December 2016

Emitting Money

Why Carbon Efficiency Matters For Businesses & Investors

TERRA ALPHA
INVESTMENTS

Terra Alpha Investments, LLC is an advocacy investment firm established in 2014.

Our vision is to drive systemic change in our economy, so that it is more aligned with our natural systems.

Our firm's mission is to demonstrate that Environmental Productivity enhances long-term returns as expressed in real investment results and to advocate for the widespread adoption of Environmental Productivity across the global economic system.

At Terra Alpha Investments, LLC, we advocate for the accounting for and disclosure of relevant environmental data from company operations because we see it as material to thorough investment research and understanding corporate efficiency. Using company-reported data (not third-party estimates), we compare the resource intensities of companies to peers in their sub-sector. If a company surpasses a threshold of efficiency relative to its peers, it is eligible for consideration based on our fundamental and valuation analysis process.

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Introduction

Businesses and investors who consider the constraints to growth and the possibilities for outperformance related to their carbon footprint, will be better positioned to succeed versus their peers, and to maximize the returns on their investments. This report aims to provide investors and businesses with a clear case for the risks and opportunities presented by greenhouse gas (GHG) emissions[i] and furnish them with tools to incorporate this knowledge into their operational and investment decisions. GHG emissions and energy consumption data, along with other environmental factors, can provide investors with material information to minimize risk and maximize returns.

Carbon[ii] is an essential element in the global economy. From our global energy supply (dominated by fossil fuels), to deforestation, livestock farming, and industrial processes, carbon emissions are embedded into the daily operations of all companies and throughout their supply chains. As is now well understood, these emissions (mainly stemming from the burning of fossil fuels for energy) have unbalanced the planet's atmospheric composition and threaten to cause greater harm should global societies (including businesses) not adapt. Companies that can operate efficiently, emitting less carbon and consuming less power, will be more effective and profitable moving forward.

As the effects of GHG emissions from a carbon-heavy economy have become better understood, and as regulatory frameworks (at local, national, and global levels) governing these emissions have become more stringent and costly, there is increasing awareness that companies must re-examine the role carbon plays in their enterprises. The risks stemming from carbon emissions are continually growing, making it imperative for businesses and investors to act sooner rather than later. Advances in energy efficiency and renewable energy technologies are building momentum for a paradigm shift and demonstrating that low-carbon energy systems are a reliable replacement to conventional sources of energy. Many companies have already entered the market or repositioned themselves in order to compete in a more carbon- and energy-efficient[iii] world, and these efforts have already begun to pay off.

[i] For more information read Greenhouse Gases - A Primer.

[ii] Carbon and carbon emissions will be used interchangeably throughout this document as a shorthand reference for greenhouse gases and greenhouse gas emissions.

[iii] Improving carbon-efficiency and energy-efficiency are distinct concepts that are usually (though not always) positively correlated. (CE- the efficiency with which a business consumes and emits GHG resources; EE- the efficiency with which a business consumes electricity).

Key Takeaways

- **The Real Costs of Our Carbon-Intensive Economy:** The greenhouse gas emissions caused by society and the global economy have altered the planet's climate. The effects of this alteration are already - and will continue to be - extremely costly, in both societal and economic terms. Conventional power generation and fuel consumption are inextricably tied to the emission of carbon and largely responsible for the increased atmospheric concentration of GHGs.

- **How Businesses and Investors Can Gain From Early Action:** There are already vast opportunities to capture for businesses and investors who adopt more carbon-efficient business models and portfolios. Reducing costs of operation, gaining strategic resilience, and accessing new and growing markets are examples; businesses and investors who capture these opportunities will benefit greatly.

- **How Investors and Businesses are Hurt by a Failure to Act:** Businesses face a multitude of risks from their continued dependence on GHG-emitting technologies and inefficient consumption of power. Supply and subsequent price volatility, the assured prospect of increasing regulation across the globe, and greater consumer/asset owner scrutiny all threaten both businesses and investors who do not adapt.

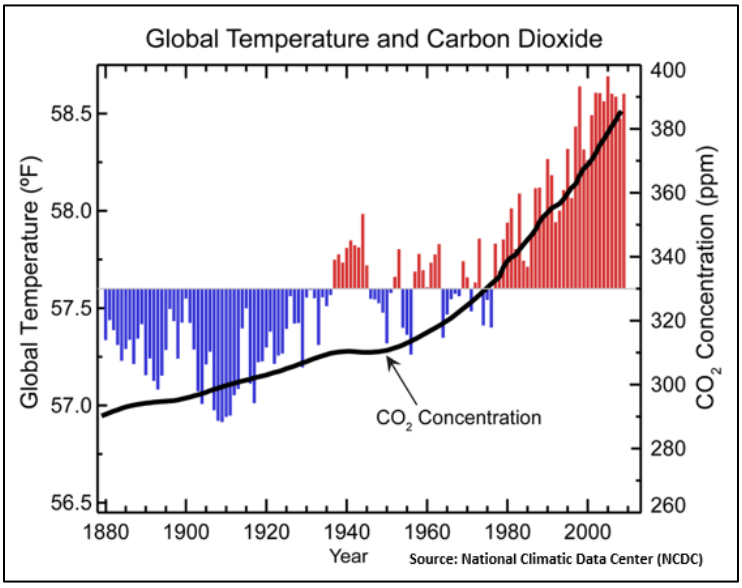
- **Recommended Business Leader Actions:** Companies who monitor their GHG footprint and energy usage can manage it better. Those who effectively manage these factors will both avoid risks, as well as capture opportunities. Many tools and organizations already exist to help companies measure, reduce, and report their emissions.

- **Recommended Investment Professional Actions:** There is a growing demand for investment professionals to incorporate carbon emissions and other environmental factors into their strategies, and many investors have already made strides to do so. Investors still need to demand more quantitative, robust, and contextualized disclosure from companies across the board. Those who incorporate this information - taking a sector-specific materiality focus around carbon efficiency and power consumption - into their investment process can reduce risk and improve their returns.

The Real Costs of Our Carbon-Intensive Economy

Human activity has long shaped ecosystems and environments across the globe. However, perhaps no activity has impacted the planet more so than human emissions of greenhouse gases (GHGs) into the atmosphere.[iv]

Since the turn of the 20th century, global atmospheric CO_2 concentrations have risen from around 280 parts per million (ppm) to (periodically eclipsing) 400 ppm today. Mainly driven by fossil fuel combustion for energy, this rise in the amount of CO_2 and other GHGs in the atmosphere has subsequently led to a rise in global temperatures.[iii] In a study of the past 134 years, the ten warmest years occurred in the past two decades, 14 of the 15 hottest years on record have occurred in the 21st century, and 2016 is the third consecutive year of record heat.[1]

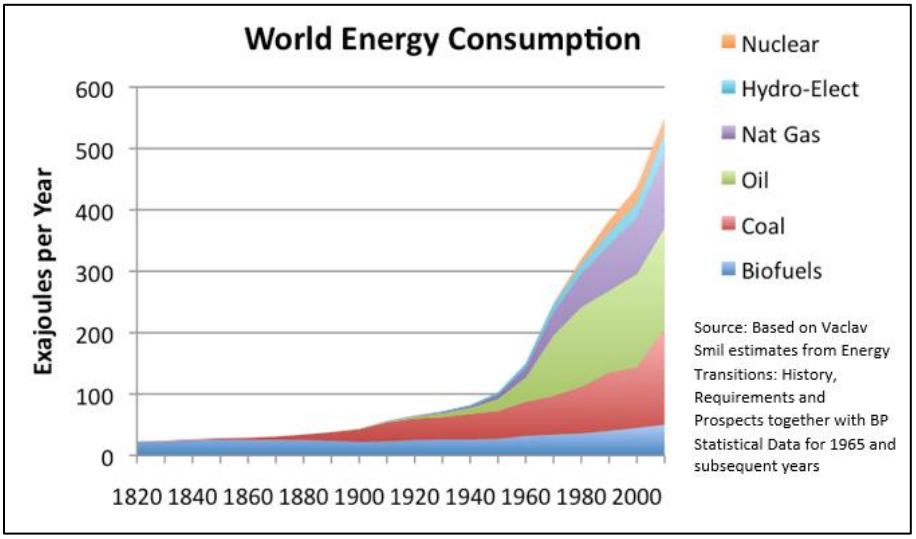


The connection between human demand for energy and carbon emissions is very real. Fossil fuels account for roughly 80% of the global power supply.[2] Businesses today are overwhelmingly powered by conventional, carbon-intensive fossil fuels. Electricity generation is the single largest source of carbon emissions; as of 2015, annual emissions totaled 12.6 gigatons of CO_2 - roughly equivalent to the average annual emissions of 2.43 billion passenger vehicles.[3] Energy production and consumption combined account for around two-thirds of global GHG emissions.[4]

- A 2015 report in *The Economist* stated that the present value of expected losses to the world's current stock of manageable assets (≈$143 trillion) due to climate change was $4.2 trillion [by 2100]. This loss is roughly equivalent to the total value of all the world's listed oil and gas companies or Japan's entire GDP.[5]
- A 2016 study from the London School of Economics cautions investors that climate change could decrease the value of the world's financial assets by $2.5 trillion.[6]
- By 2030, average net losses incurred due to climate change will be 3.2% of global GDP (>10% if emissions continue unabated).[7]
- By 2100, if efforts to curb GHG emissions are not further pursued, the per-capita incomes of 77% of countries in the world will be lower relative to current levels and global incomes will decline by 23% (relative to the world without climate change).[8]
- In the U.S., four impacts alone—hurricane damage, real estate losses, energy costs, and water costs—will come with a price tag of 1.8% of U.S. GDP, or almost $1.9 trillion annually (in today's dollars) by 2100.[9] For many countries, these costs will be or are already much higher.
- By 2100, the world's economies stand to lose over $14.3 trillion due to climate change, the equivalent of the world losing its 90 largest companies.[10]

[iv] Over 97% of climate scientists endorse the position that humans are causing global climate change. (http://iopscience.iop.org/article/10.1088/1748-9326/8/2/024024/pdf)

These impacts are only complicated further by both the growing global population (projected to expand by 2.3 billion people over the next 35 years) and the large group of people still living without access to electricity today (nearly 1.3 billion people) but looking to gain access to electricity over that time frame.[11,12] With such a large and growing demand for basic goods and services -- all requiring some amount of energy -- global businesses must be able to operate at a higher energy efficiency and with a lower carbon footprint if they wish to grow, too. Similarly, investors need to consider both the risks and opportunities posed by carbon emissions, as more carbon-efficient companies will be better equipped to succeed.



How Businesses and Investors Can Gain from Early Action

Businesses are faced with an abundance of opportunities to improve efficiency, shift to more reliable energy sources, avoid regulatory risks, and overall improve returns. Operationally, the case for companies reducing their carbon footprint is becoming increasingly self-evident as technological advances, economies of scale, and supportive policy drive down cost. The strategic benefits of reducing emissions and adopting energy-efficient/clean[v] technologies are even more clear-cut. Most evidently, a shift toward a carbon- and energy-efficient future provides incredible market opportunities for businesses and investors. Over half of Fortune Global 500[vi] companies report finding business opportunities resulting from modified consumer behavior due to climate change.[13]

Operational Opportunities

For most companies, operational opportunities stemming from reducing GHG emissions can have swift and significant financial impacts. In 2015, 63 suppliers disclosed to CDP a combined savings of $1 billion from "emissions reductions activities."[14] These opportunities include a significant amount of "low-hanging fruit" projects that can quickly reduce a company's GHG profile, while simultaneously saving money. These gains capitalize on the incredible amount of energy that is currently wasted throughout the economy.

