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Simulating Climate Risk Into Markets and Policies: A New Approach to Financial Analysis and Policy Formation

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Simulating Climate Risk into Markets and Policies

A new approach to financial analysis and policy
formation

Miguel A. Bantigue

5/11/2012

This dissertation is written for the purpose of understanding the importance for renewable and sustainable investing via systematic change. It explores how climate change and business-as-usual methods are detrimental to the finance, economics, and politics of sustainability. This thesis hopes to forge interest and understanding for the need to create better a better form of analysis for companies and governments to implement.

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Introduction

“To be truly sustainable, equity and justice must be addressed in different ways than they are now”

- Viderman, 1995

Widely considered to be the next big industry boom, the sustainability trend and the multiplier effect it will carry to other industry sectors are being compared to the significance and impact of the industrialization age. To list a few categories under the main framework of sustainability are renewable energy, energy storage, waste management, and water conservation. Of these, renewable energy and water conservation are the most important. Energy is the backbone of any economy, and water is the most important commodity – not only does water sustain life, there is also no known alternative. Although effort has been made to proliferate sustainable trends and work sustainable factors into financial analysis or policy making, many companies and governments remain complacent with business-as-usual (BAU) methods. It is important to reevaluate, develop, and integrate new criteria and benchmarks into risk analysis, and ultimately, our decision-making processes.

The switch towards a sustainable economy, functioned by renewable energy resources, is not so much of a question *if* it will happen, but rather *when* sustainable practice amongst businesses and governments will be pervasive enough to prevent any further advance in adverse climate change. One way or another, every type of product, industry, business, service, or policy is connected and dependent on fossil fuel for energy and operating expenses. Thus, fossil fuels pose two critical threats to the sustainability and survival of human beings and the ecosystem. The first issue is the finite supply of oil, gas, and coal. The second problem is the greenhouse gas emissions (GHG) affecting the biodiversity of the planet and health of human beings. Likewise, water is increasingly becoming polluted and scarce; it is a topic that is reaching the forefront of company investments and government negotiations.

It is important to do a deep dive into the problems with business-as-usual methods (BAU), today's market failures, and the approach to natural resource economics. For companies and governments, it is essential to stress that pollution and climate change are a threat to natural security. The United States, for example, remains heavily exposed to oil dependency from hostile regions in the Middle East. Not only does this increase risk in price fluctuations, but also fuels tension between countries or threatens ecological security, which is tied to economic health (i.e. Gulf Oil Crisis). Equally important is the rise of *climate refugees* due to climate change.

However, since many companies and governments have stressed their preference to secure economic stability instead of environmental sustainability, it is the goal of this dissertation to provide a new analytical framework geared towards showing the correlation between long-term economic growth and strategic positioning for companies as well as governments. By qualifying environmental stewardship through utilitarian qualities instead of biocentric values, sustainable investing can be seen as a profit driven initiative capable of high returns on investment, as opposed to the underperforming Socially Responsible Investing (SRI) approach companies use as an excuse for public relations. Unlike SRI, which performs poorly due to its strategy of limiting possible companies to invest in, Sustainable Investing (SI) is a particular discipline focusing on intangible assets and management decisions of any company to strategically position themselves against climate change factors; company marginal abatement costs of emissions will be reduced in the long run. For governments, sustainability will not only offer self-dependency from foreign energy suppliers, but will also be an industry and job creator.

Sustainable investing has a long journey ahead before systematic change occurs within companies and governments. It is the ultimate goal of this report to formulate a new strategy for assessing risk exposure to climate change and pollution by simulating outcomes. Whereas financial reports and decision-making processes rely on current trends and measurable assets, many fail to account for *black swan* situations, i.e. sudden catastrophes or effects of climate change. This thesis will

suggest and explore a new form of analysis to supplement existing methods. By simulating catastrophes and climate change with governments and companies as the game's players, the institutions aforementioned will be able to define their positions or shortcomings to the effects of climate change, whereas today's business-as-usual standard of reporting is focused on short term rewards.

Chapter One: Climate Change Causes, Data, and Trends

In this section, it is important to define terms and explore the existing data, trends, policies, and economic decisions resulting in environmental degradation. Climate change is the standard deviation from the naturally occurring variation in earth's climate, which is directly or indirectly caused by human beings. In our planet's historic timeline, and our species' short-lived history, the Industrial Revolution was truly the turning point that unbalanced the global carbon cycle. It was the Industrial Revolution that started our dependence on fossil fuels – from industries, transportation, operational processes, to city planning and development. This section will help to provide climate change facts and trends caused by poor governmental policies, economic choices, and ill-informed investment strategies.

Energy Resources:

Of all the fuel resources available, coal is the dirtiest since it emits the most carbon. Carbon Dioxide is the main contributing gas to global warming. Similarly, the largest emitters of carbon are power plants, which produce electricity for homes, commercial spaces, and factories. Power generation is responsible for 33% of global CO₂ emissions¹. Transportation, although a much smaller contributor, is still a significant factor, producing 13% of carbon emissions. Livestock, however, emits 18% of all carbon emissions worldwide, more than the global transportation system (including cars, planes, & ships), according to the UN Food and Agriculture Organization (UN FAO)². The same report mentions that industrialized nations consume 43% of the planet's meat and are the main contributors of emissions from livestock production. As for the change in rate of increase in greenhouse-gas emissions (GHG), it is now one hundred times higher than in the last 20 thousand years³. Lastly, real estate is also closely

¹ Saving Kyoto, pg. 77

² UN FAO, 2006

³ Chiehlinsky, 1977(a)

linked with the welfare of the environment. The IPCC reports that residential communities are responsible for 21% while commercial buildings account for 11%⁴.

In total, fossil fuels are accountable for 87% of increased atmospheric carbon dioxide due to petroleum's profitable endeavors, while land-use change and deforestation only account for 20%.

Effects:

As reported by the World Health Organization (WHO), climate change has been responsible for the deaths of more than 150,000 people with illnesses of more than five million each⁵. The signals and warnings of climate change are but a fraction and taste of the potential devastation and impact brought about by unmitigated pollution levels. Main co-submitter of the Kyoto Protocol, Graciela Chichilnisky, lists some examples of climate change – the 'heat waves in western Europe that claimed thirty thousand lives in 2003, monsoon that left 60% of Bangladesh underwater in 2004, and the Atlantic Hurricane, Hurricane Katrina'⁶. It is highly expected that climate change will increase the frequency and gravity of hurricanes, heat waves, cyclones, monsoons, and droughts.

