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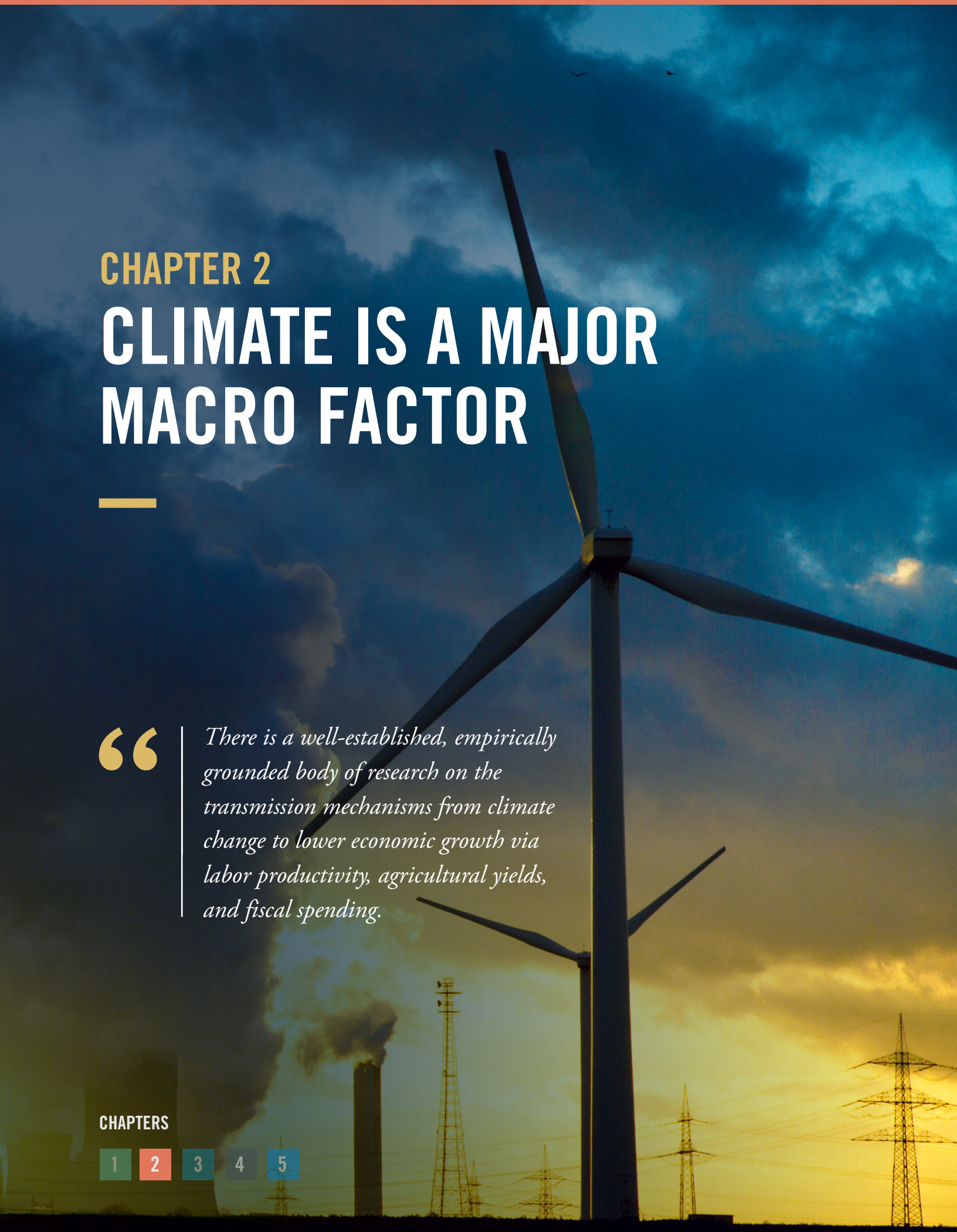
India Mutual Fund