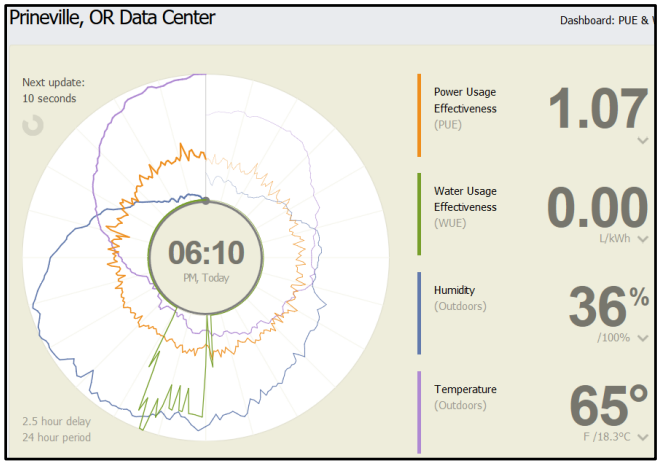
In the U.S., 67.4 quadrillion BTUs of energy (62% of all energy produced) is wasted annually due to inefficiencies in production, transmission, and end use via motors, switches, etc.[15] For example, on an annual basis, typical servers in business/enterprise data centers deliver between 5-15% of their maximum computing output. Thirty percent of all servers (around 10 million) are in fact comatose (have not delivered information or computing services in six months or more).[16] This inefficiency equates to at least $30 billion in data center capital sitting idle, globally.[17] Similarly, if all computers in the U.S. achieved a 30% average energy reduction, consumers could save $3 billion/year and reduce power consumption equivalent to that of all the households in Los Angeles and Chicago each year. This reduction would avoid 20 million tonnes of carbon emissions with zero impact on computer performance or user convenience.[18] Through technological and process efficiency improvements, companies can capture these enormous amounts of value.

- **UPS's** fleet efficiency routing software, ORION, is estimated to result in **annual savings of 10 million gallons of fuel,** a reduction of 100,000 tonnes in CO_2 emissions, and an estimated $300 to $400 million in savings and cost avoidance once U.S. implementation is complete at the end of 2016.[19]
- As early as 2012, the difference in fuel costs for maritime shipping vessels between a B-rated (GHG emissions rating) and an F-rated Capesize vessel was, on average, **$5,500 per day, or nearly $1.5 million annually**.[20]
- From 2009 to early 2016, **Hilton Worldwide's** environmental management program reduced energy use by 14.5% and carbon output by 20.9% (vs. 2009 levels) and saved the hotel chain $550 million.[21]

[v] Low GHG-emitting

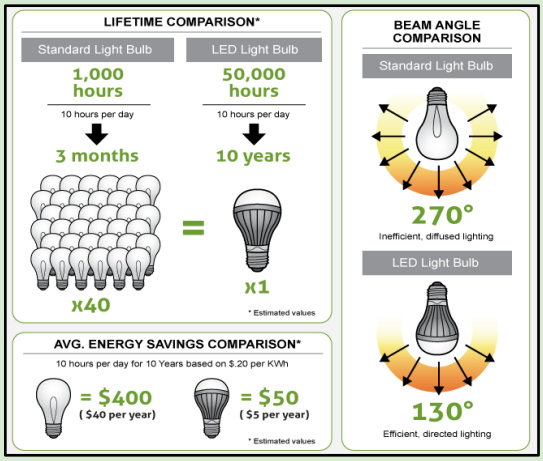
[vi] The Fortune Global 500, also known as Global 500, is an annual ranking of the top 500 corporations worldwide as measured by revenue.

- From 2010-2013, **Facebook has saved more than $1.2 billion** by using Open Compute, an open source, inter-company collaboration around data center design to streamline the efficiency of its data center and servers. These savings are the result of hundreds of small improvements scaled across Facebook's hundreds of thousands of servers. This project has saved Facebook enough energy to power 40,000 homes and delivered carbon savings equivalent to taking 50,000 cars off the road.[22] Facebook even provides real-time and historical usage data for several of their data centers (pictured right).



Lighting the Way to Change

One of the most popular methods for improving energy efficiency across all sectors has been lighting retrofits. LED bulbs use as much as 90% less power than standard bulbs and have vastly greater lifespans, up to 40x longer than incandescent bulbs. The Department of Energy estimates that lighting retrofits reduce electricity consumption by 30-50% and result in 10% to 20% savings in cooling costs.[23]



Just from 2012-2015, LED bulb sales have gone from 8% of lighting sales to 68%; they are set to reach 77% in 2020. Prices have dropped 90% since 2008, and the LED lighting market is anticipated to grow 45% per year through 2020 when it reaches $63.1 billion.[24]

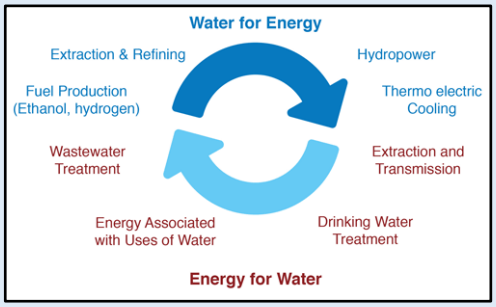
Bulb manufacturer **Philips** and REIT **Jones Lang LaSalle** (JLL) partnered in 2012 to provide LED lighting to JLL's clients. At the time of signing, the deal had the potential to provide energy savings of up to $100 million for JLL's Asia Pacific clients alone. Including these gains from LED bulbs, JLL has reduced greenhouse gas emissions by 12 million tonnes since 2007 – equivalent to removing approximately 2.5 million cars from the road, all while saving clients $3.2 billion in cumulative annual energy savings, with an average energy cost reduction of 15-20%.[25]

Companies reducing their GHG emissions by shifting their power supply toward a greater mix of renewables can realize similar savings and operational benefits. The use of renewable energy sources is inherently cheaper over the long term as procurement (wind, solar, hydro, and geothermal) is free. The main barrier for companies (the upfront cost of purchasing and installing these technologies) has been declining precipitously over the past several decades. In the last five years, wind power prices dropped

by 35%[26] and solar prices by 50%. [27]The levelized cost of generation per MWh for onshore wind is expected to fall 41% by 2040 and by 60% for solar photovoltaics, making these two technologies the cheapest ways of producing electricity in many countries during the 2020s and in most of the world in the 2030s.[28] Many businesses have already realized these opportunities:

- New York-based utility **Con Edison** estimates it will save roughly $1 billion by deploying a mix of renewables (solar, fuel cell, and efficiency measures), instead of building out conventional energy infrastructure to accommodate growing demand in New York City.[29]
- The Israeli government aims to reduce carbon emissions by 25% by 2030 (vs. 2005 levels). Much of this reduction hinges on increasing the national renewables mix from 2% to 17% of all power generation.[30] In total, the government estimates this plan will help save about $8 billion over the next 14 years.[31]
- In the U.S., companies will need to cut emissions by an average of 3% to meet the 2° requirement set by the COP21 Paris Agreements. These cuts are expected to **save these companies $190 billion by 2020.**[32]
- **General Motors** has saved roughly $80 million to date from using renewable energy and expects their annual savings to grow as they increase their percentage of renewables in their portfolio.[33]

Energy-Water Nexus



Carbon emissions are intrinsically connected to aspects of nearly all business operations. One of the most fundamentally interrelated of these connections is between energy and water. Water is required in some way, shape, or form to help produce or generate most sources of energy. Similarly, the extraction, transport, treatment, and distribution of water are all energy-intensive processes. In the United States, there is a relatively even split between water withdrawals for irrigating crops (40% of total) and for cooling thermoelectric power plants (39%).[34] Global annual water consumed for energy production is approximately 45 billion m^3.[35] This relationship allows for significant efficiency gains on one factor when improvements are made on the other.[vii]

- California's mandatory 25% reduction in urban water use, adopted in May 2015 due to the ongoing severe drought, resulted in significant carbon emissions reductions, as well. From June 2015 to February 2016, 922 gigawatt-hours of electricity were estimated to be saved -- similar in scale to taking almost 50,000 cars off the road.[36]
- **PepsiCo**. reduced its operational water use last year per unit of production by 26%, which helped contribute to a similar 16% energy efficiency improvement in legacy operations (vs. 2006 baseline). As a result, the company achieved cost savings of $600 million from 2011-2015.[37,38]
- **Constellation Water's** commercial and industrial customers reduced their CO_2 emissions by about 75,432 tonnes from 2012-2014 through the company's water-efficiency projects.[39]

[vii] For more information, see Navigating Rough Waters

Strategic Opportunities

Reducing GHG emissions and improving energy efficiency has many benefits beyond direct operational impacts, as well. Strategically, companies can profit from:

- Increased energy independence/security and more stable energy costs.
- Better positioning for future energy markets as a result of increasing carbon emission regulation and decreasing renewable energy costs.
- Greater flexibility in asset location and operation as a result of distributed generation.
- Reduced likelihood of negative attention for a perceived contribution to global climate change.
- Increased likelihood of stimulating greater interest from customers, as well as attracting and retaining employees.

Recognizing the long list of strategic advantages stemming from reducing GHG emissions and improving energy efficiency, many companies have already begun to take action:

- **Nike** partnered with private equity firm, Apollo Global Management in August 2016 to create an apparel supply chain company in order to more effectively monitor and reduce carbon emissions and energy consumption by the company and throughout their supply chain. Their goal of "embedding sustainability and transparency into the business" will allow Nike to capture a wide range of strategic benefits, notably, from being more carbon efficient.[40]
- In September 2016, **General Motors (GM)** announced plans to generate or source all electrical power for its 350 operations in 59 countries with 100% renewable energy by 2050.[41] The stated motivations for this commitment were to "strengthen their business through lower and more stable energy costs."
- **Apple** currently powers 100% of its operations in China and the U.S. and more than 93% of its worldwide operations with renewable energy.[42] The company has formed a subsidiary (**Apple Energy**), which will sell solar power generated by its solar arrays across the U.S.[43] Apple also has a clean energy program, through which it will partner with suppliers in China to install more than 2 GW of new clean energy in the coming years, avoiding over 20 million tonnes of GHG emission from now through 2020.[44]

A global survey of 3,700 business school students conducted by Yale's Center for Business and the Environment found **nearly half of students were willing to work for less** at a company with a strong sustainability record. A further 20% stated their refusal to work for an environmental laggard, no matter the financial incentive.

(Source: http://cbey.yale.edu/)

Perhaps the most powerful endorsement of the strategic benefits accompanying a reduced GHG footprint is the action being taken to do so by one of the world's most tactical and forward-thinking organizations -- the U.S. Department of Defense.

The Pentagon Goes Green To Save Money and Lives

The U.S. Department of Defense, the world's largest employer, has made a serious commitment to reducing its carbon intensity in recent years, largely due to the strategic benefits it perceives.[45] In 2011, President Obama launched The Energy Savings and Performance-Based Contracting Investments Initiatives program (ESPBCII), which called for the U.S. government to execute $4 billion in energy-saving/emissions-reducing projects by the end of 2016. All branches of the U.S. military have taken up this challenge to lead the way in improving their carbon efficiency.

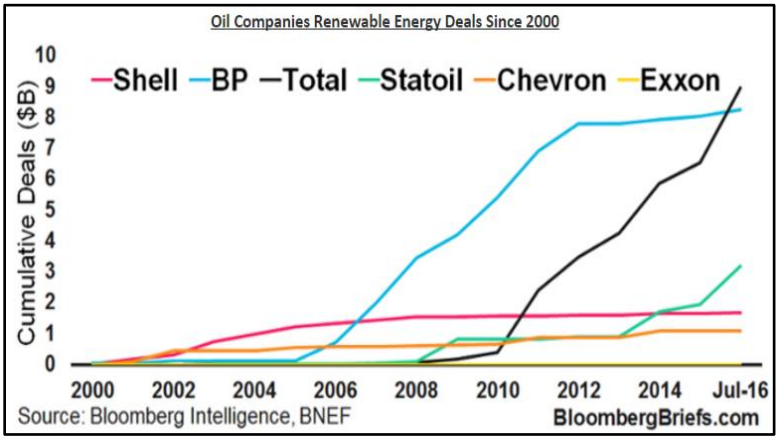
Army: From 2011-2016, the U.S. Army has invested $1 billion in 127 energy-efficiency projects, contributing 33% of the progress to the $4 billion ESPBCII mark.[46] The Army has a Net Zero Initiative for nine pilot installations to achieve net zero (energy consumption, water use, and waste generation) by 2020.[47]

Marines: At Camp Lejeune, NC, a coal-fired steam plant was replaced by lower-emitting natural gas boilers. The switch is expected to cut carbon dioxide emissions by 69,000 tons and save about $13 million annually.[48]

Navy: The U.S. Navy set a goal that by 2020, 50% of its total energy consumption will come from alternative sources. This goal includes reducing the commercial fleet's petroleum consumption by 50%.[49] In April 2016, the Navy said it would ask its 100 largest suppliers to disclose their greenhouse gas emissions, as well as their strategies for cutting them, via CDP.[50] By the end of 2016, the Navy plans to deploy its "Great Green Fleet," a Carrier Strike Group operating on alternative fuels (nuclear power and a blend of advanced biofuels), and employing energy-efficient technologies and operating procedures.