Scientists have estimated that average global temperatures have already risen by about 0.74 degrees Celsius. At two – four degrees Celsius, there are thresholds or tipping points in which devastating impacts to life and biodiversity would be irreparable. It is therefore important to work towards sustainable investing, and a systematic change to business-as-usual methods or else an increase of two degrees Celsius will be inevitably catastrophic by the end of the 21st century.

This warming of the planet has not only shifted weather patterns, or changed biodiversity, it has also been responsible for the spreading of illnesses to areas unsuspected otherwise. Already, twelve deadly diseases to human beings and nature are spreading to new locations beyond their local regional

⁴ IPCC, 2011

⁵ World Health Organization: Climate Change and Human Health – Risks and Responses

⁶ Saving Kyoto, pg 2

hubs. These illnesses include 'avian influenza, yellow fever, babesiosis, tuberculosis, cholera, sleeping sickness, ebola, rift valley fever, intestinal parasites, the plague, and lyme disease⁷.

Aside from pollution and climate change, a global water crisis is equally important. While population and demand is exponentially increasing, water resources are becoming more scarce and polluted⁸ - wastewater from factories and manufacturers has contaminated important water supplies. For example, in China, more than 40% of rivers have been classified as severely polluted⁹. Likewise, access and circulation of water is asymmetrical based on geographical and socioeconomic distribution. Only one percent of the world's water is fresh water, and 70% of this fractional value is already allocated to agriculture, 22% to industries, and only 8% for personal consumption¹⁰.

Potential Consequences:

It is estimated that global warming can result in seas rising by 64 to 80 metres (210 to 262 ft)¹¹ – this would occur if all the ice in Greenland and Antarctica were to melt. Chapter 2 in this dissertation will expound on how cities such as Miami, New York City, Tokyo, or the Polynesian Islands, will face growing risk and pressure from rising sea levels. Glaciers, which hold a majority of Earth's freshwater supply, are melting at incredible rates – Switzerland has already lost 2/3rds of its glaciers. Governments will be burdened by either the economic loss or cost to avert damage due to rising sea levels.

Another concern of increasing global temperatures is the Permafrost region in Russia and Alaska. These areas harbor high concentrations of methane that, if released into the atmosphere, would severely accelerate the greenhouse effect. In Russia, Western Siberia is home to the largest peat bog (region as big as France and Germany combined). This particular region is experiencing the most drastic

⁷ Smith, 2008

⁸ UNEP Global Environment Outlook Report

⁹ Browder, 2007

¹⁰ WBCSD, 2005

¹¹ US Geological Survey

climate changes. If the Permafrost region melts, scientists have expressed their concerns that up to 70 thousand tonnes of methane will be released in the ensuing decades¹². Methane is a much more concentrated and damaging gas than carbon dioxide, exponentially worsening the greenhouse effect.

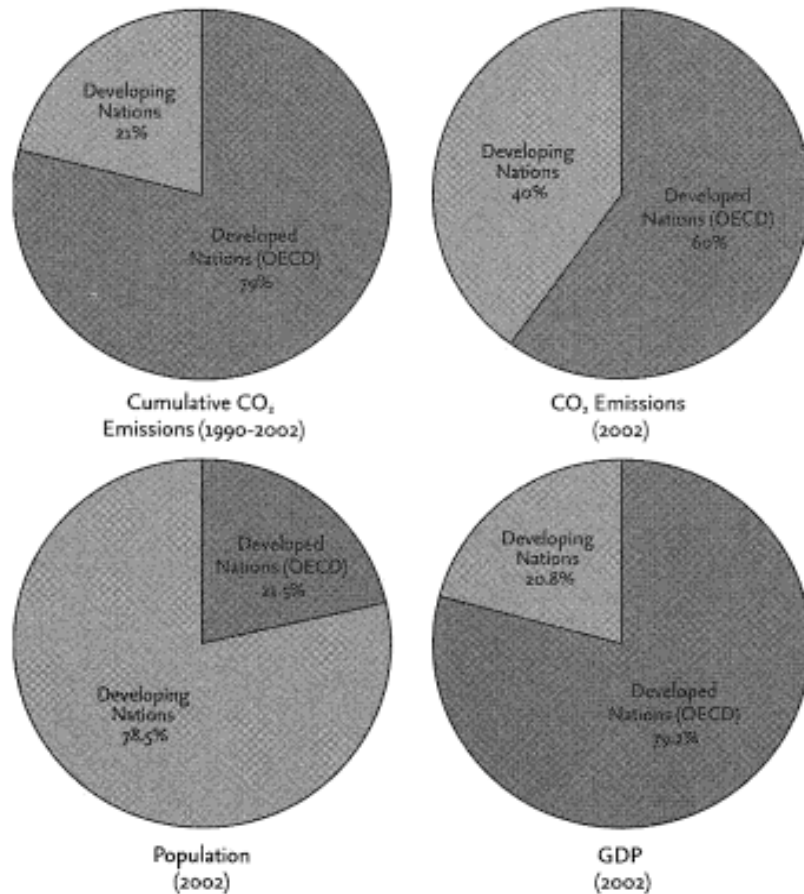
Of the carbon emissions we produce, a majority of the particles in the air will fall into the sea. As a result of unusual high amounts of carbon intake, oceans will be much more acidic, threatening life - 50% of corals in the Caribbean have already been destroyed.

Climate change thus imposes a challenge to the sustainability and survival of our species, plants, and animals. Food and water resources scarcity will increase due to the adverse effect of climate change, while diseases will increase in rate and geographic expansion.