MEGATRENDS

WEATHERING CLIMATE CHANGE

Opportunities and risks in an altered investment landscape



CHAPTER 2

CLIMATE IS A MAJOR MACRO FACTOR

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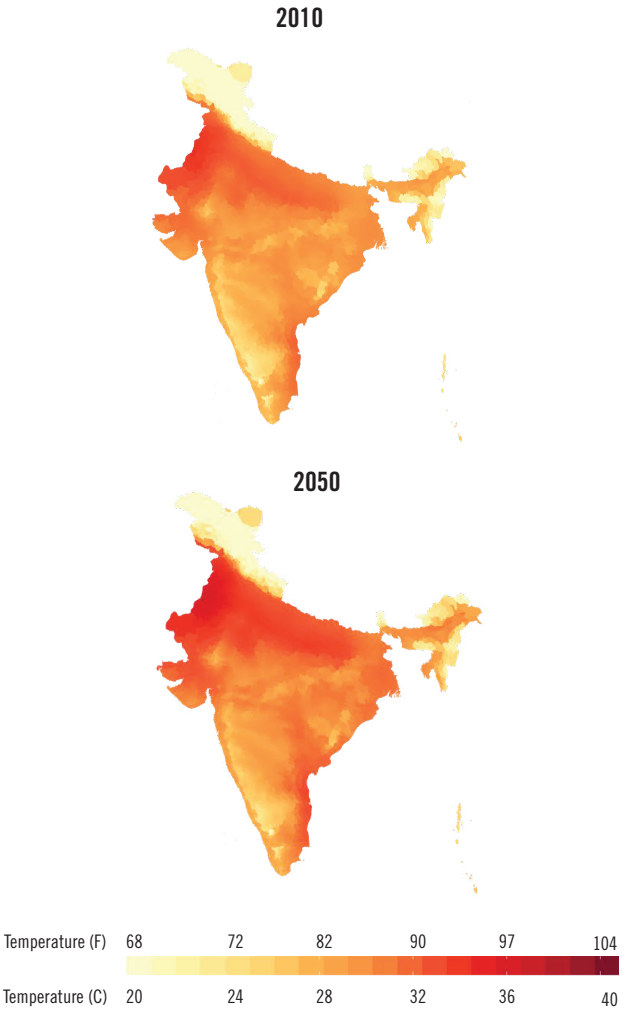
CLIMATE IS A MAJOR MACRO FACTOR

Climate change is not only altering the contours of our planet and weather system, it is also transforming the global economy. This metamorphosis will spur a generational reallocation of resources over coming decades – leading to the emergence of a new set of winning and losing countries and sectors.[29]

There is a well-established, empirically grounded body of research on the transmission mechanisms from climate change to lower economic growth via labor productivity, agricultural yields, and fiscal spending (Table 1). In this chapter we focus on three critical implications of this for investors:

- **A highly uneven impact across countries and sectors.** The impact of climate change on growth will be unevenly spread across countries, with many emerging markets such as India bearing the brunt of the consequences while a few developed countries close to the poles remaining mostly untouched (Exhibit 8). There will be a wide dispersion across sectors in the economy as well.
- **A prolonged sunset for fossil fuels.** The evolution from a global economic system marked by virtually unconstrained use of inexpensive fossil fuels to one that fully prices in the externalities of greenhouse gases will be the defining transition of our generation – but will play out over a significantly longer time horizon than many investors might be expecting.
- **The indirect, knock-on effects from climate change are likely to be more consequential than the direct ones.** The socially and politically disruptive second-order effects of climate change – escalating risks like "climigration," civil and political unrest due to water scarcity, widespread zoonotic diseases – could ultimately overwhelm first-order effects.

Exhibit 8: **Heat Risk in India Is Rising**



Source: "Climate Change and Heat-Induced Mortality in India," Climate Impact Lab, 2019
Note: Average daily summer temperatures calculated over June, July, and August. This exhibit shows the rise in temperature under the RCP 8.5 scenario.