The military is pursuing these initiatives principally for their strategic advantages. These changes bring maximized mobility from distributed generation capability of renewables, reduced exposure to price and supply volatility of oil (increased energy security), overall lower costs of operation, and reduced GHG emissions/contribution to climate change.[51]

Oil and Gas companies, whose business plans operate around the extraction, sale, and eventual combustion of fossil fuels, are beginning to make strategic investments in renewables too.



- **Total SA** has spent almost $9 billion since 2000 on clean and alternative energy investments (led off by a $1.38 billion deal in 2011 for 60% of **SunPower Corp).** Total's stated goal is to have low carbon businesses make up around 20% of its portfolio in 20 years.[52]
- **Statoil ASA** has made around $3 billion of public renewables investments since 2000.[53]
- **Neste**, an oil refiner, has grown its renewables business from $370 million in 2010 to $2.7 billion in 2015, focusing large amounts of resources on renewable diesel.[54]

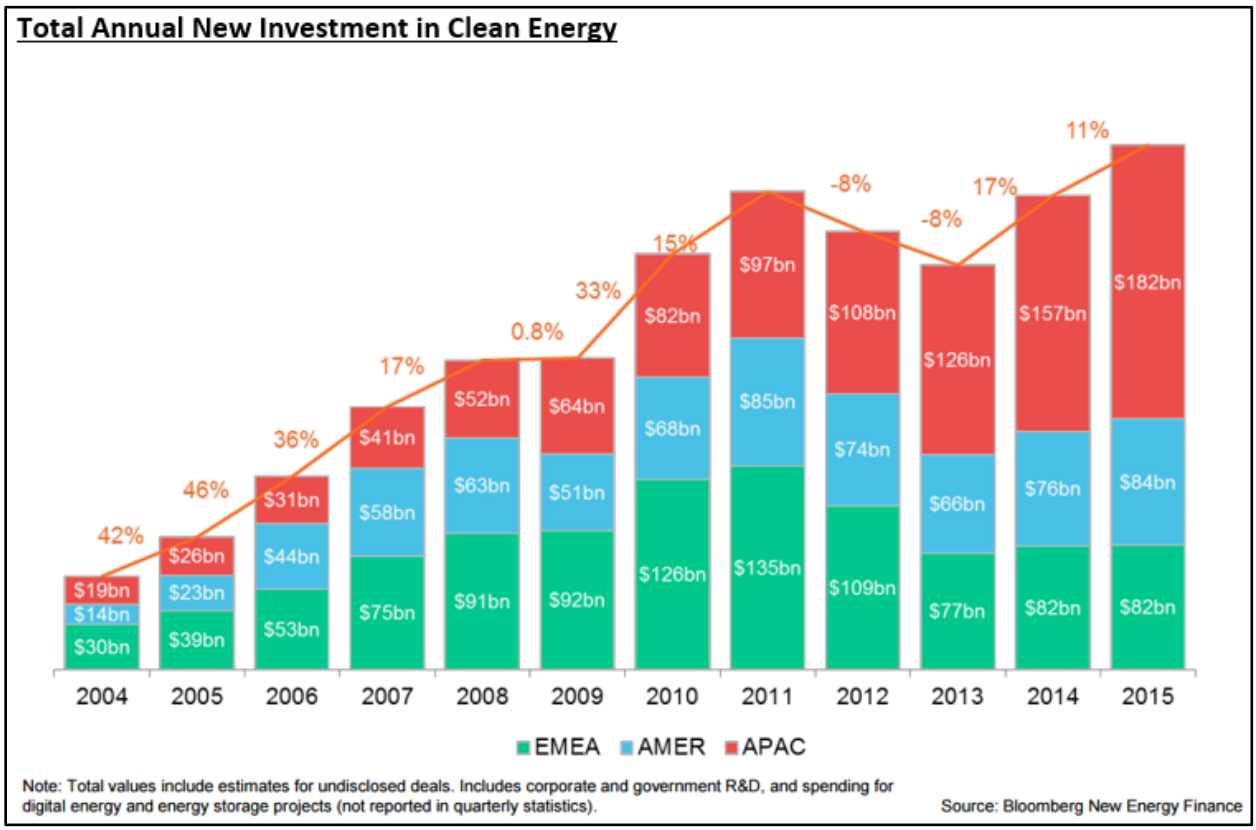
The recognition of the strategic benefits of low-carbon business strategies has also led to the creation of a variety of organizations/coalitions aimed at helping companies improve their carbon efficiency (See **Appendix A**).

Market Opportunities

Perhaps most explicit of all the opportunities presented to businesses from improving carbon efficiency are the vast amount of market opportunities available. The world currently buys about **$3.5 trillion worth of primary energy** – coal, oil, natural gas, nuclear, and renewables every year.[55] With the global population expected to grow 20% by 2050 and global demand for electricity expected to increase 56% from 2010 to 2040, there is a clear need to develop and expand more carbon-efficient power sources, products, and services now.

Furthering this momentum is pressure from new regulations. The International Energy Agency (IEA) estimates that the Paris Climate GHG emissions reduction pledges will create a $13.5+ trillion market for investment in energy-efficiency and low-carbon technologies[viii] from now through 2030 ($840 billion/year on average).[56] With the private sector accounting for around half of the world's electricity consumption, there is an incredible opportunity for businesses to not only improve their carbon efficiency but to enable others to do so, as well. Already, investment in low-carbon technologies and renewable energy has been rapidly growing.

- Since 2007, the global market for environmental technology and resource efficiency has, on average, grown by 11.8% annually (vs. 2.4% growth for the larger global economy).[57]
- Investors have spent more than $2 trillion on clean-energy plants in the past decade.[58] In 2014, $270 billion was spent on renewable energy technologies, which **made up more than half of the net power capacity added worldwide**.[59]

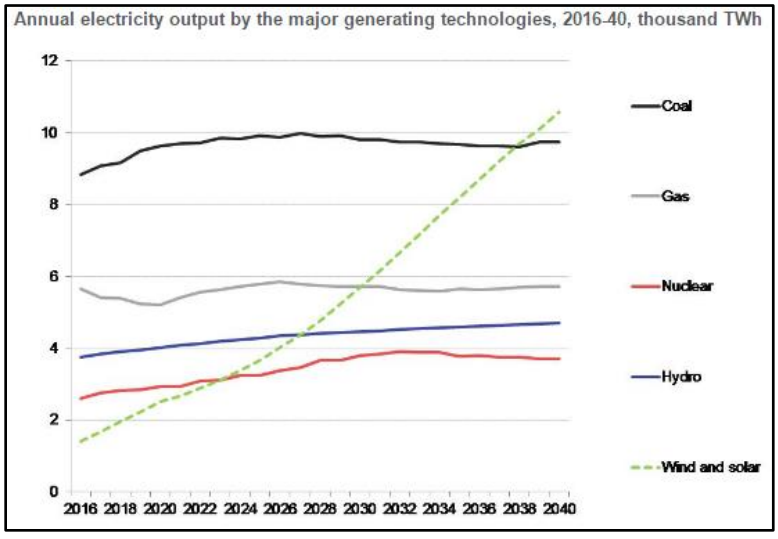


[viii] Some $7.8 trillion will be invested in green power, with onshore and offshore wind attracting $3.1 trillion, utility-scale, rooftop and other small-scale solar $3.4 trillion, and hydroelectric $911 billion.

- In 2015, coal and gas-fired electricity generation attracted less than half the investments made in renewable capacity.[60] Renewables (excluding large hydro) made up 53.6% of the gigawatt capacity of all technologies installed in 2015.[61]
- Global investment in clean energy totaled $116.4 billion in the first half of 2016.[62] $7.8 trillion will be invested globally in renewables between 2016 and 2040.[63]
- The World Bank estimates the world needs to triple its investment in sustainable energy infrastructure per year, from around $400 billion now to $1.25 trillion by 2030.[64]

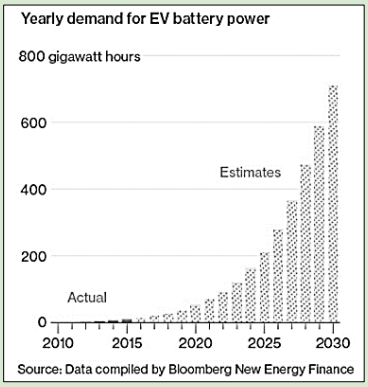
These investments have seen rapidly growing returns, as well. Renewables accounted for nearly half of the growth in global electricity generation capacity in 2014.[65]

- Over the past five years alone, U.S. wind power capacity has more than doubled, and solar output has grown even faster — by nearly 32 times. [66] [67]
- In 2015, renewables surpassed coal to become the largest source of global electricity capacity.[68]
- Solar PV costs have plunged 80% since 2008.[69]
- Wind and solar are estimated to become the cheapest ways of producing electricity during the 2020s and in most of the world in the 2030s. Onshore wind costs will fall by 41%, and solar PV costs will fall by 60% by 2040.[70]
- By 2040, zero-emission energy sources will make up 60% of installed global capacity. Wind and solar will account for 64% of the 8.6 TWh of new power generating capacity added worldwide over the next 25 years.[71]



Companies are already recognizing the value and opportunities represented by these shifts. In 2016, 69% of the Fortune Global 500 companies reported increased demand for lower-carbon products and services.[72] A recent UN study found that **70% of executives** representing companies with annual revenues of more than $1 billion see climate change presenting **growth opportunities for their company within the next five years.**[73] One of the largest such opportunities lies in transportation. Responsible for 22% of energy-related GHG emissions worldwide, and with an emissions rate increasing faster rate than any other sector, there has been a bevy of recent activity to capture opportunities in the low-carbon transport market.[74]

Cars Shrinking Their Footprint



The global personal transport marketplace has changed drastically in the past several decades. The vast majority of these changes-growth of the electric vehicle (EV) market, the rise of car- and ride-sharing services, mass-transit improvement and a general trend of declining car ownership-all serve to facilitate a less carbon-intensive future for passenger cars. Many of these changes have taken place rapidly and are forcing market participants to adapt accordingly. For example, ridesharing has gone from a non-present market to a billion dollar industry in under 4 years. Similarly, plug-in EVs from major automakers debuted in 2011 and today, see more than 20 EV and plug-in hybrids offered by over a dozen brands. Statistics like these only serve to highlight the further growth the low-carbon transport market is expected to make in the future:

- Ride-sharing usership in the U.S. alone is expected to grow by double digits in 2017.[75]
- EVs are projected to become 10% -15% of the global auto market by 2020,[76] and 35% by 2040 (90x 2015 EV sales).[77]
- EVs will be just as cost effective as traditional vehicles by 2022.[78]
- Automated mobility services could capture two-thirds of the entire U.S. mobility market by 2030.[79]
- Personal vehicle demand is estimated to drop by as much as 40% by 2030, as consumers choose from a growing number of mobility options.[80]
- One of the world's largest automakers, Toyota, has promised to reduce global average new-vehicle CO_2 emissions by 90% by 2050 (vs. 2010 global average).[81]

Beyond transportation, companies in a variety of fields have been experiencing market demand shifts toward greater GHG efficiency and/or enabling other companies to cut their emissions.