Backs Against the Wall

According to the World Bank Development, even if every man, woman and child in developing nations, which total to about five billion people, became completely carbon neutral, they would still fail to make a dent in reducing carbon emissions¹³. Poor nations only contribute to 40% of global

Figure 1: Distribution of World Health, Population and Emissions



¹² Saving Kyoto, pg. 12

¹³ WBD Indicators, 2007: World Resources Institute Database

carbon emissions. Figure 1 shows that emission production is dominated by developed countries. As the diagram shows, rich industrialized nations pollute up to 60% of GHGs (greenhouse gas emissions) even though they only make up 20% of the world's population. In the 2007 IPCC report, scientists have deduced that with a threshold point of 500 parts per million (ppm) of CO₂ concentration in the air, we are at 380 ppm today¹⁴. A carbon-stabilizing level of 450 ppm must be accomplished by 2050, but the rate and resource consumption of developed nations threaten this goal. Given our consumption of natural capital and the amount of pollution we emit, at least three-five planets are needed if everyone in the world had the same access and opportunities to those in western countries.

After what would have been a hopeful alliance for the United States and the rest of the international community regarding carbon emission reduction and sustainability under President Clinton, the United States became one of the last bastions of "climate denial"¹⁵. Today, the focus is shifting from the United States to China, with the latter soon becoming the world's largest polluter, overtaking the United States.

The Problems with Business-as-Usual

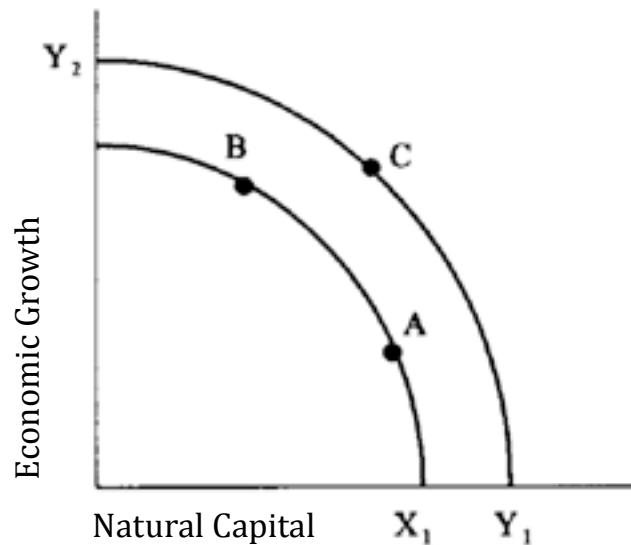
Scaling down and looking at micro-level decision-making, which is helping to fuel climate change, the problem with business-as-usual (BAU) methods is the concept of discounting business cash flows to arrive at the time value of money. The problem with this method is that costs are underestimated with the intention of equating a future nominal value (capital plus interest inflation) to present real value. Since a fixed amount of money today is more valuable than the same amount of money in the future, concern for future decisions are less recognized, inevitable affection future generations. The cost of climate change damage in the future would be discounted to appear less in

¹⁴ IPCC, 2007

¹⁵ Investing in a Sustainable World pg 224

Dollar value today. People will be more inclined to spend their wealth now and realize today's benefits than plan for the long term.

Figure 2: Productions Possibility Curve



Since energy is the root of GDP growth, reducing emissions for current energy providers is directly correlated with reducing economic growth.

If we consider this consumer behavior to the macro level, the gross domestic product (GDP) of a country is widely accepted as a leading driver for growth. However, GDP does not take sustainability or depletion of

natural resources into account. In fact GDP growth can be a hollow indicator given the example that a country may be experiencing an economic boom in the short term, but at the expense of its natural capital, and will shift its productions possibility curve (Figure 2 above) inwards. An inwards shift in the long term would indicate that the economy is not only smaller, but also incapable of growing or attaining previous levels of experienced/potential economic growth. Moreover, GDP does not factor in the externalities and pollution of production or over consumption. Equally important, fossil fuel prices do not fully price in operational costs required in the extraction of these resources: transportation and security costs of importing oil from the Middle East are subsidized to make retail fuel affordable, at the cost of American taxpayers. It is because market prices are not evaluated wholly that countries opt to specialize and overexploit certain commodities. Economically developed countries have well-defined property rights. In most poor countries however, governments treat resources as common property resources instead of assigning property rights responsibilities. This inevitably leads to developing nations

decimating forests, water supplies, arable land, and fisheries to mention a few. This idea of common property versus private property ownership is at the very core of climate change. One can say that this approach of common property resources has developed a behavior of freeriding and foregone responsibility. Lastly, market prices do not reflect the environmental damages caused by the procurement and usage of resources as well as the effect on biodiversity by removing resources from the ecosystem. Instead, primary resources cultivated by developing countries, are grossly inexpensive and provide a false sense of comparative advantage, hence the specialization and overexploitation of natural capital. GDP and existing price mechanisms thus reflect today's market failure of subsidized fuel prices and unsustainable extraction rates of commodities beyond replacement costs.

While this section discusses environmental degradation due to our poorly informed choices, the next section will investigate how climate risks will limit our choices and adversely affect economies, geopolitics, and financial markets. Climate change reaffirms the golden rule – that what we do onto others, we should expect to happen onto us. In this case, environmental repercussions may be more than our species can handle to continue survival.

Chapter Two: Monetizing Climate Risk for Companies and Governments

The saying goes that 'energy is the mother of all goods and the economy' – but everything must still come from mother nature. Although there are still people who choose to deny the existence of climate change, there is an overwhelming trend and acceptance of climate risks. However, most cannot quantify the impact of environmental degradation, nor understand the intrinsic relationship between biodiversity and capital markets because both sectors have different metrics. This section will quantify environmental damage in terms of the Dollar, and how gross negligence will inevitably affect economic and political stability.

The problem with the business-as-usual mentality and expectations of the American dream is that people are depleting more resources from the environment to chase the same quality of life afforded in the West. There are hundreds of millions to be born and awaiting the same luxury and consumerist lifestyles. In the following years, everyone will be faced with the combined problems of climate change, depletion of natural capital, religious fanaticism, and widening spreads in the quality of life. Likewise, the origin of certain problems can be often misinterpreted - certain basic economic needs between peoples can quickly devolve into religious and racial cleansing. Given these surmounting problems, we need to recognize, analyze, and plan how to solve the fundamental cause of a world that is quickly spiraling out of control. I believe the root of our problems is the scarcity of the world's resources, and that climate change has become our biggest threat.

