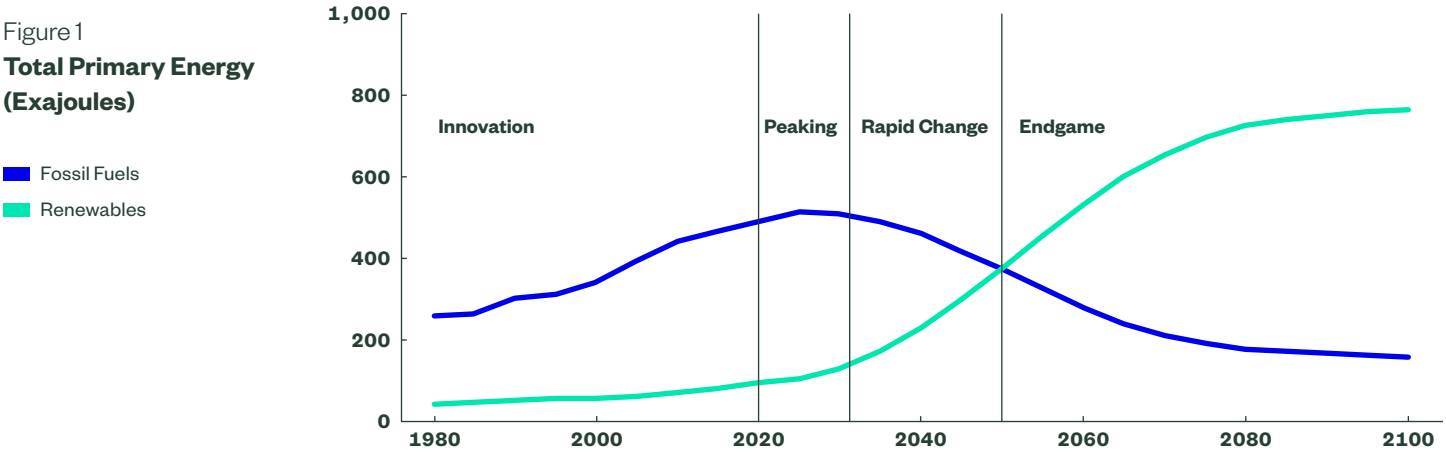
The global energy system is undergoing a seismic transition from one based primarily on fossil fuels to one increasingly based on renewable energy sources. The last time a change of this magnitude occurred was over 200 years ago when coal started to replace biomass.

The generally agreed transition framework outlined in the chart below follows three stages:

- Peaking of fossil fuel demand
- Rapid growth of renewables
- Endgame — a long-term decline in fossil fuel demand

What is driving the shift to renewables?

Figure 1
Total Primary Energy (Exajoules)



Source: Shell Sky Scenario, Carbon Tracker annotation.

Four Key Drivers of the Energy Transition

1. Necessity

There is widespread consensus that we need to reduce greenhouse gas emissions and air pollution, and address water scarcity. The 2015 Paris Agreement to combat climate change recommended that we limit global temperatures rise this century to 2°C above pre-industrial levels and pursue efforts to reduce it to 1.5°C. In 2017, the International Energy Agency (IEA) showed that for the Paris Agreement goals to be achieved would require a reduction of carbon emissions and fossil fuel usage by 22% and 11% respectively by 2030.

There are also geopolitical drivers including countries' desire to:

- Escape dependence on fossil fuel imports
- Gain geopolitical influence
- Become industry leaders in renewables technology
- Create local jobs
- Avoid stranded assets

It's notable that most countries are fossil fuel importers. Three quarters of fossil fuel exports come from just 10 countries with 5% of the global population.

> **"For the vast majority of countries — and the global population — the energy transition represents a tremendous opportunity."**

2. Policy

The Paris Agreement was the manifestation of over 190 countries' commitment to reduce fossil fuel usage, encourage growth of renewables and make fossil fuels pay for their environmental costs. These countries have committed to increasing energy efficiency and decarbonising their electricity sector.

The Paris Agreement commitments along with the falling costs of renewables should encourage policymakers to facilitate the energy transition by (among other things) taxing the fossil fuel sector for the externalities they impose on society.

The private sector should continue to drive change. For example, DivestInvest and Climate Action 100+ have mobilised capital to encourage companies to decarbonise. Google and Apple now source all their energy from renewable sources and are extending this to their global supply chains.