- In February 2016, **Intel** announced that new technologies in chip manufacturing would favor lower energy consumption over faster execution times – effectively calling an end to 'Moore's Law.'[82] Bolstering this claim, rival chip maker **AMD** highlighted in late 2015 that their latest processor reduced carbon emissions by 50% vs. its prior generation. The analysis found that an enterprise customer upgrading 100,000 notebooks from the prior-generation chips could **save around half a million dollars and 3,350 tonnes of CO_2 over just a three-year period.**[83]
- Cement production, which comprises around 3.4% of human CO_2 emissions has seen a similar market shift toward carbon-efficient solutions.[84] The global **"green cement" market is expected to reach $37.76 billion by 2024,** and dozens of companies are trying to provide solutions.[85] In January 2016, **Heidelberg Cement,** one of the three largest cement companies in the world, entered into a joint venture to scale a process which takes CO_2 from cement smoke stack flue gas and converts it to low-carbon fuel for transport.[86]

- The smart thermostat (devices that optimize and reduce building energy consumption) market grew 123% in 2015 and is currently valued around $879M (4.9M devices).[87] **Nest Labs**, a maker of smart thermostats and other smart-home devices, was bought by **Google** for $3.2 billion in February 2014. When combined with other devices that help to reduce energy consumption around the house, the smart-home market is expected to grow from $46.97 billion in 2015 to $121.73 billion by 2022.[88]

Some established companies have already refocused their businesses to participate in the low-carbon economy.

GE Moving Toward the Future

In 2005, GE launched the Ecomagination program to build products solving environmental challenges, namely, reducing greenhouse gas emissions. Since 2005, more than 140 diverse products from jet engines and wind turbines to efficient home appliances and LED light bulbs have been introduced. In 2010, GE set the ambitious goal of growing Ecomagination's revenue twice as fast as total company revenue within five years. In 2012, the program met this objective, generating revenue of $25 billion. From 2005- 2013, GE eliminated 26 million tonnes of GHG emissions – equivalent to taking all cars in Massachusetts off of the road.[89]

Products from the program include the Evolution Series Tier 4 Locomotive, which the company says will reduce emissions by more than 70% from the previous model and a concept called the Digital Wind Farm, which can boost a wind farm's energy production by 20%.[90]

As of 2015, GE has already invested $17 billion of R&D in Ecomagination and aims to invest a total of $25 billion by 2020. The program has more than paid for itself, as it generated $232 billion in revenue (as of 2015), representing a growth rate of four times GE's overall revenue growth.[91] GE plans to invest a further $10 billion in the program by 2020 with anticipated GHG emissions reductions of 20% (vs. 2015 levels).[92]

Most notably, many countries have made renewables a priority moving forward and have already created massive and growing markets for carbon-free energy. China is a striking example of this impact.

China's Renewable Revolution

China is the biggest energy user and GHG emitter in the world. With a growing population of nearly 1.4 billion, China has made ambitious strides in the past decade to begin curbing its carbon footprint and is now the world's leading solar and wind power producer.

2009 - The State Council announced a plan to reduce the carbon intensity of the national gross domestic product by 40-45% by 2020 (vs. 2005 levels).

2013 - A low-carbon pilot program was put underway in several Chinese cities. It is now underway in 13 Chinese provinces and cities.

2014 - President Xi Jinping pledged to peak China's emissions around 2030 and increase the share of renewable energy sources in the economy from 8.3% in 2010 to roughly 20% by 2030.[93]

2010-15 - Investment in renewables in China rocketed from $39 billion to $111 billion. Electric capacity for solar grew 168-fold, and wind power quadrupled.[94]

2015 - The country invested $110.5 billion, or 36% of all global investment, in renewables.[95] China accounted for roughly half of all wind additions and 40% of all renewable capacity increases in 2015.[96]

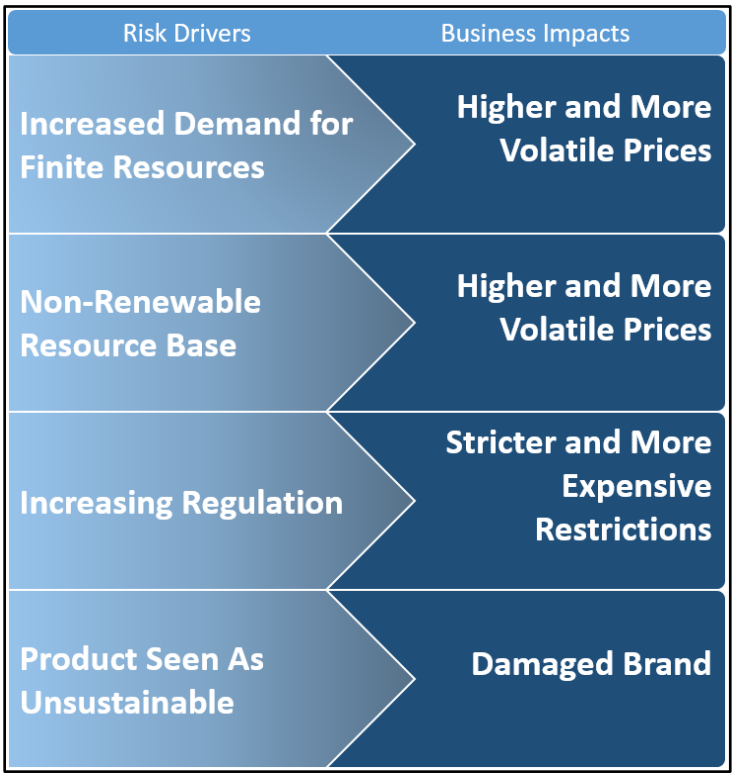
2016 - The **China Minsheng New Energy Investment Co**. announced the intent to invest $16.1 billion in five renewables areas over the next three to five years, with the eventual goal of installing 12 GW.[97] In comparison, the U.K. will barely have 11 GW of installed solar nationwide, by the end of 2016.[98] The company's current project will be the world's largest solar power plant, a $2.34 billion, 2 GW solar farm, which will produce more photovoltaic power than Thailand's entire installed capacity and nearly the same amount as Canada.[99]

Currently, the installed generating capacity of wind power in China has exceeded 90 GW. Solar power capacity has reached 30 GW.[100] Combined, this is more than enough energy to meet the entire country of New Zealand's current energy demand.[101]

How Investors and Businesses are Hurt by a Failure to Act

In January 2016, the World Economic Forum's 650 experts assessed 29 global risks and determined that the largest risk over the next ten years will be the failure of climate change mitigation and adaptation.[102] A month prior, the Sustainability Accounting Standards Board (SASB) reported that 93% of American public companies face some degree of climate risk.[103] These risks stemming from carbon emissions can be manifested in three primary forms: Operational, Regulatory, and Reputational risks.

Every company, regardless of sector, emits or depends on other services/products that emit GHGs in their supply chain. These emissions and their subsequent risks come with a price tag. Increasingly, risk drivers around GHG efficiency and overall footprint are impacting businesses' bottom lines.



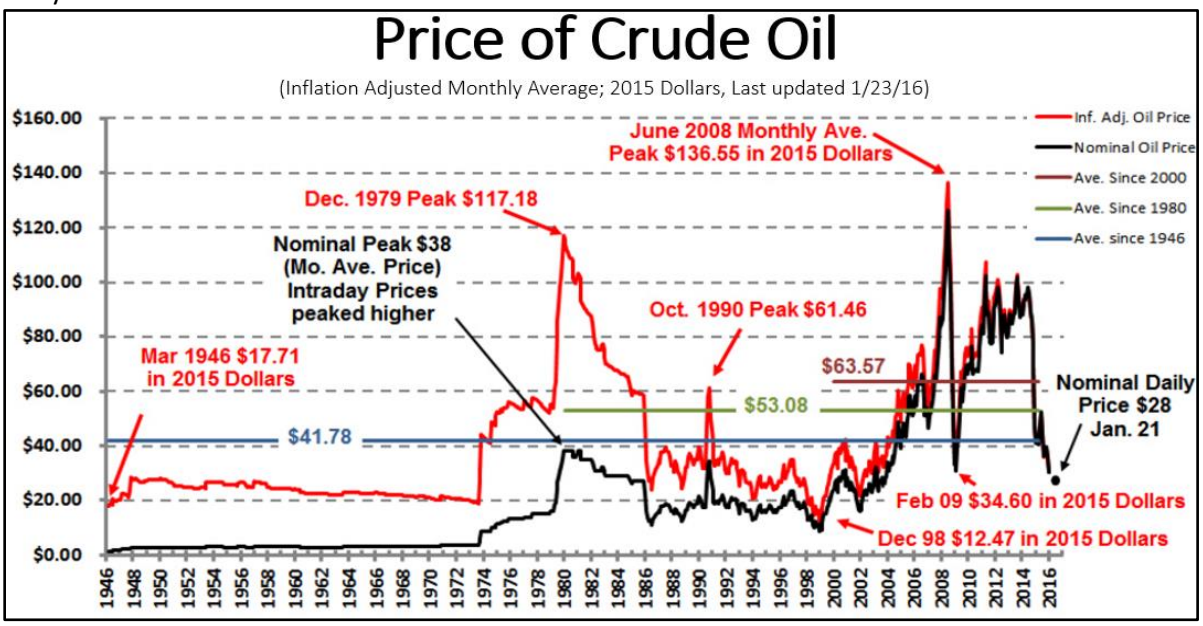
Operational Risks

If a company is over-reliant on carbon-intensive fuels or processes to operate at any point in their supply chain, they are increasingly exposed to operational risks. Ongoing volatility can even impact companies who have hedged risks linked to price fluctuations and fuel supply. As global reserves of these fuels continue to be consumed, extraction and production are becoming increasingly more expensive.[104] However, fossil fuel companies are not the only ones bearing these risks. Companies with inputs to production linked to carbon-intensive fuels, high-energy intensities, significant transportation needs, or even insurance liabilities are all similarly subject to operational risks posed by GHG emissions.

- In 2005, **Kraft Foods** raised pricing on many of its products by an average of 3.9% and cut its 2005 profit estimates citing rising energy and packaging costs.[105] Higher energy costs again caused price increases (22% increase on Maxwell House coffee) at Kraft in 2011.[106] This relationship is not unique, the U.S. Department of Agriculture found that of each dollar Americans spend on food, seven cents is tied to the cost of energy.[107]
- Since April 2015, **six publicly-listed U.S. coal producers** have **filed for Chapter 11 bankruptcy**: **Peabody Energy, Arch Coal, Walter Energy, Alpha Natural Resources, Patriot Coal, and Xinergy Corp**. Peabody stock dropped around 80% from its March 2016 price peak to early September 2016. With natural gas prices reaching their lowest levels in almost two decades in 2016, wholesale power prices have gone down for all generators, and coal has become increasingly

cost-uncompetitive. The Energy Information Administration estimates coal production will fall 16% in 2016, which would be the largest annual percentage decline since 1958.