As expressed by the IPCC, climate change has become the most impacting problem we have produced as a species¹⁶. Climate change is often categorized as an environmental problem; but it should equally be understood as a social, financial, and moral issue. Robert monks, an investor, argued that while individuals work to sustain and ensure money for their retirement, people need a safe and clean environment to live and use their capital on¹⁷

In the book, "Sustainable Investing", edited by Krosinsky & Robins, the world's population is described not only as a *universal owner* of the planet's natural resources (from a utilitarian perspective), but also an owner of the climate change problem¹⁸. Instead of acting as the world's responsible caretakers of its resources, we have become the masters of the earth's natural capital, and recognize the development of human civilization as well as financial benefit as isolated phenomena from the sustainability of the ecosystem. However, while the concept of investment is based on a risk-return tradeoff, we, as universal owners should understand the gravity of what we may lose due to our

¹⁶ IPCC 2007

¹⁷ Monks, 2000

¹⁸ Sustainable Investing, pg. 192

investments, which can worsen climate change. At the bottom line, all industries and businesses have to chase profit to advance and survive, and the pressure to maximize financial benefit for a business's owners and equity holders puts constant pressure on managers to prioritize short-term returns. However, this approach has given leeway to business externalities that are detrimental to the social benefit of individuals, poor nations, and habitats. It is important to change the approach to business management from short term to long-term growth and cash flow.

Criticism

It seems that even though there is overwhelming scientific data about climate change, there is still huge opposition and denial of this issue. The simple reason is energy (the backbone of economic function and markets), and the existing industries that are threatened by a global initiative to switch energy resources. Energy is the most important factor in industries and production since without energy, all industries will cease to function.

Many companies have argued that cleantech investing, socially responsible initiatives, or sustainability research analysis cannot be arguably justified since the costs to implement such systematic change will be too overbearing. These financial institutions and analysts, who are expected to be the experts of their respective sectors and stocks, are supposed to be the most credible source of knowledge regarding financial markets. However, these are the same institutions that have caused multibillion-dollar losses, federal bailouts, millions of jobs losses, and a violation of trust in the market system in the 2008 subprime mortgage crisis. Their status quo approach has led to the most recent recession due to irresponsible sub-prime mortgage lending in search for profit. It is the same for climate change, since these institutions profit immensely from oil and unsustainable trading of commodities. Renewable energy and clean technology threatens their existing portfolio of investments.

Capital Markets

Critics of climate change, and those who continue to argue in favor of economic stability versus reallocation of capital into renewable energy fail to acknowledge the current market failure of business-as-usual methods and capital markets. Since financial return continues to be the driving incentive and reward that clouds the management of businesses and economic growth, the government does not impose on companies to internalize environmental externalities in reporting standards. While businesses may delve into sustainable strategies, these are still recognized as extra-financials separate from accounting requirements. Increasing costs of compliance to environmental stewardship will amount to an increasing presence of risk, whether taxes or investments, in the balance sheet and financials of companies. Whether governments take a proactive approach to amending accounting methods or face the inevitability of climate risk in company financial statements, today's accounting procedures give leeway to market failure. Investors cannot recognize the social and environmental externalities of companies, thus further fueling and inflating business-as-usual methods to continue a company's short-term strategy for profit.

There is an inherent danger when market bubbles occur due to companies being overvalued for their cheap and quick product/service turnover versus long-term value creation. These bubbles will burst when our overweighed sectors in fossil fueled plants and powerful, but inefficient companies will be most affected by climate risks.

Operating Risks

Climate change poses many risks to companies and governments, especially operating and capital cost risks associated to more stringent governmental regulations, and access to commodities. For example, industries dependent on resource extraction such as mining, mineral extraction, oil, gas, and forestry, can and have been accumulating increasing environmental costs that are 10-30% of their

annual operating costs. These figures will likely increase the liabilities of companies in today's extremely competitive markets. Higher costs will further shave profit margins, and impact company stocks. No doubt, few well-managed companies will position themselves to take advantage of companies who continue to operate in business-as-usual settings. Since the effect of climate change will further pressure governments to create and enforce harsher penalties for polluting, companies will risk incurring capital costs to switch to cleaner technologies. Today, scrubbers can cost up to \$300 million per single 850-mw plants. Companies forced to switch later than sooner will be at a huge disadvantage.

Environmental regulations and taxes will reduce company profits and cost significant capital expenditures to adhere to required emission reductions, or else face paying expensive penalties. When companies are forced to switch and invest in newer technologies, all previous technology investments will be rendered inadequate or subjected to noncompliance penalties. In turn, companies will have no choice but to pass on this additional cost to its customers via higher service/product retail prices. If these companies are forced to increase their product price, they will lose market share to companies who have already factored in sustainable technology and can not compete at lower prices.

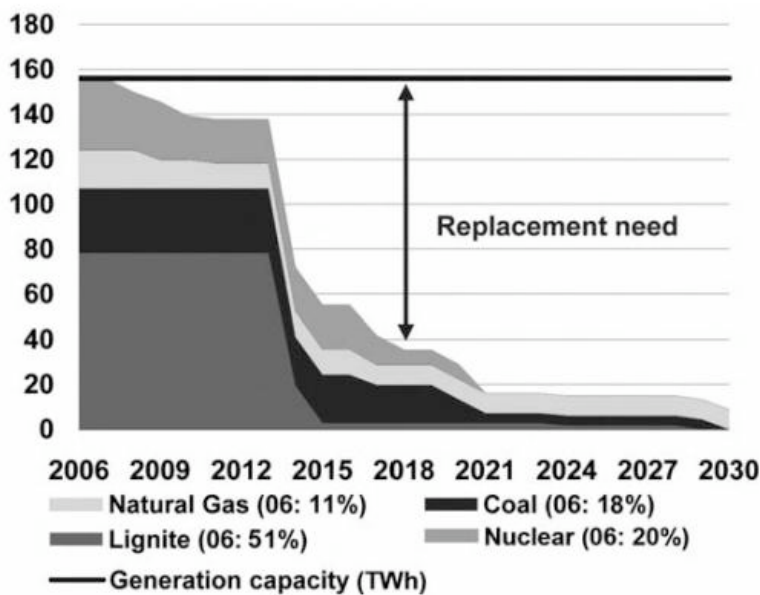
Aside from mandated requirements imposed on industries, companies will face steepening operating costs due to the overexploitation and degradation of resources; and the companies who are either most exposed or affected by climate change will incur reputational risks of bad management against their company branding.