3. Technology

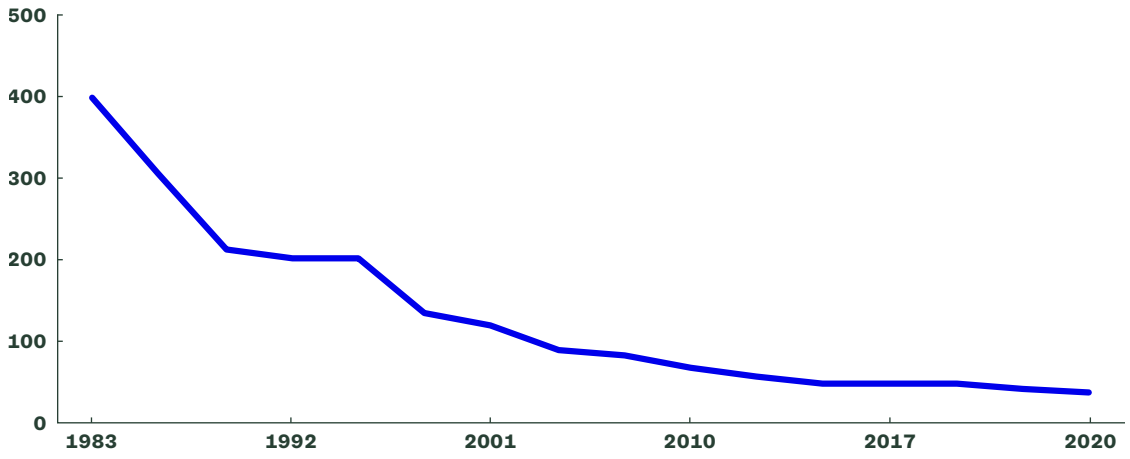
Solar, wind and batteries have enjoyed rapid technology-driven growth driven by 'learning curves' — costs have been falling around 20% for each doubling in capacity. This has led the International Renewable Energy Agency (IRENA) to predict that renewables will be cheaper that fossil fuels in every major region of the world by 2020. In the US, the cost of electricity produced from new solar and wind installations is now below the costs of electricity produced from most new fossil fuel stations.

> **"IRENA predicts that renewables will be cheaper that fossil fuels in every major region of the world by 2020."**

The spectacular fall in prices has created rapid global growth curves (S-curves) for solar, wind and batteries, which are expected to continue.

Wind Data from IRENA shows the average global cost of electricity from wind has fallen 60% since 2000 from $150 per MWh to $60. This compares with electricity from fossil fuels, which is $50-$150 per MWh.

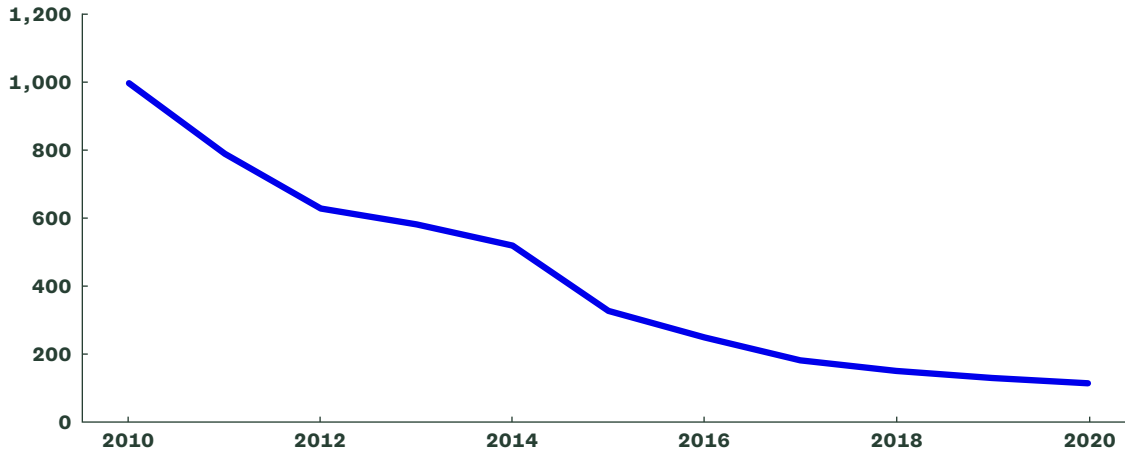
Figure 2
Wind Costs ($/MWh, Global Average)



Source: IRENA.