- **Alcoa Inc.** stated in April 2016 that Q1 **earnings fell 92%**, and the company forecasted cutting as many as 2,000 jobs as a result.[108] Low fuel prices drove the earnings slump which consequently weakened aluminum prices. Prices had dropped 40% over the prior five years on the London Metal Exchange.
- **Royal Dutch Shell** reported a **71% decline in net profit** during Q4 2014, citing rising costs for exploration as a primary reason for the enormous drop. In September 2014, Shell announced the halt of its arctic oil exploration in the Chukchi Sea for the "foreseeable" future. Shell **had spent over $7 billion** on its failed hunt for oil and said it would have to take a hit of around **$4.1 billion** on future earnings as a result of the decision.[109]
- A rapid 58% plunge in oil prices from mid-2014 to 2015 turned many airlines' fuel price hedges into big money losers. In 2015, **Delta Airlines** accumulated hedging **losses of $2.3 billion**, while United Continental Holdings **lost $960 million** on its bets.[110] From January to March 2016, United Continental shares dipped 29%, and Delta share prices dropped 28%. In June 2016, **Delta's** CEO revealed that the airline had lost about **$4 billion cumulatively** on oil hedges over the prior eight years. Fuel accounts for between 23% and 33% of Delta's costs from year to year.[111]



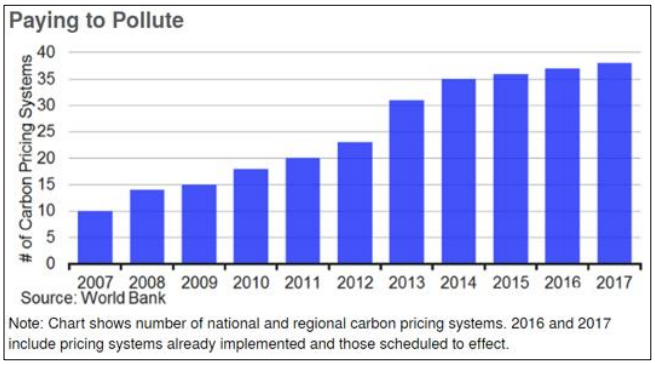
The price of oil has been volatile and rising over the past 40 years. Price as of 12/1/2016: **$51.40**

Indirectly, companies are subject to a whole host of operational risks stemming from carbon emissions. Increased atmospheric concentrations of GHGs and the resultant changing of the planet's climate leaves businesses exposed to **increased instances of water stress, extreme weather events, and higher temperatures**.[ix] According to the insurance group **Munich Re**, the number of weather-related loss events over the past three decades has quintupled in North America, quadrupled in Asia, and increased in Africa, Europe, and South America. In the United States alone, 11 events crossed the $1 billion mark in losses in 2012.[112]

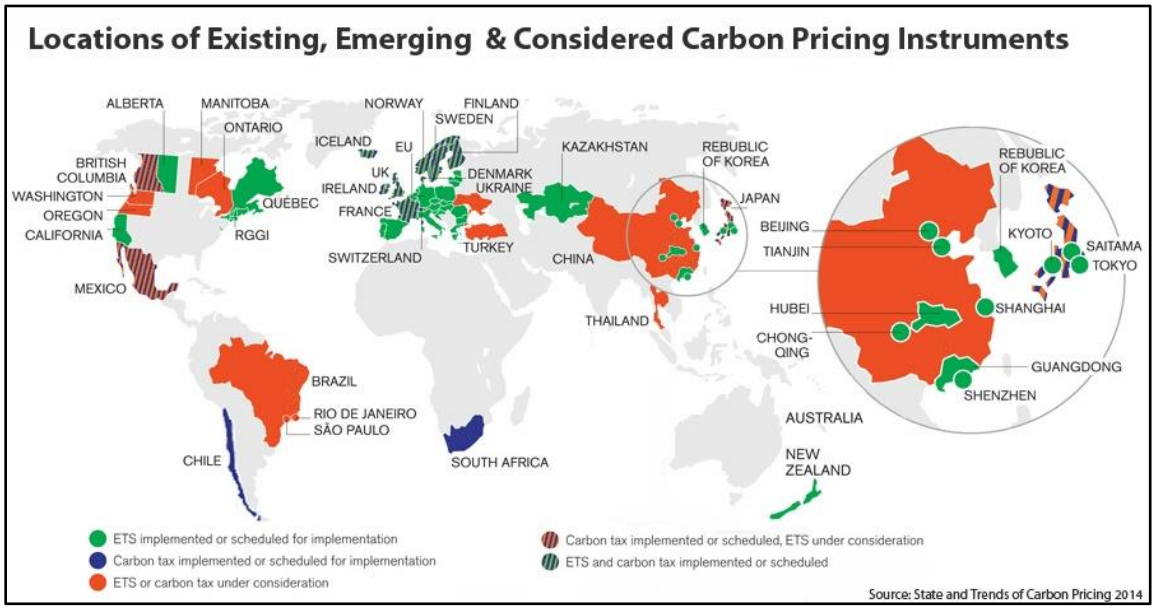
[ix] For more information, see Navigating Rough Waters

Regulatory Risks

Regulatory risks are perhaps the most well-known potential risks faced by businesses either emitting carbon or dependent on carbon-intensive inputs or outputs. As the effects of carbon emissions on the planet's climate have become better documented, governments around the globe have begun to take regulatory action. From putting a price on carbon (i.e., carbon tax, emissions trading scheme), setting emissions restrictions, creating energy efficiency standards, or creating or withdrawing subsidies, regulatory action on carbon emission has undeniably impacted how many companies conduct business today. All industries are affected, as well. According to S&P, regulation may represent a greater threat to some financial service providers than some of the direct operational costs resulting from carbon-induced climate change.[113] Without a doubt, regulation surrounding carbon emissions and power/fuel generation and consumption has risen significantly in the past few decades:



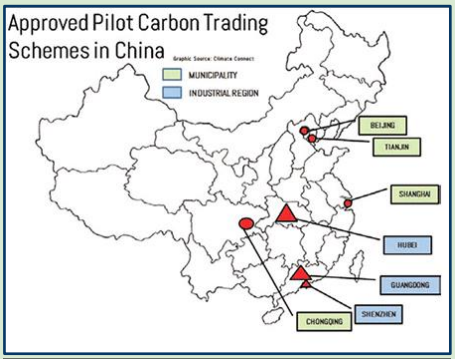
- Since 1997, the number of climate change laws and policies passed by national governments has **doubled every five years.**[114]
- By the end of 2014, there were **804 climate change laws and policies globally – rising from only 54 laws** and policies in 1997, and 426 in 2009.[115]
- Energy-efficiency regulations now cover 27% of the world's energy consumption (up from 12% in 2005).[116]
- As of 2013, fifteen countries are implementing or have passed legislation putting a price on carbon.[117]
- In 2014, about 40 national and over 20 sub-national jurisdictions have already implemented or scheduled emissions trading schemes or carbon taxes. Together, these jurisdictions account for more than 22% of global emissions.[118]



Many more countries and jurisdictions are advancing preparation for pricing carbon, as well.[119]

Regulating the World's Biggest Emitter

In conjunction with its massive investments in renewable energy over the past several years, China has made a similar regulatory push. After establishing pilot systems in three cities starting in 2013, **China is launching carbon-trading programs in seven regions in 2017**, anticipated by many to become the world's largest carbon-trading market. These programs are all in preparation for a potential national plan by 2020.



[http://carbonmarketwatch.org/chinas-pilot-emissions-trading-systems/)

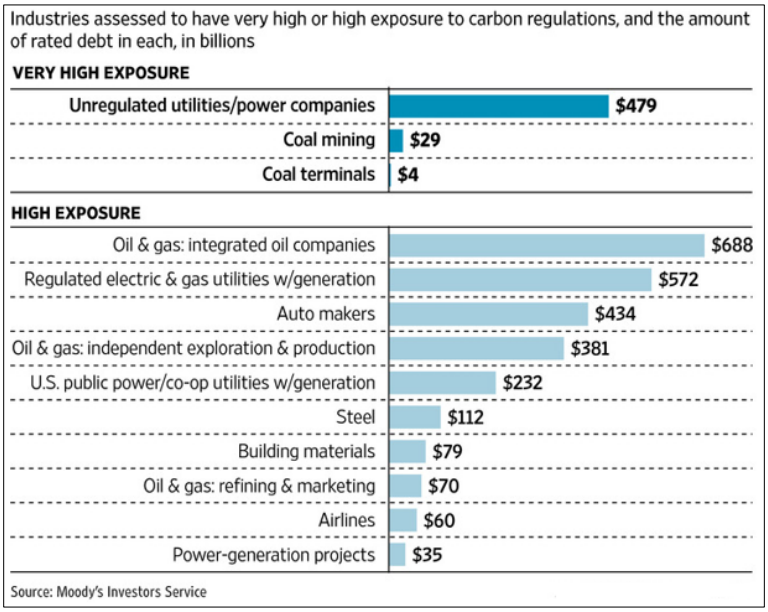
China, the world's biggest energy consumer, has pledged to peak its emissions around 2030 and plans to derive 20% of its energy from clean sources by then, as well as reduce its use of coal.

Across the rest of Asia, South Korea launched an emissions trading system of its own in 2015, and Japan is considering a similar route in order to meet its goal of 44% power from zero-emission sources by 2030.[120]

As countries continue to increase their level of regulation on carbon emissions and energy efficiency, businesses are increasingly impacted:

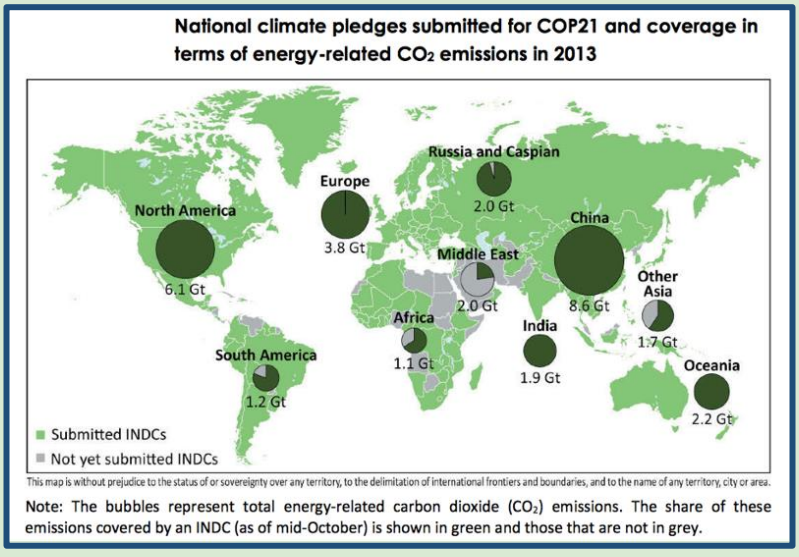
- In August 2016, Harley Davidson was fined $12 million in civil fees for selling unregulated after-market devices that increased vehicle pollution.[121] This fine amounts to over 10% of H-D's Q3 2016 net income.[122]
- In 2012, ExxonMobil was fined £2.8m for failing to report carbon dioxide emissions from a plant in Scotland.[123]
- Southern California Gas Co's 2015 gas leak near Porter Ranch has cost the utility more than $700 million, equivalent to nearly 90% of the company's Q1 2016 gross profit. However, the utility still faces potential cost from over 100 remaining lawsuits from both residents and regulators.[124]
- In September 2016, **Suncor Energy Inc**., Canada's largest oil producer, began talks to "strand" or abandon some high cost, greenhouse gas-intensive crude-oil deposits, despite regulation requiring the maximum amount of oil to be extracted regardless of the economic value. The request was made in order to cut costs amid slumping oil prices and greater regulation. The province of Alberta was set to double its carbon tax on oil producers and has vowed to cap oil-sands GHG emissions from operators at 100 million tonnes.[125]
- In 2016, grocer **Trader Joe's** agreed to spend $2.5 million to reduce coolant leaks and pay civil penalties after it failed to promptly repair leaks of an HCFC (potent GHG used as a coolant in refrigerators), in violation of the Clean Air Act.[126] Costco and Safeway have also been hit with penalties and abatement costs - $2.4 million and $4.7 million respectively for similar refrigerant GHG reductions in recent years. [127]

While some nations are further ahead of others in regulating businesses' carbon footprints, the international community is clearly moving toward broader and more stringent regulation which will generally, put a higher price on carbon.



Recent Key Events in International GHG Regulation

- **COP 21**- At the December 2015 Paris Climate Accords, 195 countries committed to limit global temperature increases from pre-industrial levels to below 2 degrees Celsius (2°C). Over 150 countries, representing 90% of global economic activity and nearly 90% of energy-related greenhouse gas emissions, have submitted pledges to date.
- **Paris Agreement Ratified** – On October 5, 2016, the threshold (≈55% of countries) of ratification of the Paris Agreement was achieved and the Agreement entered into force 30 days later (November 4). As of November 29, 114/197 parties have ratified the agreement.[128]
- **Kigali HFC Amendment**- 170 nations gathered in Kigali, Rwanda to amend the Montreal Protocol and on October 15, 2016, agreed to eliminate use of hydrofluorocarbons (extremely potent GHGs) by 90%, beginning in 2019.[129]



Overall, 2016 led to an incredible amount of progress in advancing government regulation around GHG emissions. The result of the 2016 U.S. presidential election will have some impact on U.S. implementation of pending climate agreements. However, global climate agreements already in force and the overall momentum of the international community towards reducing global GHG emissions will be difficult if not impossible to reverse.