Table 1: **Macroeconomic Implications of Climate Change**

	Labor Productivity	Agriculture Yields	Government Deficits
Key drivers	■ Disruptions to transportation and electrical systems due to extreme weather events ■ Physical and cognitive decline due to rising temperatures outdoors and indoors ■ Increased absenteeism due to higher morbidity rates	■ Deviations from longstanding patterns of temperature and rain ■ Rising salination of farmland from sea level rise ■ Extreme heat stresses both livestock and crops ■ New weather conditions bring new weeds, insects, vermin and crop disease to previously unexposed areas	■ Rising costs for essential adaptation and mitigation projects ■ Reduced revenues from decreased economic production ■ More frequent emergency spending for disaster recovery
Potential magnitude	■ **Up to 2% of global GDP annually:** Current estimates suggest the annual productivity loss from global warming amounts to roughly 2% of global GDP[30]	■ **6-14% annually:** A 2 degree-Celsius increase in global temperature reduces global yields of agricultural staples such as wheat, maize and rice by 6-14% in the absence of technology or mitigation efforts[31]	■ **$100s of billions:** In 2017, for example, multiple major hurricanes hit the US leading to hundreds of billions of emergency federal spending that year alone
Where will the impact be felt most?	■ Sectors: Construction, mining, manufacturing, agriculture ■ Equatorial countries highly impacted (e.g., Brazil, Nigeria and India) ■ Northern polar regions least impacted (e.g., Canada, Scandinavia, Russia)	■ Equatorial countries highly impacted (e.g., Pakistan, Iran and Nigeria) ■ Coastal countries highly impacted (e.g., Australia, Vietnam and India) ■ Crop yields may increase in northern Europe, Russia and Canada	■ Municipal and state government finances will be most vulnerable ■ Sovereign fiscal budgets may be strained as private property losses are nationalized under emergency measures

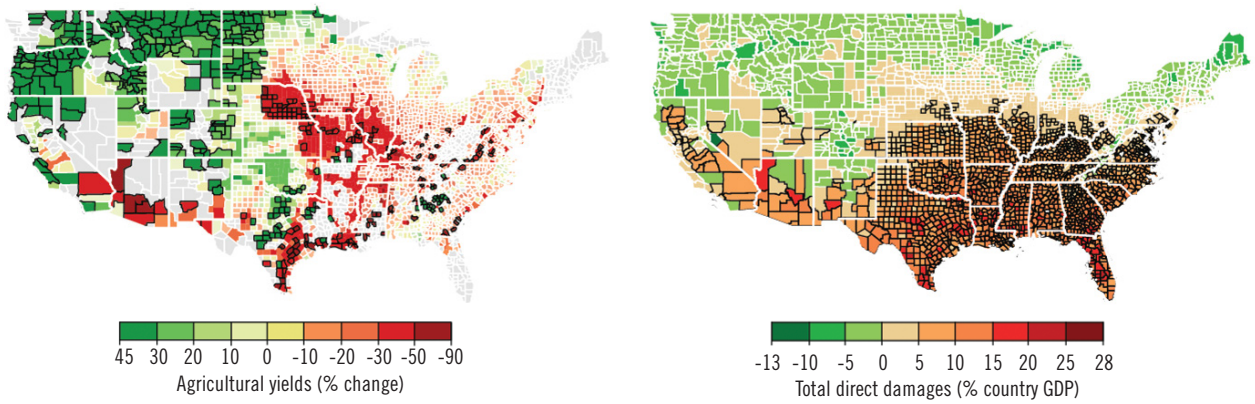
1. Climate change's impact on productivity and economic growth will be highly uneven

Climate change has already begun to cause a wide range of physical effects. Rising sea levels, more intense droughts, floods and storms, changing weather patterns, waves of extreme heat all pose serious challenges for firms, investors and the broad economy. Collectively, these are often referred to as physical risks from climate change.

These physical risks will curtail growth around the world. However, growth in developed markets is likely to be less impaired than emerging markets. According to the International Monetary Fund (IMF), the median effect of a 1 degree Celsius annual increase in average temperature on annual GDP per capita growth is minimal for advanced economies, which tend to have colder climates on average. At an extreme, remote parts of Russia may see an economic boom as previously uninhabitable polar regions become more hospitable to farming and other economic activity.

However, there will be significant variation in climate effects *within* individual countries. The US is a good example (Exhibit 9). Areas along the Atlantic Ocean and Gulf of Mexico are impacted by rising sea levels and more frequent, damaging hurricanes. The southwestern US will experience extreme heat,

Exhibit 9: **Climate Change Will Have a Varied Impact Across the United States**



Source: Solomon Hsiang, et al., "Estimating Economic Damage from Climate Change in the United States," *Science*, June 30, 2017

drought, and wildfires. Meanwhile vast stretches of the northern sections along the border with Canada will hardly be impacted at all.