Solar Since 2010, the average global cost of solar electricity has fallen almost 80% from $350 per MWh to $80 in 2018, with the possibility of reaching $60 in 2020. In certain locations like India and the Middle East, costs are even lower. As with wind, costs should continue to fall as technology improves.

Figure 3
Solar Electricity Costs ($/MWh, Global Average)



Source: IRENA.

Batteries Lithium-ion batteries are a key technology in electric vehicles and should help drive the increase in the share of solar and wind in grid infrastructure. Lithium-ion battery costs have fallen under $200 per KWh of capacity and are expected to reach $100 per KWh in the early 2020s. At this level, the price of electric vehicles will be comparable with conventional cars, but the fuel and running costs of electric vehicles will be lower.

The increasing digitisation of electricity and transport in the form of cheap sensors and cloud storage will facilitate rising penetration of renewables and electric vehicles. Furthermore, digitisation will be used to increase efficiency and reduce waste.

4. Developing Market Leapfrog

The energy transition in developed markets is likely to be complicated by legacy subsidy regimes and falling energy demand. In contrast, developing markets have strong energy demand growth and we expect them to drive the transition, leading them to 'leapfrog' developed markets.

> **"Developing markets have strong energy demand growth and will drive the transition."**

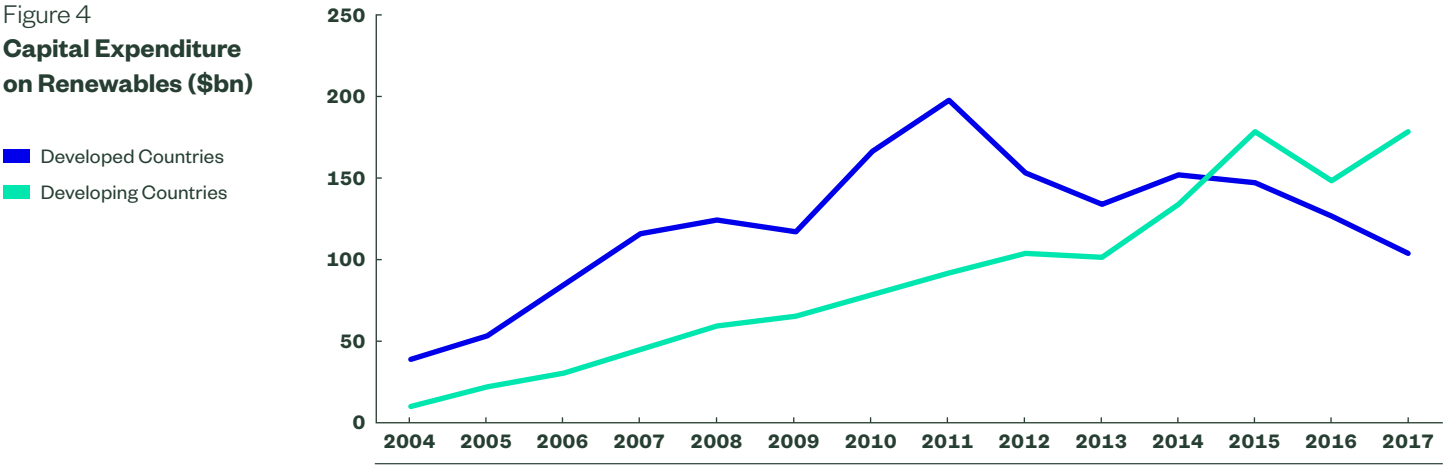
A similar leapfrog has already taken place in developing countries where many people without phones moved straight to mobile phones, missing the intermediary stage of fixed-line telephones.

Developing markets have more incentives to adopt renewable energy because of:

- Higher population density
- More pollution
- Rising energy demand
- Less fossil fuel legacy infrastructure
- Rising energy dependency

The shift is already underway with developing markets overtaking developed markets as the largest source of capital expenditure on renewables in 2015. The IEA forecasts that over the next 25 years, 27% of energy demand growth will come from India, 19% from China and a further 19% from the rest of Asia.