This growing body of regulation combined with the plummeting prices of renewable energy poses a very serious risk to companies with large amounts of high-carbon assets.

Stranded Assets

Stranded Assets are assets that need to be written down before the end of their expected lifespan as they have become obsolete or non-performing. As fossil fuels and carbon emissions continue to be more heavily regulated and the price of renewable energy technologies continues to drop, there are increasingly inherent risks in holding companies with large carbon reserves. Citigroup estimated the potential value of fossil fuel assets stranded by the COP21 agreements alone to be $100 trillion.[130] This potential risk of stranded assets, as well a philosophical conflict with fossil fuels role in climate change, has caused many investors to divest from fossil fuel companies.

In September 2014, 181 institutions representing $50 billion in assets made a divestment commitment.[131] Notable divestors included the Norwegian Sovereign Wealth Fund -– the largest investor in the world – as well as the Rockefeller Brothers Fund. As of December of 2015, universities, insurers, cities, and other investors had divested more than $3.4 trillion from fossil fuel companies.[132]

Rank	Oil & Gas Company	Oil & Gas Gt CO2
1	Gazprom	44.069
2	Rosneft	16.776
3	PetroChina	8.066
4	ExxonMobil	7.960
5	Lukoil	7.115
6	BP	6.388

To the right is a snapshot of the Carbon Underground 200 List, which identifies globally the top 100 public coal companies and the top 100 public oil and gas companies, ranked by the potential carbon emissions content of their proven reserves. The reserves of these companies total 474 gigatons (GT) of potential CO_2 emissions, almost five times more than can be burned for the world to have an 80% chance of limiting global temperature rise to 2°C (3.6° F).

While companies cannot anticipate all regulation, those who innovate their operations and collaborate upstream and downstream to reduce their carbon emissions and energy consumption will be better prepared to face the risk of growing carbon-related regulations and a generally higher price of carbon.

Pressure on Investors

Investment professionals who do not adapt will also face growing pressure on the regulatory front. In December 2015, The Financial Stability Board established the Task Force on Climate-related Financial Disclosures (TCFD) under the chairmanship of Michael R. Bloomberg, tasked to develop climate-related financial risk disclosures for use by companies in providing information to lenders, insurers, investors, and other stakeholders. The backing and membership of TCFD solidifies the reality that environmental factors, such as carbon emissions, should and will soon become mainstream within the investor community. Illustrating as much, in May 2015, the French government required pension funds, insurance companies, and other institutional investors to disclose the risks they face from climate change associated with carbon-intensive assets, as well as their opportunities to invest in low-carbon and renewable energy. Investors will also need to set targets, measure progress, and explain if their targets are not achieved.[133]

Reputational Risks

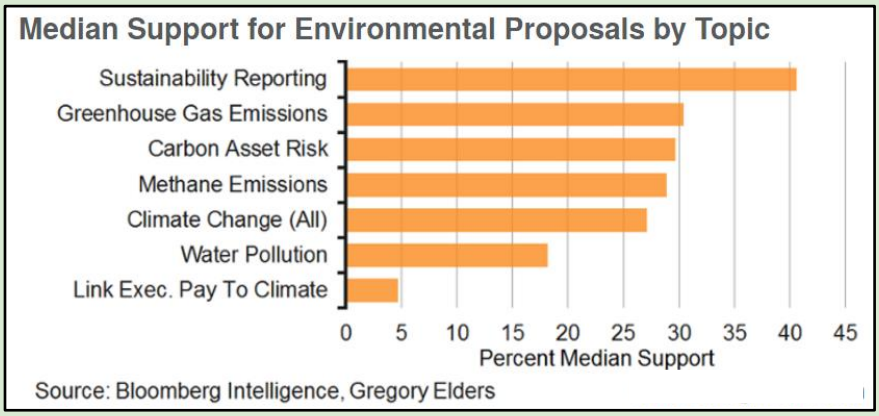
Of increasing importance to companies over the past several decades has been the reputational impact of being perceived by customers, investors, or other stakeholders as having a large carbon footprint. Largely this scrutiny is linked to a perception of a company contributing to climate change and externalizing social and environmental costs onto others. Reputational risk can be either direct, stemming from a company-specific action or policy, or indirect, in the form of public perception of the overall industry.

A poor reputation around carbon emissions can have a variety of impacts on a company:

- Reduced sales from consumer boycotts
- Damaged investor relationships that spur divestment
- Increased stringency of a regulatory environment
- Reduced attractiveness in the eyes of current or potential employees

The significance of reputation to a company's valuation is of increasing importance today as well. A recent study by the World Economic Forum found that three-fifths of chief executives said they believed corporate brand and reputation represented more than 40% of their company's market capitalization.[134]

Big Oil's Reputation



One of the most visible instances of reputational impact on companies has been the growing investor scrutiny of large oil and gas companies in the past several decades. Increasingly, individual shareholders, activist investors, and some institutional investors have been demanding that these companies acknowledge the stranded asset risk they face from policy changes, as well as physical climate change. In less collaborative approaches, shareholders have been divesting from fossil fuel companies entirely due to the uncertainty they perceive these companies facing in a less carbon-intensive future economy. The CalPERS pension fund ($294 billion AUM) along with other shareholders, recently pressured ExxonMobil and Chevron at their annual meetings to address their businesses inherent connection with GHG emissions and climate change. [135]

Over the past five years, investors have submitted an increasing amount of shareholder proxy proposals for votes at annual meetings. In 2015 alone, investors filed about 100 proposals on climate change/GHG emissions. Fossil Fuel companies and utilities (e.g., **Exxon Mobil, Chevron, Devon Energy Corp., Dominion Resources Inc., ConocoPhillips and Duke Energy Corp)** were the highest recipients of such proposals. As is evident from the above table, there is a significant amount of shareholder support for these initiatives.

Much of the focus on these issues is currently directed at large oil and gas companies. However, this does not immunize other companies (especially those in the power generation, heavy industry, and transportation sectors) from similar scrutiny.

In May 2016, the head of the global shipping industry association Sustainable Shipping Initiative, stated that the **shipping industry needed to pass new industry emissions standards** prior to COP-22 in November 2016[x], citing a damaged industry reputation as one of the primary needs to do so.[136] The September 2015 Volkswagen (VW) Emissions Scandal not only impacted consumer perception of VW's diesel cars as "dirty," but the reputation of the entire auto segment. In Western Europe, diesel cars' share of new car sales fell 3.1% to 49.7% in April after the scandal; this was the first time diesel's market share of new cars fell below 50% in several years.[137]

However, it is not just consumers' and investors' perception of a company's carbon footprint that matters, all stakeholders are placing increasing value on the materiality of carbon emissions. This recognition is already being seen in both business to business interactions throughout supply chains, as well in client expectations of their money managers.

BICEPS Network

Boosting Initiatives for Collaborative Emission-reduction with the Power of Shippers (BICEPS) is a joint initiative of five global shippers: AB InBev, AkzoNobel, DSM, FrieslandCampina, and Huntsman. Launched in 2015, BICEPS uses a rating system for these companies to use in their global procurement process of ocean freight container carriers.[138] Of the five areas, the system focuses on, emissions, transparency and projects to improve carbon efficiency favor heavily:

1. Publication of sustainability information
2. Actual emission scores and targets
3. Improvement projects, and project statuses
4. Collaboration of the carrier with the outside world
5. Long-term horizon in relation to sustainability

One reason for corporate interest in maritime shipping emissions is that the shipping sector makes up around 2.2% of global CO_2 emissions; however, the UN projects CO_2 emissions from vessels will rise between 50% and 250% by 2050 if business continues as usual.[139]

[x] Update: On October 28, 2016, the IMO revealed a global GHG emissions strategy would be adopted in 2018.

Portfolios Carbon Footprints' Under Greater Scrutiny

Investment professionals will face similar pressure as transparency around portfolio carbon footprinting, and more broadly, Environmental, Social, and Governance (ESG) performance, improves.

Currently, a number of financial information providers including Morningstar, Sustainalytics, MSCI, 3D Investing, and As You Sow, have third-party ratings with the objective of providing investors with a guide to the overall "Sustainability" of investment funds.[140] These ratings score funds on a variety of ESG factors, including carbon footprint. In March 2016, Morningstar became the first organization to make their scores - provided for over 21,000 mutual funds - publicly available. Increased accessibility to the public has allowed retail investors to further push their pension plans and money managers for more highly-rated ESG options. Additionally, these scores reduce the importance of fund marketing around sustainability and force managers to have real scores that backup their claims. The number, accuracy, and robustness of these scores will only continue to improve in the future.

The pressure felt by investment professionals from this growth in portfolio transparency is further exacerbated by growing interest from asset owners. In 2015, Morgan Stanley found that 71% of individual investors are interested in sustainable investing.[141] Younger generations in line to inherit new wealth are particularly keen on ESG-informed investing. A recent survey found 66% of millennials as being familiar with socially responsible investing and roughly 80% expressing an interest in those strategies.[142] Furthermore, across all asset classes, millennials believed they could achieve market-rate or better financial returns while pursuing positive social and/or environmental change.[143] Taken together, these trends stand to permanently change the investment landscape and benefit managers who embrace incorporating environmental data into their investment strategies.

Recommended Business Leader Actions

All companies must measure their carbon footprint and evaluate their exposure to related risks. By using existing measurement and reporting tools, these risks can become opportunities. Many companies have already taken action. In 2015, over 50% of the G20's market capitalization disclosed scope 1 and/or scope 2 data (see **Appendix B)**. 77% of respondents from the Fortune Global 500 said their companies engaged with their suppliers on climate change strategies (up from 67% three years earlier).[144] However, there is still work to be done. A 2016 CDP survey found only 27% of the 4,000 responding companies engaged their supply chains around carbon disclosure.[145] This statistic more accurately depicts the reality that many businesses today still do not measure or report their direct carbon emissions, let alone the emissions from their upstream and downstream impacts.

❶ Evaluation

Most importantly, a company must first begin by monitoring and measuring their carbon emissions. Scope 1 emissions (generated by company-owned assets) and scope 2 emissions (from purchased power, heat, steam, or cooling) are the primary scopes to be mapped and calculated. Beyond that, companies should begin working with their upstream and downstream suppliers and customers to understand the indirect emissions baked into the company's products or services. **For many businesses, scope 3 emissions account for more than 70% of their carbon footprint**.[146] All potential sources of emissions, from fuel consumption, power demand, waste sent to landfills, leaking refrigerants, etc. should be monitored and measured. For more information on emissions scopes, see **Appendix B**.

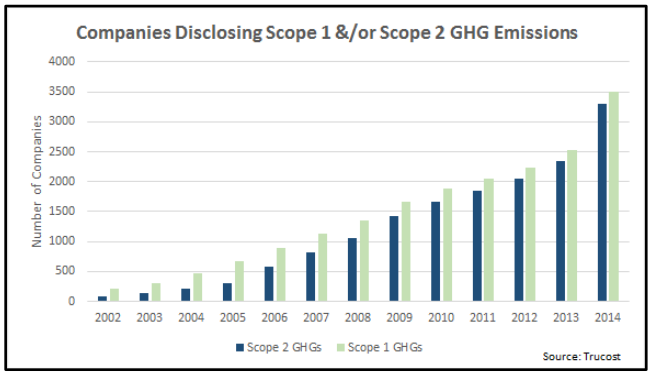
Companies must regularly monitor their exposure to carbon risk, and when material, take it into consideration when making business decisions.