Second, the economic effects of climate change will also be more severe in emerging markets. Many equatorial climates – namely, emerging markets in South America, Asia and Africa – have higher average temperatures and are more likely to see significant declines in productivity and growth due to climate change. Over the long term, this may shift aspects of economic production away from the equator. And while these adversely impacted economies generate two-fifths of global GDP today, they account for 85% of the current population.[32] Furthermore, many have large agriculture sectors which will be increasingly vulnerable. The heightened impact of climate on emerging markets may also accelerate political instability and inter-regional wealth inequality.[33] Even among emerging markets, the impacts of climate change will be uneven and disparate. Within the MSCI EM Index, for example, there is a wide dispersion of climate impact among its constituents (Exhibit 10).

Third, the impact across sectors of the economy will be broad as well. While virtually all sectors will feel the impact of climate change, some will be adversely impacted more than others. For example, airlines, utilities and energy are highly vulnerable to transition risk given their reliance on high-carbon fossil fuels. Many segments of the food complex – including soft drink and beer producers, fisheries and wineries – face future challenges from physical risk. Additionally, construction and some areas within the hotel and entertainment sectors are vulnerable to physical climate risk.

It may be intuitive for investors to merely avoid those sectors most vulnerable to climate change. However, such an approach may overlook significant

Exhibit 10: **There Is Wide Divergence in Climate Risk Across Emerging Market Countries**

Climate Risk	MSCI Emerging Market Index		JP Morgan Global Bond Index – Emerging Markets	
Low	South Korea Czech Republic Poland	United Arab Emirates Chile	Czech Republic Poland Russia	Malaysia Hungary
High	South Africa Brazil Indonesia	Philippines India	Turkey Mexico Peru	South Africa Brazil

Source: Notre Dame Global Adaptation Initiative Country Index, data released July 2020

opportunities, given there is extensive variation within each sector as well. As we explore in Chapter 4, active investors may find some pockets of outperformance even within the most vulnerable sectors.

2. A prolonged sunset for fossil fuels

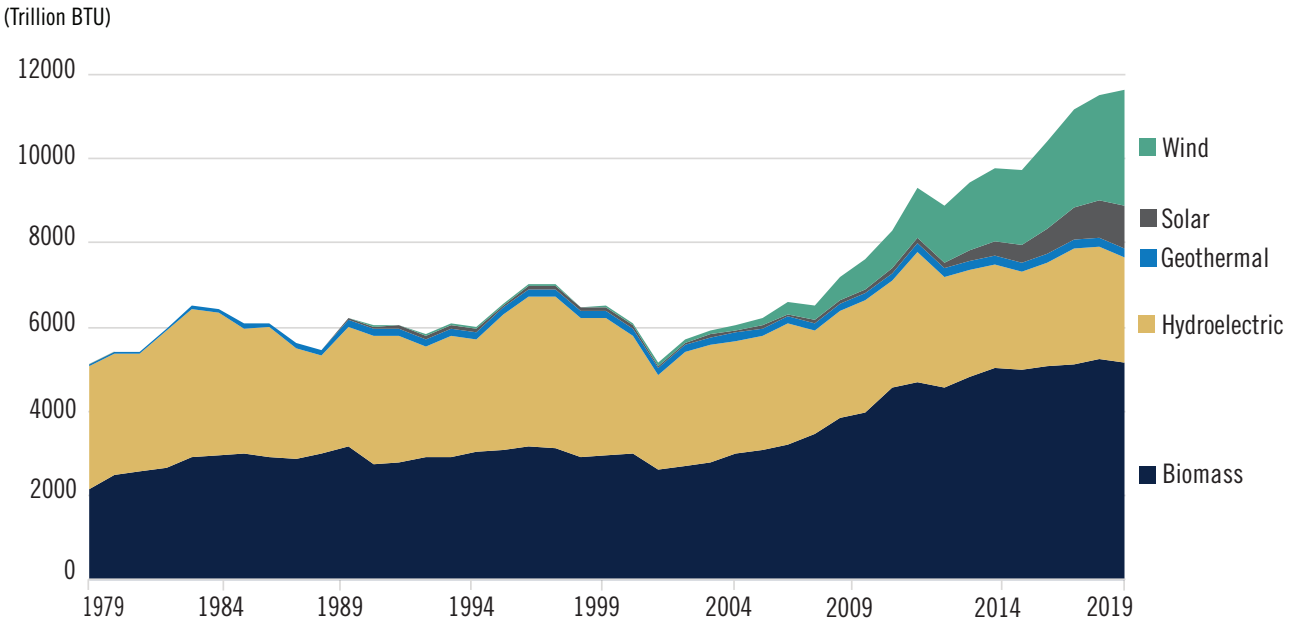
The transition to a low-carbon economy is already underway, creating the threat of stranded carbon assets. This is often referred to as transition risk. This is apparent in both the relative shrinking of the oil and gas sector in global markets and the coincident rapid expansion of renewable energy.