Industry Exposure

Although all industries can be affected by operating risks due to climate change, the value of certain sectors are more exposed than others in a carbon-constrained future. Electricity generation, in particular, will be the most affected sector. Energy generation is the very backbone and mother of every economy; if energy provided is disrupted, every industry, from industrial, commercial, to service

providers will be affected. Since a majority of today's electric utilities rely on fossil fuel combustion and are the main contributors of greenhouse gas (GHG) emissions, a carbon-constrained future of pollution caps and carbon certificates will put significant pressure on fossil fuel plants to diversify into alternative resources or invest in clean technology. The Intergovernmental Panel on Climate Change's fourth Assessment Report states that despite lobbying efforts of utility and gas companies, the demand and requirements for the most emission-intensive power generators to become carbon-free is inevitable¹⁹. If the threshold for global warming is an increase of 2-3 degrees Celsius above pre-industrial levels, then at a minimum of a 50% decrease in greenhouse gas emissions must be obliged by year 2050.

Figure 3: RWE's expiring lifetime curve



German Electric Utility company RWE is an example of the costly implications of climate change and demand for carbon-neutrality. Electric utility plants have expected lifetimes and are depreciated every year. Figure 3 shows that 76% of RWEs lifespan for its power plants will be over

by 2020, and 80% will have to be replaced. There are three risks to RWEs business-as-usual strategy²⁰. Firstly, since the company has not diversified into alternative energy resources, a majority of its portfolio of power plants will be over by 2020. Secondly, RWE will incur huge capital expenditure costs to replace and build electricity plants – RWE can either invest in cleaner technologies or face increasing costs of operating fossil fuel plants. Lastly, RWE risks losing reputation and market share against other cheaper

¹⁹ IPCC 2007

²⁰ Sustainable Investing, pg. 78

electric utilities who were smarter to invest in solar, wind, biofuels, hydro, and other alternative sources.

Water

Dwindling water supplies for businesses will translate to higher operating costs due to water scarcity and higher prices. For example, water-intensive industries, which include steel, paper, pulp, shale, and oil, will have to reformat procedures and methods to curb rising water costs and ensure constant water resources. Industries, such as tourism or fishing, will be severely impacted since they are dependent on the aesthetic qualities and rich biodiversity of lakes, rivers, and coasts. Water efficiency will thus require research and development, as well as investment for industrial, manufacturing, and irrigational purposes. These investments will have to respond to two operational risks: water efficiency, and alternative water resources (i.e. desalination plants). Thus, company management that does not factor in water sustainability will face operational risk, while others will undoubtedly position themselves well to take advantage of this opportunity. Companies that will be discriminated as water-intensive users or discharging wastewater into the surrounding local environment will risk negative attention and resistance from communities. Companies that do not position themselves as market pioneers in water conservation and efficiency will find themselves cost inefficient and incurring investment risks because they will have no choice but to pay for increasing fees from water suppliers.

Politically, since water is our most important commodity for survival, and a critical component for manufacturers, disputes and fights may occur over water resources. It is predicted that demand for dwindling supplies of water will cause tension and conflict between countries in the near-sighted future²¹. Whereas industries in western industrialized countries will be in a position to take advantage of better planning and existing technologies to mitigate water risk, regions such as China and South Asia,

²¹ Garamone, 2007

which are emerging hubs of economic growth, will face challenges in water supply chains, depletion, and degradation. Also, unlike most political disputes today, water does not recognize national boundaries, and the decisions or actions of one will inevitably affect others, especially neighboring countries. For example, the devastated ecosystem of the Gulf Coast due to the BP oil spill has severely impacted the water quality, tourism and fishing sectors of not only the United States, but also Cuba and Mexico.

While the population is exponentially expanding, governments are not investing in secure water channels. Today, one in three people lack access to clean water. Analysts predict that by 2025, 33% of the world's population will be subjected to drought or unsustainable water resources²². Moreover, in poorer countries, agricultural communities are becoming more desperate and using wastewater to irrigate farms²³. With oil, there are growing alternatives; with water, there are none.

Threshold

Unlike politics or finance, which can be regionally constrained in some respect, climate change is a phenomenon that involves every person and all countries regardless of who should shoulder the responsibility of averting climate risk. The effect of carbon emissions and global warming does not recognize borders. Thus, victim or pollution producer, the atmospheric implications of carbon emissions will be distributed evenly across the world.

The IEA reports that about \$45 trillion in investments is needed to cut the total amount of global emissions in half by 2050, the threshold date, before the world is too environmentally damaged to sustain a functioning ecosystem²⁴. The amount required is neither a loss in GDP, nor an obstacle in growth; rather, the \$45 trillion required is a redirection of capital into new technologies and responsible

²² Saving Kyoto, pg. 17

²³ Bloomberg, Billionaire Lauder's Water Investment Strategy

²⁴ IEA, 2008

companies. This amount translates to a \$1.3 trillion annual global investment into clean technology and renewable energy. That means that while \$148 billion spent in 2007 was the record for global renewable investments, nine times greater in investments is needed to meet the 2050 goals. While this poses significant risks, this also opens huge opportunities we will explore in the next chapter.

Recognizing the threshold of the ecosystem to withstand the effects of climate change is a key step in preventing further environmental damage, and to a limited degree, reversing effects. As climate scientist Martin Parry had mentioned, “We now have a choice between a future with a damaged world or a severely damaged world”²⁵. Our present rate of consumption, expansion, and pollution has already damaged and affected the environment, with desertification spreading in Northern Africa, melting icebergs, and record high temperatures. This threshold speaks of a severely damaged world that threatens our very survival as a species. Going past this threshold poses severe threats to the world’s populated coastal cities or small island nations dependent on agricultural yield and/or exposed to flooding²⁶. These weather changes will give birth to millions of displaced people, who will be known as climate refugees.

This threshold is a finish line no one will want to reach; even if industrialized nations are at the best position to effect positive change given the financial capital they hold to invest into renewable energy and clean technology, developing countries will have an increasing role of responsibility since they presently hold the advantage of economic growth and opportunities. Even if developed countries successfully reduce their carbon footprint and environmental externalities, developing countries can have a huge effect on climate change if they pursue a carbon-dependent strategy towards economic growth since the threshold goal is a necessity to achieve regardless of who reduces. Thus, Kyoto Protocol co-author Graciela Chichilnisky describes that climate change poses one of the great geopolitical ironies: that “for the first time in history, welfare of rich nations will depend directly on

²⁵ Martin Parry, quoted in Pearce, 2005.