Evaluation Tools

How can a company evaluate carbon risk? There are a number of consulting companies (both well-known, full-service strategy firms and lesser-known, emissions-specific experts) that offer emissions management services. There are also several different tools offered by non-profits to help companies measure their carbon footprint and break it up between the various scopes. Other organizations provide sector research and suggest standards and frameworks for disclosing. Some tools are targeted more at investors, and some are more for companies' internal use. Other tools are more focused on disclosure, an essential step once companies have collected their emissions data **(See Appendix A).**

❷ Disclose

Once measured, it is critical to disclose carbon emissions data. **Investors crave clarity, security, and transparency above all.** A company's carbon footprint is a material factor that helps provide investors with all three of those conditions in their company analysis. Additionally, it gives companies the ability to optimize carbon efficiency and minimize carbon risk. More and more companies are recognizing the importance of GHG disclosure (2,066 companies disclosed their scope 1 & 2



emissions in 2014).[xi] As disclosure rates continue to increase, a company can more accurately benchmark performance against that of their peers.

Companies are demanding disclosure, as well. As of May 2016, a record number of the world's largest purchasers in the private and public sectors (89 organizations **representing a combined annual spend of more than $2.7 trillion**) were requesting carbon emissions and climate risk data from over 8,300 suppliers worldwide (signatories include global retailer Wal-Mart, Goldman Sachs, The Coca-Cola Group, and the U.S. Department of the Navy).[147] Similarly, in August 2016, The General Services Administration, the largest buyer of goods and services in the world, announced plans to require large- and medium-sized contractors to publicly disclose their greenhouse gas emissions and related reduction goals through an annual report.[148]

Disclosure Tools

Companies can disclose their carbon emissions through a variety of channels: publicly through their sustainability report or an integrated annual report, as well as in response to a CDP survey. The **Greenhouse Gas Protocol** is the universal standard demanded for most corporate carbon disclosure frameworks and surveys (GRI, CDP, etc.). Incorporating disclosure into an integrated report with company financials, as well as contextualizing emissions by having them certified as **Science Based Targets** are considered best practices. Information on these organizations and several other disclosure tools can be found in **Appendix A**.

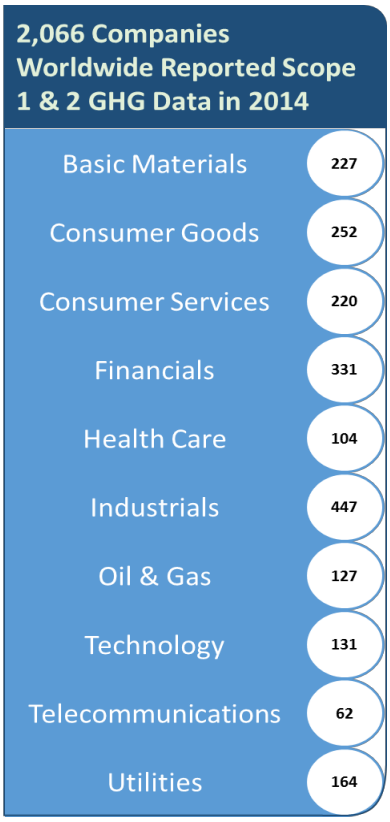
[xi] Data derived from Trucost

Recommended Investment Professional Actions

There is clear evidence that investment professionals can enhance their investment decision-making process by incorporating meaningful "non-financial" information into their fundamental analysis.

Investors who earnestly incorporate companies' GHG emissions data into their investment process stand to reduce risk and improve the return potential of their portfolios.

- A 2015 Harvard Business School study found, "firms with strong ratings on material sustainability issues (including carbon efficiency) have better future performance (in terms of profit margin growth) than firms with inferior ratings on the same issues."[149]
- A March 2015 meta-study of over 200 ESG research studies found 90% of studies illustrated that sound sustainability standards lower the cost of capital of companies, 88% showed that solid ESG practices result in better operation performance of firms, 80% showed that good sustainability practices positively influenced stock price performance of companies.[150]
- A 2016 report from S&P Dow Jones Indices found that, "more carbon- and resource-efficient companies outperform the less-efficient ones" and that focusing on efficiency could also help businesses mitigate risks such as regulation, resource depletion, and reputational risks.[151]



There is **already a significant amount of acceptance within the financial community as to the financial materiality of carbon emissions.**

- **PGGM**, the second-largest Dutch pension fund manager, said it is working to lower the carbon footprint of the real estate funds it manages by 50% before 2020 in order to, "get out ahead of any possible carbon regulation that may be imposed on the sector."[152]
- CDP, which requests information on the risks and opportunities of climate from the world's largest companies, currently has a signatory base consisting of **822 institutional investor signatories with a combined $95 trillion in assets** who are requesting more disclosure (including carbon footprinting).
- **Legal & General Investment Management,** the U.K.'s largest asset manager, recently launched a fund which will invest in a new index of 3,000 stocks shifted toward companies with lower greenhouse gas emissions profiles. The company also announced that it will be voting against the reappointment of chairmen at any of their holdings "who do not do enough to reduce carbon emissions."[153]

What should investment professionals do?

❶**Help to improve the quality and quantity of environmental and other "non-financial" data by demanding companies enhance disclosure.** While investors today have markedly greater access and general transparency around company GHG emissions and energy usage than just a decade ago, there is still a great deal of improvement to be made on both fronts. As the monitoring and disclosure around emissions continues to become more robust, investors will benefit greatly.

❷**Gather existing data and resources to assess carbon risks and energy opportunities in portfolios and accounts**. Investors can acquire corporate emissions information through a variety of channels (see Resources & Data section below). The most commonly disclosed data points are Scope 1 & Scope 2 emissions (see **Appendix B)**. (*The table below illustrates an exemplary piece of corporate disclosure on carbon emissions.*)[xii]

❸**Develop an approach for integrating emissions factors into your investment process.** For example, at Terra Alpha, our investment process begins by screening the universe of global, publicly-traded companies that disclose at least Scope 1 and 2 GHG emissions to identify the most carbon-efficient companies[xiii] within their sector or sub-sector. From this **Environmentally Productive** universe of companies, more traditional fundamental and valuation analyses (including further assessment of relevant ESG factors) are applied to identify potential holdings for our portfolio.

Resources/organizations that provide greater information on carbon-efficiency risks and opportunities from an investor perspective are listed in **Appendix A**. The Sustainability Accounting Standards Board (SASB) has developed industry-specific sustainability accounting standards to assist investors in **assessing the most material ESG information** by sector - including GHG emissions-related data.

Note: Examining company emissions on a per-unit of revenue basis allows for greater uniformity in comparing businesses. Additionally, understanding the emissions profiles of different business models and segments at the industry, sector, or even sub-sector level is imperative to ensuring false comparisons are not made (e.g., not equating an Automobile manufacturer's emissions profile with that of an Auto Components manufacturer). Beyond immediate annual emissions, targets and progress toward those targets are a good way of determining a company's momentum in becoming more carbon efficient.

❹ **Calculate the carbon footprint of your own portfolio(s)**. There are a wide range of publicly available tools for doing so. Making this information available to current and potential investors/clients will increasingly be expected of investors.

❺**Consider other environmental factors such as Water and Material Efficiency as part of the investment process.** While carbon emissions are a material factor to consider when investing in any business, these other factors provide even greater insight into how Environmentally Productive a company is.

[xii] For more information on disclosure, read Disclosure Matters.

[xiii] Terra Alpha also examines several other environmental factors in this process, including water and waste.

Examples of Good Practices in GHG Emissions Management and Disclosure

3M - Monitoring Emissions to Capture Opportunities

3M is an American multinational conglomerate. 3M has been setting environmental goals since 1990 and disclosing carbon emissions since 2002. 3M reports publicly and to GRI using the GRI standards, as well as responding to CDP surveys. 3M reports its Scope 1, 2, and 3 GHG emissions, as well several other variant statistics.

	2002**	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012*	2013*	2014*	2015*
Total (Million MT CO2e)	17.80	17.90	13.50	11.80	10.40	8.40	6.74	5.01	6.23	6.09				
2002 Revision Total (Million MT CO2e)	18.30										6.62	7.95	6.63	5.63
Scope 2 Indirect (Million MT CO2e)	1.57	1.58	1.64	1.70	1.68	1.67	1.63	1.72	1.94	2.03	2.25	2.36	2.24	1.86
Scope 1 Direct (Million MT CO2e)	16.20	16.30	11.80	10.10	8.75	6.73	5.11	3.29	4.28	4.06	4.37	5.59	4.39	3.77
Total Emission % Reduction vs 2002 Revision	0%										-64%	-57%	-64%	-69%
Total Emission % Reduction vs 2002	0%	0.25%	-25%	-34%	-42%	-53%	-62%	-72%	-65%	-66%				

*2012-2015 US EPA GHG-MRR/IPCC AR5 based inventory accounting is not directly comparable to 2002-2011 WRI/IPCC TAR, AR4 based GHG accounting.
**2002 Inventory recalculated according to US EPA GHG-MRR/IPCC AR5 methodology (2.7% Increase over original reported value).

3M

Below is a snapshot of the company's GHG emissions data available on Bloomberg Professional.

3M Co — 98) ESG News | NSE » — Currency USD

Metrics	vs History Current	History	Change	vs Peers Low	Range	High	Median	Difference	History
Environmental				◆Mdn ●Comp					
11) GHG/Revenue	186		-19.7 B	47.4		694.3	366.1	-180.1 B	
12) Energy/Revenue	272.9		8.1 W	99		6282.9	4869.1	-4596.2 B	

11) Overview | 12) Environmental | 13) Social | 14) Governance | 15) Exec & Dir Comp | 16) ESG Ratios | 17) CDP

In Millions of USD except Per Share	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
12 Months Ending	12/31/2006	12/31/2007	12/31/2008	12/31/2009	12/31/2010	12/31/2011	12/31/2012	12/31/2013	12/31/2014	12/31/2015
Environmental										
Environmental Disclosure Score	25.58	41.86	41.86	53.49	53.49	54.26	57.36	57.36	56.59	55.81
Total GHG Emissions	10,270.0	8,450.0	6,790.0	4,900.0	6,200.0	6,090.0	6,780.0	7,950.0	6,640.0	5,630.0
Total Energy Consumption	8,055.6	8,055.6	7,938.0	6,994.3	7,773.4	7,841.0	8,184.5	8,442.2	8,533.0	8,261.4
GHG Scope 1	8,740.0	6,740.0	5,130.0	3,200.0	4,300.0	4,060.0	4,550.0	5,590.0	4,400.0	3,770.0
GHG Scope 2	1,530.0	1,710.0	1,660.0	1,700.0	1,900.0	2,030.0	2,230.0	2,360.0	2,240.0	1,860.0
Total GHG Emissions	10,270.0	8,450.0	6,790.0	4,900.0	6,200.0	6,090.0	6,780.0	7,950.0	6,640.0	5,630.0
GHG Scope 3	–	–	–	–	–	–	10,660.0	10,640.0	11,110.0	9,500.0

Over a similar time frame, 3M's share price has outperformed nearly all of its peers.

Name (BICS Best Fit)	1Y Tot Ret	3 Year Annualized Total Return - Current	5 Year Annualized Total Return - Current	10 Year Annualized Total Return - Last Month End
Average	-4.35%	7.78%	18.07%	5.08%
3M CO	9.57%	12.91%	19.58%	11.86%
SUMITOMO REALTY & D...	-33.02%	-15.61%	12.33%	-2.02%
STORA ENSO OYJ-R SHS	2.90%	12.99%	17.76%	0.13%
DAI NIPPON PRINTING...	-13.75%	4.11%	9.45%	-3.04%
MASCO CORP	11.58%	19.71%	31.54%	6.40%
MITSUBISHI ELECTRIC ...	10.14%	13.21%	15.98%	4.02%
INTERNATIONAL PAPER...	11.03%	4.80%	16.24%	6.87%
KLABIN SA-PREF	-33.28%	10.10%	21.69%	16.45%

Resources and Data

Where does an investor look for information about a company's carbon efficiency?