Take the market value of Exxon Mobil, for example. Just seven years ago, Exxon had the largest market capitalization of any US company. Since then it has lost more than half of its value – in part reflecting more transition risk – and finally being removed from the Dow Jones industrial average in August 2020.[34] In late 2020, NextEra, the world's largest provider of wind and solar energy, actually surpassed Exxon Mobil in market valuation.[35] Indeed, the energy sector has fallen from the S&P 500's second largest sector by weight in 2008 to its smallest today.[36]

At the same time, 2019 was the first year solar and wind made up the majority of the world's new electrical power generation – a seismic shift in how nations get their electricity. In 2010, wind and solar made up less than a quarter of new power generation. Now, they account for more than two-thirds.[37] In the US, renewable energy capacity has nearly doubled since 2000, and now accounts for almost 20% of utility-scale electricity generation (Exhibit 11).[38]

However, there is a long way to go before arriving at a new, low-carbon economy. Fossil fuels (e.g., coal, oil, LNG and natural gas) account for nearly 80% of global energy consumption today. Under current policies, consumption of renewable energy is forecast to double over the next 20 years. However, fossil fuels are projected to still account for about 70% of global energy consumed in 2050 (Exhibit 12).[39]

Exhibit 11: **U.S. Electricity Generation From Renewables Has Expanded Rapidly Since 2000**



Source: "October 2020 Monthly Energy Outlook," US Energy Information Administration, October 2020

The truth is that renewable energy faces significant challenges today. First, to decarbonize the world's power generation, energy storage capacity needs to grow tremendously. The most scalable renewable energy sources such as solar and wind are intermittent, meaning they cannot provide a constant source of energy. As a result, utility companies must maintain some fossil fuel capacity – which can be switched on and off easily – to meet peak energy demand on days when the sun and wind are not strong. Of course, battery storage and transmission can ease renewable energy's intermittency problem. But the technology is not sufficiently scalable yet and material improvements around cost and storage efficiency are still needed.

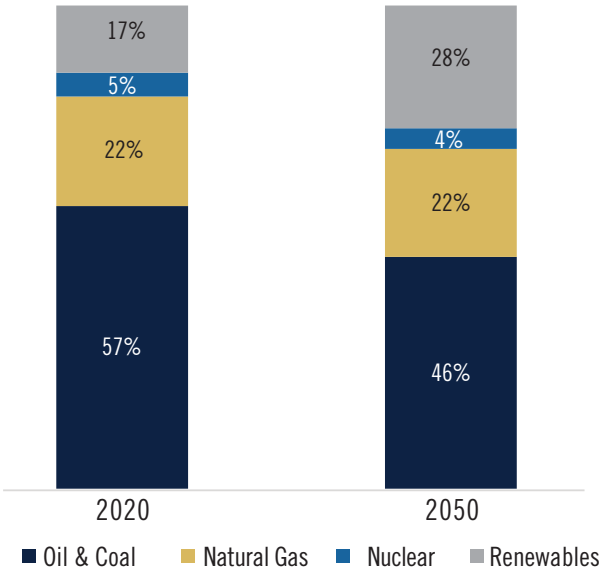
Second, to build out renewable energy capacity and infrastructure to a sufficient scale – from transmission networks for wind and solar to electric charging stations along highways – requires a massive amount of investment and time. According to one recent estimate, it would take $120 trillion in cumulative investment between 2015 and 2050 to reach the Paris Agreement goal of limiting global temperature rise below 2 degrees Celsius.[40] This would amount to more than $3 trillion of global investment every year until 2050. Though some of this investment would still be allocated to fossil fuels and energy efficiency, more than half would need to go towards renewables and electrification of transport and infrastructure.