Figure 4
Capital Expenditure on Renewables ($bn)



Source: BNEF.

China overtook the US as the world's largest deployer of solar and wind capacity in 2012, and electric vehicles in 2016 and is far ahead of developed countries in new energy technologies like electric bikes, electric buses and smart meters. China is also the world's largest producer and exporter of key renewables technologies, giving it industrial advantage and greater geopolitical influence.

India is also making progress. The cost of solar electricity in India has fallen below that of coal-fired power stations and the government is targeting all new car sales to be electric by 2030.

Mechanics of the Energy Transition

We expect the energy system to evolve in three stages:

Energy Efficiency Moderates Demand Growth

Historically, annual global energy demand growth has been around 3%, but gains in energy efficiency have reached 2% in recent years. This has resulted in energy demand growth falling to 1-2%, with major implications. The amount of renewable energy needed to create peak fossil fuel demand is three times lower than previously.

Electricity Sector Decarbonises

The rapid growth of solar and wind is spurring the decarbonisation of the electricity sector. Indeed, fossil fuels in electricity generation in OECD countries peaked in 2007 when solar and wind were only 1% of the electricity mix. In 2017, solar and wind were 6% of global electricity supply, but 45% of the growth in supply.

End-use Sectors are Electrified

The final step in the transition has already begun. The IEA finds that the share of final energy consumption from electricity has been rising over time across the building, industry and transport sectors.

Phases of the Transition

We can use the theory of the diffusion of innovation to model the energy transition and how the phases could unfold by country and sector:

Phase	Name	Description	Energy Transition Example	Approximate Period (Globally)
1	Innovation	Challengers are small, niche and expensive and need government support. New technology increases market share.	European solar and wind sector 10 years ago; Global electric vehicles 2 years ago	2000–2020
2	Peaking	Early adopters adopt new technology and its market share rises above 10%. Challengers compete with incumbents on price and take all demand growth. Demand for incumbents peaks.	Peak fossil fuel demand in China	2020–2030
3	Rapid Change	Early majority uses new technology and challenger grows rapidly as incumbents decline. Incumbents still dominate the market, but their business models are destabilised.	European electricity sector today; conventional car demand after c2023	2030–2050
4	Endgame	Challenging technology provides over half the supply and outcompetes incumbents in other areas. World is still a long way from this stage.	Electricity sector in Denmark; car sector in Norway	2050–2100

Source: Carbon Tracker.

Historians often focus on the endgame when renewables become bigger than fossil fuels, but the financial consequences are likely to be felt long before then. It took over 100 years for coal to finally overtake biomass in 1905, yet the consequences of the shift to coal were a dominant feature of the prior 100 years.

Arguments have been made that the reliance on fossil fuels in the form of winter heat and airplane fuel will prevent the energy transition from happening. However, these are phase 4 problems that we predict will be solved long into the energy transition, once easier challenges have been overcome.

Country and Sector Sequencing

European countries are leading the way in the electricity sector. Over 50% of Denmark's electricity comes from solar and wind (phase 4) and Germany and the EU are seeing declining fossil fuel demand and restructuring of the electricity sector (phase 3). China is about to reach peak fossil fuel demand (phase 2), while Africa remains in phase 1 where renewables technology is being tested and costs are falling.