Currently, over 2,000 global public companies disclose some level of corporate-wide information about their operational GHG emissions (Scope 1 and 2). The number of companies reporting this information has been increasing each year. Disclosed data commonly can be found through a few channels:

- A company's public reports (e.g., annual reports and sustainability reports)
- Third-party data repositories (e.g., Trucost, CDP, Global Reporting Initiative (GRI), Bloomberg's ESG section, and Thomson Reuters)

Conclusion

- Growing global emissions of greenhouse gases since the advent of industrialization have destabilized the planet's atmosphere and have begun to impact the climate. This imbalance is already incurring and will continue to incur substantial costs throughout society and on both businesses and investors.
- Largely, these emissions are tied to human consumption of fossil fuels for energy and thus embedded in activities across all sectors.
- Most companies who maximize the efficiency with which they and their supply chains emit GHGs can very quickly capture operational cost savings. As the overall economy shifts toward a less carbon-intensive model, these companies will be strategically positioned to outperform their peers, as well.
- This broad economic shift toward a carbon-efficient future is also creating broad market opportunities for companies to offer products and services with lower carbon footprints, as well as the development of entirely new markets for businesses to enable consumers and other businesses to reduce their carbon footprint.
- Operational constraints, increasing stakeholder awareness of the need to reduce carbon emissions, and a growing and inevitable regulatory movement pose unavoidable risks for companies that do not reduce their carbon footprint.
- Corporate disclosure of carbon emissions affords investors an additional material metric by which they can judge a company and its future prospects for financial success. Increasingly, consumers are demanding for ESG factors (including carbon emissions) to be considered by their investors.
- While GHG emissions are the most widely-disclosed environmental metric today, there is still significant progress to be made in terms of the number of companies disclosing and the quality of their disclosures. If they are to gain a greater perspective of their portfolios risks and opportunities, investors must prompt further disclosure from more companies.

Companies benefit from understanding and measuring the embedded GHG emissions throughout their business, disclosing this information publicly, and working to improve their overall GHG-efficiency.

Investors can enhance their returns by integrating carbon- and energy-efficiency-related opportunities and risks into their investment strategies; this necessitates demanding greater corporate disclosure of GHG emissions data.

Appendix A – Tools for Measuring and Evaluating Emissions Metrics

Targeted Toward Companies	Targeted Toward Investors	Measuring Tool	Disclosure Tool

Bloomberg

Bloomberg, accessible through Bloomberg Professional software, has a robust ESG category of information for each company that discloses environmental, social, and governance information.

Business for Innovative Climate & Energy Policy (BICEP)

BICEP is an advocacy coalition of businesses committed to working with policymakers to pass meaningful energy and climate legislation that will enable a rapid transition to a 21st-century low-carbon economy.

Business Renewables Center (BRC)

BRC is a program that convenes corporate buyers, service providers, and project developers with 131 members to date. This network functions as a go-to place for large companies to get in touch with the organizations and companies that will advance the transaction process. The BRC provides price comparisons between wind and solar projects against the wholesale market by location. The driving objective of the BRC is to add 60 GW of wind and solar capacity to the U.S. grid by 2030. The BRC only facilitates corporate purchasing of off-site, large-scale wind and solar energy projects in organized wholesale markets (i.e., it helps companies sign PPAs for wind or solar projects in areas where a company can do so without conflict with their utility). 91% of renewable energy deals in 2015 involved a BRC company.

CDSB

Climate Disclosure Standards Board (CDSB) is an international consortium of business and environmental NGOs. They offer companies a framework for reporting environmental information with the same rigor as financial information. This framework helps CDSB to provide investors with decision-useful environmental information via the mainstream corporate report, enhancing the efficient allocation of capital.

Targeted Toward Companies	Targeted Toward Investors	Measuring Tool	Disclosure Tool

CDP

CDP

DRIVING SUSTAINABLE ECONOMIES

CDP's annual climate change & supply chain questionnaires collect company data on companies operational and supply chain carbon footprint. CDP has the most comprehensive collection of self-reported environmental data in the world. Their network of investors and purchasers represents over $100 trillion, along with policy makers around the globe.

Corporate Renewable Energy Buyers' Principles

WWF WORLD RESOURCES INSTITUTE

The Corporate Renewable Energy Buyers' Principles is a manifesto that articulates the renewable energy purchasing desires of the companies that have signed on. It was written in a collaborative effort by WRI and WWF and has been adopted by 58 of some of the world's biggest companies. The Corporate Renewable Energy Buyers' Principles are a tool to get companies on the path to setting their own renewable energy targets.

Global Reporting Initiative (GRI)

Global Reporting Initiative™

GRI is an independent, international organization aimed at empowering decision makers to create a more sustainable economy. GRI's Sustainability Reporting Standards are one of the world's most widely used standards on sustainability reporting and disclosure.

Greenhouse Gas Protocol

GREENHOUSE GAS PROTOCOL

The Greenhouse Gas Protocol (GHGP) is the most widely used international accounting tool for government and business leaders to understand, quantify, and manage greenhouse gas emissions. The GHGP serves as the foundation for nearly every GHG standard and program in the world - from the International Standards Organization to The Climate Registry - as well as hundreds of GHG inventories prepared by individual companies.

International Integrated Reporting Council (IIRC)

INTEGRATED REPORTING <IR>

The IIRC works to develop the International Integrated Reporting Framework through which companies can report integrated information about strategy, governance, performance, and future prospects. The framework explains the underlying concepts behind integrated reporting and provides guidelines.

Targeted Toward Companies	Targeted Toward Investors	Measuring Tool	Disclosure Tool

Low Carbon Technology Partnerships Initiative

LCTPi is an action-oriented program that brings together companies and partners to accelerate the development of low-carbon technology solutions to stay below the 2°C ceiling. LCTPi has gathered over 150 global businesses with 70 partners to work collaboratively on the climate challenge. Focus areas include: Climate Smart Agriculture, Forests as Carbon Sinks, Cement, Chemicals, Carbon Capture & Storage, Renewables, Low Carbon Transport Fuels, Low Carbon Freight, and Energy Efficiency in Buildings. The LCTPi process facilitates the co-creation of a commitment by a sector working group to contribute to the 2°C goal be it via reduction of its emissions or by providing solutions that help other sectors reduce their emissions. Once agreed, companies identify the main barriers to achieving their shared ambition and agree on a joint action plan to remove those barriers and scale up solutions.

Renewable Energy Buyers Alliance (REBA)

REBA is an association of other corporate buyers' associations: namely, the BRC, WWF's and WRI's Corporate Renewable Energy Buyers' Principles, and BSR's Future of Internet Power initiative (which is a group of companies that rely on data centers that are committed to using 100 percent renewable energy). The three buyers' associations convene members of their individual multinational corporate members during the annual REBA summit in order for the groups to work in an organized and coordinated manner to minimize the chance of service redundancy and to develop a game plan for the U.S energy landscape as a whole.

RE100

RE100 is a coalition of international companies that publicly pledge to procure 100 percent of their electricity from renewable sources of energy (the timeline for doing so; however, is up to the individual companies). 81 corporate entities are now members.

Sustainability Accounting Standards Board (SASB)

SASB provides industry-specific insight on which sustainability factors are most important to companies and most material for investors. Through these industry standards, companies can tailor sustainability initiatives to maximize value, while also disclosing information more effectively to investors.

Targeted Toward Companies	Targeted Toward Investors	Measuring Tool	Disclosure Tool

Science Based Targets

The Science Based Targets initiative is a partnership between CDP, UN Global Compact, WRI, and WWF, which helps companies determine how much they must cut emissions to prevent the worst impacts of climate change. Targets adopted by companies to reduce greenhouse gas (GHG) emissions are considered "science-based" if they are in line with the level of decarbonization required to keep global temperature increase below 2 degrees Celsius compared to pre-industrial temperatures, as described in the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR5).

Task Force on Climate-related Financial Disclosures

The Task Force on Climate-related Financial Disclosures helps companies disclose their climate risk information in a clear and consistent way. It aims to highlight the financial exposure of companies to the risk of climate change. It is supported by the Financial Stability Board (FSB).

Thomson Reuters

Thomson Reuters offers a comprehensive ESG database containing information on 4,000+ global companies and over 500+ data points, including all exclusion (ethical screening) criteria and all aspects of sustainability performance.

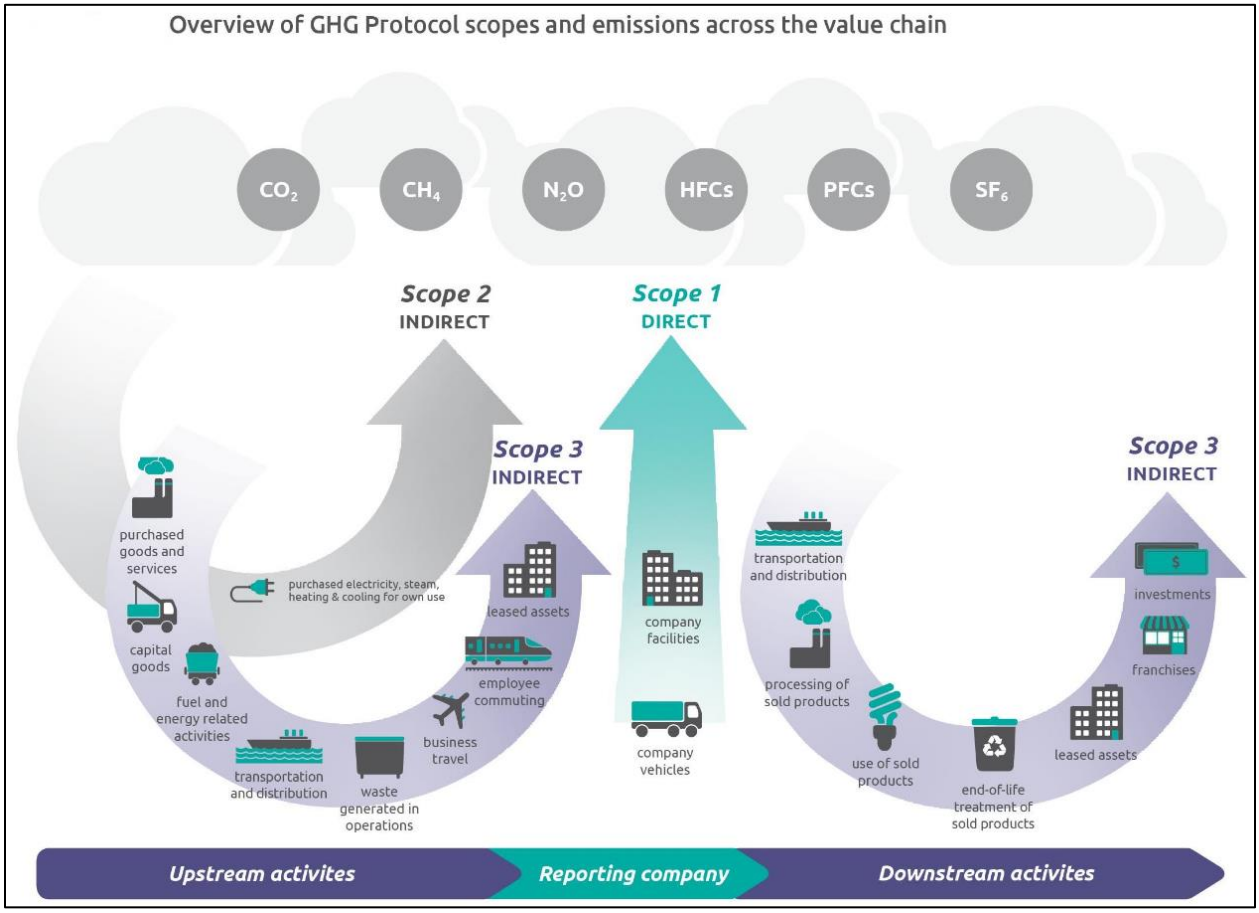
Trucost

Trucost is a third-party data aggregator that combines environmental data disclosure from other disclosure sources, as well as individual company reports.

We Mean Business

We Mean Business is a coalition of organizations working with thousands of the world's most influential businesses and investors. The coalition encourages and helps businesses to: adopt a science-based emissions reduction target, put a price on carbon, commit to 100% renewable power, engage governments responsibly on climate policy, report climate change information in mainstream reports, improve water security, commit to improving energy productivity, reduce short-lived climate pollutant emission, and remove commodity-drive deforestation from supply chains by 2020.

Appendix B – Visualizing Different GHG Emissions Scopes



Source: GHG Protocol (http://www.ghgprotocol.org/)

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