²⁶ IPCC, 2007

decisions made in poor nations in Africa, Asia, and Latin America”²⁷. As the threshold draws closer, developing nations can cause richer nations trillions of dollars in environmental damages if the former continues to operate using fossil fuels and under loose environmental regulations. The decisions of poor nations can majorly affect the quality of life in western nations. The following table shows the top 20 cities that are most exposed to flooding due to Climate Change and rising sea levels²⁸.

Table 1: Top 20 cities ranked in terms of assets exposed to coastal flooding in the 2070s

Rank	Country	Urban Agglomeration	Exposed Assets Current (\$Billion)	Exposed Assets Future (\$Billion)
1	USA	Miami	416.29	3,513.04
2	CHINA	Guangzhou	84.17	3,357.72
3	USA	New York-Newark	320.20	2,147.35
4	INDIA	Kolkata (Calcutta)	31.99	1,961.44
5	CHINA	Shanghai	72.86	1,771.17
6	INDIA	Mumbai	46.20	1,598.05
7	CHINA	Tianjin	29.62	1,231.48
8	JAPAN	Tokyo	174.29	1,207.07
9	CHINA,	Hong Kong	35.94	1,163.89
10	THAILAND	Bangkok	38.72	1,117.54
11	CHINA	Ningbo	9.26	1,073.93
12	USA	New Orleans	233.69	1,013.45
13	JAPAN	Osaka-Kobe	215.62	968.96
14	NETHERLANDS	Amsterdam	128.33	843.70
15	NETHERLANDS	Rotterdam	114.89	825.68
16	VIETNAM	Ho Chi Minh City	26.86	652.82
17	JAPAN	Nagoya	109.22	623.42
18	CHINA	Qingdao	2.72	601.59
19	USA	Virginia Beach	84.64	581.69
20	EGYPT	Alexandria	28.46	563.28

For example, if developing nations continue to use coal and oil, an increase in sea level will expose Miami to a potential \$3.5 trillion in property damages, as shown in Table 1 above²⁹. A significant number of listed cities are from OECD countries, but for all their development, they are at the mercy of the policies of developing nations. Equally important, if sea levels rose by one metre, 2.2 sq km of land

²⁷ Kyoto Protocol, pg. 19

²⁸ OECD 2007

²⁹ OECD 2007

would displace 145 million people, mostly in South East Asia, and cost \$944 billion in agricultural and infrastructure costs³⁰.

Just as investing in renewable energy and clean technology will be a costly endeavor, it would be even costlier to economies if we continue to operate at status quo. Thus, it is important to understand how much annual investment is needed from countries to redirect capital towards sustainable efforts. Former World Bank Chief Economist Sir Nicholas Stern suggests that nations should allocate 1-3% of their GDP per annum against climate change³¹. Similar to an insurance policy, governments should thoroughly run risk assessments of spending 1-3% of their GDP per annum to prevent a possible 20% global GDP reduction due to environmental damages worth up to \$35 trillion, especially to the largest coastal cities³². We are already seeing increasing trends in environmental damages.

Moving Towards the Threshold

During the heat wave crisis in 2003, Europe's public health officials were left unprepared with no response or strategy to deal with the climbing mortality rate of 35,000³³. One can expect that future climate change effects will be more severe than Europe's heat wave crisis. Governments and financial markets can run thousands of risk assessments for political and financial situations, but have severely neglected preparedness for climate change.

In 2007, property losses amounted to over \$70 billion, most of which were not covered by insurance. However, companies still paid \$23.3 billion for insured customers while 84% of paid insurance worldwide came from natural catastrophes³⁴. It is no surprise that the reinsurance giant, Swiss Re, that

³⁰ Swiss Re Economic Research and Consulting, Sigma No I/2008

³¹ Saving Kyoto, pg. 34

³² Stern 2006

³³ Saving Kyoto, pg. 15

³⁴ Swiss Re Economic Research and Consulting, Sigma No I/2008

compiled these statistics, have urged governments and leaders to prioritize climate change on their agenda. Insurance companies, particularly, will face increasing exposure to climate risks.

Emerging Markets

Climate change will be more noticeable in certain regions more than others, specifically poorer countries in Africa, South America, and Asia. While North America and Western Europe have strong governments and infrastructure to weather climate change effects, countries of less organized or unreliable governments will face the most impact.

Graciela Chichilnisky points that the global warming problem is synonymous with the world's poverty problems³⁵. The root of both problems, in a contemporary context, can be traced back to the strategy of developing countries to specialize and export natural capital. However, it is the lack of private property rights for common property instead of global competitive advantage that countries over-export. As a result, overallocation into industries, mineral extraction, and agriculture is a self-perpetuating recipe for disaster. The land becomes stressed, and homogeneity of industries poses more risk, especially to climate change and natural disasters. While the Kyoto Protocol tries to alleviate this 'tragedy of the common' approach, the United States and China have not ratified this resolution.

Although China might be the world's fastest growing economy at present, China is also quickly becoming the world's biggest polluter. The price to pay for uninhibited growth is often pollution and degradation of the environment, and China is no different. About 700 million Chinese do not have access to drinkable water and China holds 16 of the world's 20 most polluted cities. The Chinese Academy of Sciences had studied that China was poised to overtake the United States in carbon emissions eventually³⁶. Much sooner than expected, as of 2007, China finally overtook the United States as the biggest greenhouse gas emitter, with a reported 400,000 people dying each year from air

³⁵ Kyoto Protocol, pg. 62

³⁶ Buckley, 2008.

pollution³⁷. Because of this, China will be in a more precarious situation to be pressured by other countries in the next round of carbon cap emissions.

Although India is one of the fastest growing economies, India's infrastructure faces surmounting problems to its economic growth, health, and environmental sustainability. More than 25% of India's manufacturing and energy producing companies do not follow environmental standards, or easily surpass penalties due to bribery. Thus, it is estimated that India is exposed to a 1% GDP growth reduction per year and a \$500 billion opportunity cost for all industries in India³⁸. India's poorly developed utility industry, which sources most of its energy from coal, averages 85 days/year of power shortages, which is a huge production cost to companies. Likewise, India's rivers and lakes are under huge stress because of a booming population and pollution.