> *Fossil fuels will remain a prominent feature of the global energy landscape for decades.*

Third, and perhaps the greatest challenge, is that even as the transition away from fossil fuels progresses, the end goal is moving further away. Global energy demand is forecast to grow by nearly 50% between now and 2050, according to the US Energy Information Agency (EIA). This is driven mainly by emerging markets, for whom improving energy access is essential to lift millions out of poverty and develop their economies. In sub-Saharan Africa, only 50% of the population has access to electricity.[41] Meanwhile, China consumes just 35% of the electricity the US consumes per capita.[42] This indicates significant room for growth in electricity consumption in these regions. Energy efficiency measures can slow this demand growth, but will not reverse it. This is evident in the US, where energy consumption will continue to grow even as energy intensity (the amount of energy consumed per dollar of GDP) declines dramatically (Exhibit 13).

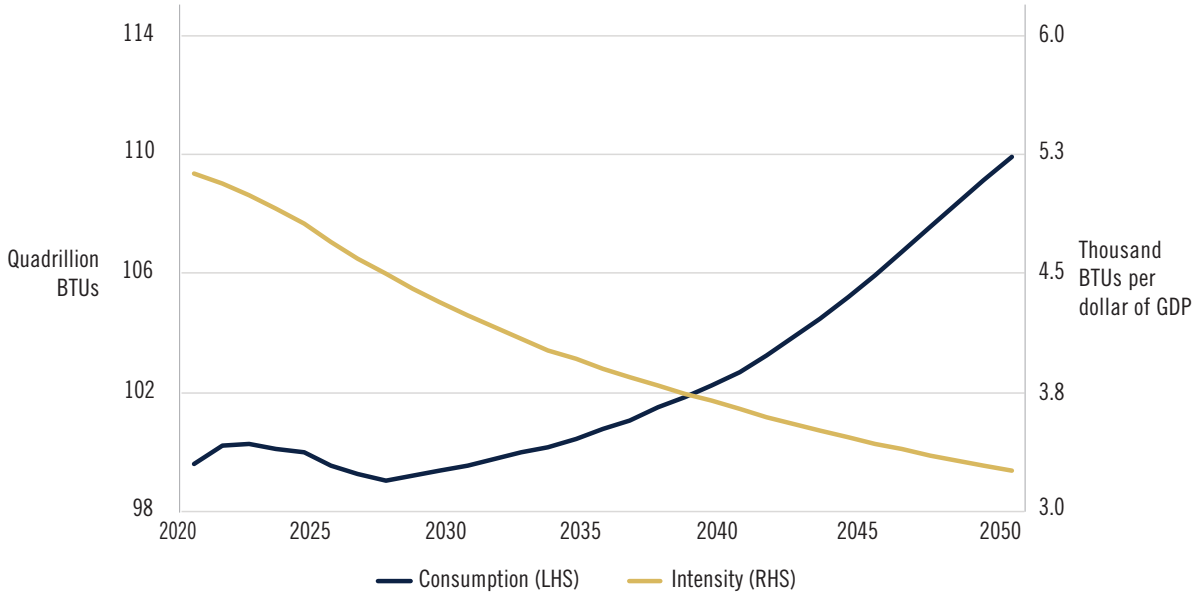
Given that fossil fuels remain abundant, easily transportable and can be switched on and off, they will remain a prominent feature of the global energy supply for decades to come. We shall return to this theme in Chapter 5, when we explore opportunities at the greener end of brown industries.