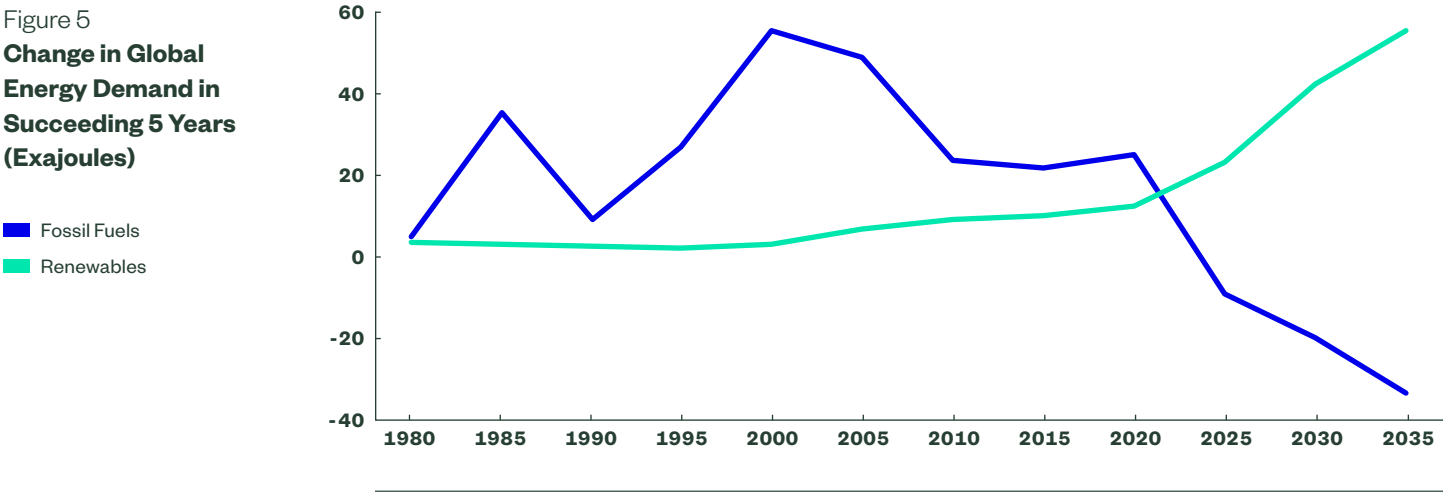
Combining country sequences, we can formulate a rough global framework for the transition:

Electricity is the first sector to transition to renewables and other sectors — notably buildings, industry and transport — will shift through electrification and other advances.

What Happens at the Peak?

While fossil fuels currently dominate renewables in the energy mix, the key issue for investors is the change in demand, rather than total demand. Looking at changes, we see from the Shell Sky Scenario that after 2025, fossil fuel demand is already falling, negatively impacting incumbents.

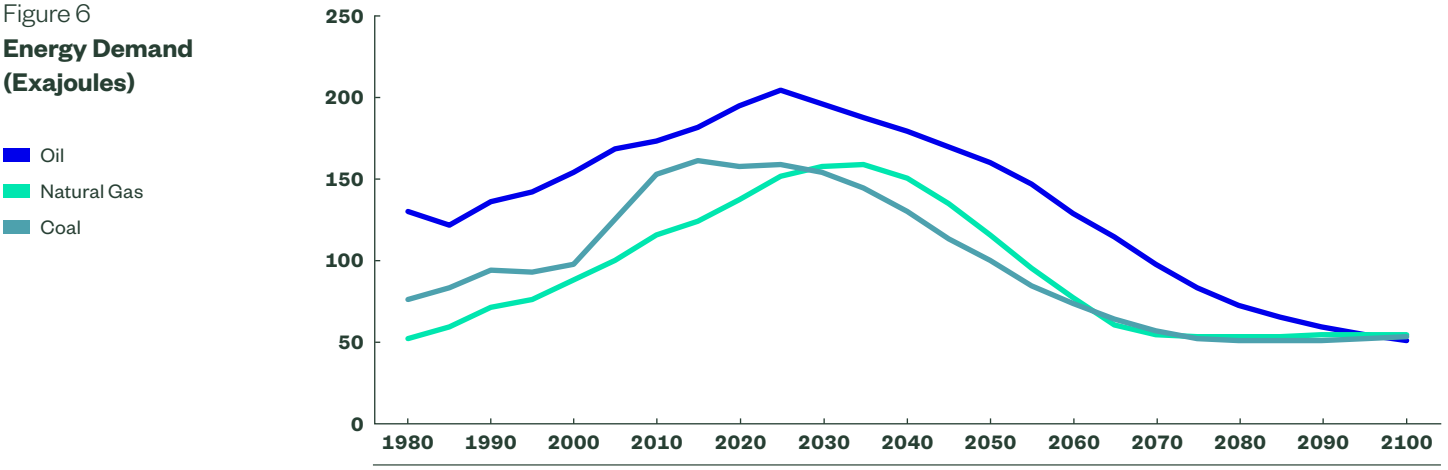
Figure 5
Change in Global Energy Demand in Succeeding 5 Years (Exajoules)



Source: Shell Sky Scenario.