Fossil Fuels

Fossil fuel implications can be best understood as a 'Gordian knot' of three interlinked issues – energy security, growth, and climate risk³⁹. Since fossil fuels are unevenly concentrated around the world with countries having more access than others, the dependence of the economy around fossil fuels have prompted wars and trillions of dollars into securitizing fossil fuel resources. Equally important, since energy is the backbone of economic development, most of our energy comes from fossil fuels. However, we must answer, at what cost is it to center our civilization around the use of finite energy resources, and the externalities of its consumption?

Since we have not internalized the full price of fossil fuels, including carbon emissions as a by-product of our continuous use of fossil fuels, we have not made efficient use of these resources until recently where increasing oil prices are driving innovation to alternatives and more efficient technology.

³⁷ Sustainable Investing, pg. 149

³⁸ Sustainable investing, pg. 168

³⁹ Saving Kyoto, pg. 34

Blackrock, a well-known investment management corporation based in New York City, reports that its key risk theme for 2012 is energy risk – the energy commodity market, especially oil, presents a tail risk for world economies⁴⁰. Genel Energy Pls Chief Executive Officer Tony Hayward had expressed that “one major political event in this region can send [oil] prices to \$150 or higher”⁴¹.

For example, the airline industry is already experiencing the negative effects of increasing oil prices. Delta and Southwest Airlines have recently reported that fuel prices are shaving away at their profit margin⁴². Fuel costs have spiked 187% in one year, and has nearly tripled since 2011. As a result, airline industries have had to pass on these additional costs to their customers, with the consequential effect of lowering demand for air travel. Likewise, smaller airline industries cannot compete or being forced to merge with bigger companies due to higher costs. JetBlue Chief Financial Officer Mark Powers expounds on the volatility and correlation oil price has to an airline’s profit or loss. Powers states that a one-cent increase in oil price translates to a \$6 million cost⁴³.

Another example is the 2010 Gulf of Mexico oil spilling which BP Plc may be penalized up to \$17.5 billion in civil pollution fines in violation of the Clean Water Act, with more fines and criminal penalties that can cost the energy giants billions of Dollars more as settlement with affected businesses and residences⁴⁴. As a result, BP’s market capitalization value has been reduced by about \$45 billion since the Gulf spill.

U.S. Navy Secretary Ray Mabus expresses his concern for the supply shocks of oil⁴⁵. Using the American Navy as an example, one cannot accurately budget for the volatility of oil and this presents a great security risk. Although the price of oil fluctuates up and down, there has been one general direction upwards. More importantly, oil prices can instantaneously spike due to political events – the

⁴⁰ Bloomberg, BlackRock Says Energy Risk ‘Key Theme’ for 2012

⁴¹ Bloomberg, Tony Hayward Sees Oil at \$150

⁴² Bloomberg, Fuel Prices Give Airlines a Hard Landing

⁴³ Bloomberg, JetBlue Sees ‘Huge Expense’ from Jet Fuel

⁴⁴ Bloomberg, BP Case Shifts to Pollution Fines that May Top \$17B

⁴⁵ Bloomberg, U.S. Navy Secretary on Energy Use, Renewables

1973 oil crisis, September 11 World Trade attack, and today's political tension with Iran's nuclear endeavors. Oil, in the commodities market, is primarily traded on fear and rumor. If Iran threatens to 'close the straits of Hormutz' capital markets almost instantaneously react negatively to the news⁴⁶. It is because of the high volatility in oil markets, as well as increasing risks due to climate change pressure, that the U.S. navy and military (both consume a total of 20% of the world's oil supply) wants to diversify their energy resources away from fossil fuels.

Geopolitics

The world is no longer divided by political ideals between capitalism or communism, with either racing towards nuclear supremacy, although the nuclear power is still a grave threat used by rogue hostile nations. Rather, the world is now divided between the rich, the poor, and each other for natural resources. A sort of free for all battle royale, we have only begun competing for commodities, especially energy resources and water, via capital markets and investments. However, worsening environmental conditions can quickly escalate tensions between countries into hostile actions.

Natural capital and commodities, such as petroleum, corn, and water are increasingly becoming more important than stocks, bonds, and other security instruments. Capital, for production input, is quickly losing ground to natural capital. The great worldwide race will be who can hog resources first.

Chapter Three: Opportunities from Climate Risk

Companies are recognizing a new layer of business and risk valuation due to climate change challenges, while seizing the competitive opportunities of sustainability. More and more analysts are integrating sustainability drivers to identify companies that exhibit an understanding while implementing strategies that take advantage of sustainability demands from a carbon-constrained

⁴⁶ Bloomberg, U.S. Navy Secretary on Energy Use, Renewables

future. Companies that are able to realize potential competitive advantages and new outlets for profit reflect good corporate governance and long term planning on behalf of their managers and executives.

The term, clean technology, can refer to products and services that provide an alternative to decrease or eradicate environmental externalities while enhancing efficiency, independence, and superior performance. Clean technology involves the development in the following industries – water/waste management, energy efficiency, renewable resources, materials, commodities, transportation, and agriculture. To list a few examples of alternative energy resources, current investments lie in biofuels, jatropha oil, ethanol, solar photovoltaics, wind, waste to energy, solar thermal, small hydro, and algae. The burning of clean coal may be more efficient than conventionally used coal, but there is nothing clean about the extraction process, which is still harmful to the environment. Biomass, although an alternative to fossil fuels, is increasingly competing for land and allocation against food production, while still an emissions-producing fuel.