Exhibit 12: **Share of Global Energy Consumption by Source, 2020-2050**



Source: "Annual Energy Outlook 2020," US Energy Information Administration, January 2020
Note: Totals might not add to 100% due to rounding

Exhibit 13: **U.S. Energy Consumption Will Increase While Intensity Will Decrease**
Energy Use and Intensity Forecast, 2020-2050



Source: US Energy Information Administration, data accessed 2020
Note: British thermal units (BTUs) are used to measure thermal heat, or energy

3. Indirect effects from climate change could be very significant

The US Department of Defense has cited climate change and a myriad of second order effects – food and water scarcity, zoonotic diseases, climate-induced migration – as "threat multipliers."[43] This will exacerbate existing social and political tensions such as poverty and inequality and even spark new geopolitical conflicts. These knock-on effects from climate-driven stresses are likely under-weighted on investors' agendas.

Internal displacement and migration

Between 2008 and 2020, natural disasters displaced as many as 300 million people, according to the Internal Displacement Monitoring Centre.[44] The World Bank projects that by 2050, climate change may push over 140 million people in sub-Saharan Africa, South Asia and Latin America to migrate within their countries, away from areas with lower water availability and crop productivity or rising sea level and storm surges.[45]

Looking forward, with more than 10% of the global population living in low elevation coastal zones, "climigration" is likely to increase dramatically as sea level rise threatens the displacement of up to 1.4 billion people.[46] There are already ongoing discussions in Europe about how to accommodate climate refugees from Africa and the Middle East, with growing concern about how to manage political and social stress in the countries or regions that receive the immigrant populations. Two oft-cited scenarios are millions of Bangladeshis moving into India and northern and sub-Saharan African populations into Europe.

Civil unrest and geopolitical conflicts

Climate change-driven scarcity of natural resources may lead to civil unrest, violence and conflict. For example, as freshwater becomes scarcer in certain parts of the world and agricultural production shifts, millions of people will face water and food scarcity.[47]

Indeed, there is already evidence that climate change-linked droughts have led to conflict in parts of Africa

and the Middle East.[48] Three examples illustrate the kind of new risks investors will need to consider:

- A recent report commissioned by US intelligence services highlighted Egypt as a country where climate volatility might induce consequential disruption within a decade, given the reliance on wheat as a dietary staple. Fifty percent of Egypt's wheat production depends on water from the Nile, which flows through Sudan and Ethiopia before entering Egypt.[49] These countries have increasing water needs and also rely on the Nile as a key source.[50]
- Protests over power outages have led to increasing civil unrest in Pakistan over the last decade, with reports of escalating violence, rioters burning trains, looting shops, blocking roads and attacking politicians' homes. An already tight water supply is becoming increasingly stressed, with the World Bank describing Pakistan as "one of the most water-stressed countries in the world."[51]
- A frequently cited geopolitical risk from climate change is the possibility of melting Arctic sea ice leading to increased tensions over newly accessible sea routes and natural resources in the Arctic.

Zoonotic diseases

Climate change is altering the transmission patterns and geographic spread of emerging infectious diseases – 60% of which are zoonotic (that is, transmitted from animal-to-human).[52] Climate change increases the risk of pandemics along two channels: unleashing new zoonotic infectious diseases and increasing the range of territories where existing disease vectors (such as mosquitoes and ticks) can thrive.[53]

The changing climate allows existing infectious diseases, once confined to warmer latitudes, to expand their range. Because warmer average temperatures can mean earlier springs, shorter and milder winters, and longer and hotter summers, conditions become more conducive for many vector-borne diseases. For example, it has broadened the regions with optimal conditions for insect-borne pathogens transmitted by mosquitoes, fleas and ticks – such as Lyme and West Nile disease, malaria, Zika and dengue fever. The new wider ranges for some insects amplify the trend already underway towards more zoonotic spillover from human-caused ecological pressures and disruptions.

Make no mistake, climate change is already a major macro factor impacting growth and productivity. It will continue to be an economic force going forward as the world transitions to a new industrial age that more adequately accounts for the climate risks and externalities that were missing from market pricing in the golden age of fossil fuels. Investors will be on the front lines, making capital allocation decisions that will directly influence this economic transition. It is critical for them to assess how markets view these risks and what may trigger a repricing of assets to more fully reflect the myriad impact from climate change. This is the focus of Chapter 3.

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