> **"Forecasts suggest that there will be peak demand for coal in 2015, oil in 2025 and gas in 2035."**

Figure 6
Energy Demand (Exajoules)



Source: Shell Sky Scenario.

When growth turns to contraction, four factors impact hard on incumbents:

- **New Entrants** Providers of new technology grow quickly and lead to greater competition that can drive down returns for incumbents
- **Lower Prices** The price of energy produced from solar, wind and batteries falls every year as technology improves. Fossil fuel companies must reduce their prices to compete.
- **Stranded Assets** As competition increases, incumbents' assets and technology start to become stranded. For example, coal-fired and gas-fire power generation capacity in Europe is already being closed as it is uneconomic.
- **Sector Disruption** A potential consequence of greater competition and falling prices is a major reallocation of capital, bankruptcies and sector restructuring.

When will Fossil Fuel Demand Peak?

Using assumptions of the growth rate of total energy demand (1.3%) and growth rate of solar and wind supply (17%), we can forecast that fossil fuel demand will peak in 2023. This prediction is based on precise projections, so below we show a range of years of peak fossil fuel demand based on different assumptions of energy demand growth and solar and wind supply growth:

Figure 7
Year of Peak Fossil Fuel Demand

Solar and Wind Supply Growth	Global Energy Demand Growth from 2018		
	1%	1.5%	2%
10%	2029	2037	2043
15%	2022	2027	2030
20%	2020	2023	2025

Source: Carbon Tracker assumptions.

The most plausible scenarios are for a global growth rate of energy demand of 1–1.5% and solar and wind supply growth of 15–20%. This gives a period of 2020–2027 for peak fossil fuel demand.

“ We believe the 2020s should be called the peaking decade.”

Electricity is key to the energy transition, being the single largest constituent of energy supply (42% in 2015). As other sectors are electrifying, the share of electricity demand for energy is growing at 3.6% per decade. The transition of the electricity sector is therefore key. We will approach peak fossil fuel demand once fossil fuels start to be pushed out of electricity supply.

The Risks for Investors

“ Investors typically react before companies see peak demand.”

Investors typically react before companies see peak demand as happened in the coal and European electricity sector transitions.

Investors will likely react faster as the energy transition impacts on global capital markets.

Broadly, investors face three types of risk from the energy transition:

- **Systemic Risk** The fossil fuel sector has large amounts of assets that will become stranded as renewables outcompete fossil fuel assets on cost. This has already happened, for example, in gas-fired power generation in Europe.

  As renewables costs fall further to below the variable cost of fossil fuels it makes economic sense to close existing fossil fuel plants. Again, this is happening in the European thermal generation sector. This is a systemic risk because the fossil fuel sector has the largest built asset infrastructure in the world, at an estimated build cost of $25 trillion, according to Shell.

- **Country Risk** Countries like Kuwait, Iraq and Saudi Arabia are highly dependent on fossil fuel exports, and so are particularly vulnerable to the transition. In contrast, lower middle-income countries that import fossil fuels like India and Pakistan will enjoy a current account boost as they increase domestic renewable energy production and cut fossil fuel imports.

- **Company Risks** Individual companies can transition but entire sectors will likely struggle, and can expect price declines, greater competition, restructuring, stranded assets and market derating. Aside from the coal, oil and gas sectors, capital goods (including gas turbines), transport (including coal ports) and the automotive sectors are likely to suffer. In fossil fuel exporting countries, the banking sector and domestic stocks will be negatively impacted.

“ Directly impacted sectors compose up to a quarter of equity indices.”

Furthermore, fossil fuel and related sectors constitute nearly a quarter of total corporate bonds followed by Fitch and a little more of bonds covered by Bloomberg.

Sectors that are particularly vulnerable are those:

- Subject to stringent regulation (e.g. European electricity)
- With weak demand growth (e.g. OECD fossil fuel demand)
- Related to capital goods (e.g. companies building diesel engines, oil platforms or gas turbines)
- With high cost (e.g. liquified natural gas or Arctic oil)
- That are highly pollutive (e.g. coal or tar sands).

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* AUM reflects approximately $43.96 billion USD (as of September 30, 2019), with respect to which State Street Global Advisors Funds Distributors, LLC (SSGA FD) serves as marketing agent; SSGA FD and State Street Global Advisors are affiliated.

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