Table 2: Sustainable/GHG reduction technologies

Energy Supply	Efficiency; fuel transition; nuclear power; renewable (hydropower, solar, wind, geothermal and bioenergy); combined heat and power; carbon sequestration; jatropha oil
Transport	Fuel-efficient vehicles; hybrid vehicles; biofuels; public transport development and city planning;
Buildings	Efficient lighting, appliances and air conditioning; insulation; solar heating and cooling; alternatives to chemicals used in insulation, or real estate development
Industry	More efficient electrical equipment; heat and power recovery; material recycling; control of non-CO2 gas emissions
Agriculture	Property management for soil carbon storage; restoration; sustainable produce cultivation methods; environmentally-friendly nitrogen fertilizer; engineered crops
Forests	Afforestation: reforestation; property management; reduced deforestation; use of forestry products for bioenergy (i.e. biomass pellets)
Waste	Landfill methane aggregation for energy; waste incineration with energy recovery; composting; recycling and waste minimization; urban planning

Source: Kyoto Protocol

Table 2 above shows the different methods of investment companies and financial institutions can choose from. This list is bound to expand as more capital is transferred to the industries

aforementioned. These are but a few of the new industry segments, which will stimulate job opportunities and further innovation. The main purpose of clean technology and renewable energy is to minimize environmental degradation. However, sustainable investing is no longer just the prerogative of those socially minded. Rather, the growing trends and higher returns will be an incentive for purely financially motivated investors to enter this market space.

There are five types of investment strategies associated with sustainability: ethical investing, responsible investing, clean technology investing, social investing, and sustainable investing⁴⁷. For this paper, we will investigate clean technology investing and sustainable investing since both strategies do not limit their selection of stocks due to moral standards i.e. tobacco companies.

Social and Sustainable Through Profit

Although environmentalists were initially skeptical of internalizing environmentalism into finance and investment strategies, a market-based approach to sustainability is proving to be an effective solution to internalize pollution and externalities⁴⁸. The United Nations Environment Program's Finance Initiative (UNEP-FI) is recognized as the first global association amongst investors to analyze and promote environmental and social (ES) risks to businesses. This really was the first spark in linking capital markets to environmental stewardship. Many newly listed clean technology companies in the public market are seeing their market shares being bought not by ethical individuals, but by sovereign funds, pension funds, and hedge funds. In this sense, critics are stating that renewable energy or clean technology firms are losing their 'social' or 'sustainable' purpose. Rather, these firms are being driven by profit and market trends. However, these entrepreneurial companies are not only socially beneficial, but are more sustainable because their profit driven strategies and cash flow will expedite the proliferation of clean technology and incentivize other companies to join the cause.

⁴⁷ Sustainable Investing

⁴⁸ Sustainable Investing, pg. 60

Capital Market Opportunities

Despite the economic recession in 2008, renewable energy and clean technology are the most rapidly expanding industries today. Financial markets and institutions are critically essential in proliferating a transition to a cleaner economy because they control the investments and capital flows that entrepreneurs need, as well as startup companies and carbon markets. Factoring in sustainable analysis in investment policies includes research of financial markets, equity valuation, portfolio allocation, and even the financial analysts responsible for covering the market.

Table 3: Centre for Tomorrow’s Company (2000)⁴⁹

Successful investment
Depends upon
Identifying targets which can provide a good return
Which depends upon
A vigorous population of enterprises
Which depends upon
A healthy macro-economy
Which depends upon
A healthy civil society
Which depends upon
A sustainable planet

Table 3 to the left shows how investment decisions will morph to integrate and understand ESG issues. When analysts, traders, bankers, and managers understand the flow chart and root of a successful investment, they will understand how sustainability is a vital driver, like the first

pyramid of a biological food chain, to protect.

The demand for sustainability and accountability has the potential to shake the foundations of capital markets. Since the threshold to avoid serious ecological damage would be an 80% reduction in global carbon emissions by 2050, the IEA has estimated that a total of \$43 trillion in new capital or redirected investments must go towards renewable energy and clean technology. The United Nations Framework Convention on Climate Change (UNFCCC) pronounced that an estimated 86% of the \$200

⁴⁹ Centre for Tomorrow’s Company (2000)

billion in required investment per year needed by 2030, will be provided by the private sector. However, The UNEP reports that about \$450 billion will have already been spent in 2012 onwards, and \$600 billion in 2020 onwards⁵⁰. This statistic provides a huge opportunity to invest in renewable and clean technology companies⁵¹. This means that new industries, jobs, and technologies will be created due to a

Figure 4: Winslow Green Growth Fund vs. Berkshire Hathaway



multiplier effect of the economy being interrelated. This exponential growth spurt also means huge profitable endeavors. In fact many green funds, prior to the 2008 recession, had been overperforming, even past the best benchmarks. Figure 4 above shows how the Winslow Green Growth Fund, which aggregates growing companies in the renewable energy, clean technology, and efficiency industries, as outperforming even Warren Buffet’s Berkshire Hathaway company in terms of return percentages⁵².

World Business Council for Sustainable Development (WBCSD) President, Bjorn Stigson, identified that if financial markets do not ramp up investments in renewable technology and reward

⁵⁰ UNEP 2008
⁵¹ UNFCCC, 2007
⁵² Yahoo! Finance

sustainable long term conduct, the goal of achieving a cleaner future would be constrained⁵³. Stigson therefore stresses that capital markets have the potential to either constrict or promote sustainability. Ultimately, climate risk presents competitive advantage for well-managed firms, and this does not necessarily follow suit for industry leaders who hold today's largest market shares. The more this approach is implemented for analysts to use, the better well-managed companies will be recognized while other lagging businesses will be incentivized to internalize sustainable management.

Historically, sustainability factors have been largely sidelined or unrecognized by capital markets. Since sustainability is still in its infant stages, seizing the early growth stages, and identifying tomorrow's well-positioned companies against a carbon-constrained economy will give investors a huge advantage to appreciate their market shares. Clean energy investments have already increased by 60% or \$150 billion on new cash flow from 2006 to 2007⁵⁴. Rest assured, even the biggest players are starting to play the sustainability game. The Carbon Disclosure Project (CDP) is the biggest aggregation of assets under management of over \$55 trillion of the world's biggest investors. The CDP includes Allianz, Societe Generale, Union Bank of Switzerland (UBS), and Credit Suisse. The CDP also boasts the largest source of corporate emissions data. Investing capital into companies that produce or make use of clean technologies or renewable energy will help create that transition from short-term driven profits to long-term appreciation of assets and shareholder value.

The main driving force of financial markets is short-term profit, rather than long-term value creation. This strategy is not necessarily bad, since short term strategies help sustain liquidity in markets; but sustainable investing and a cleaner future entail reversing this mindset. In the long term, investments and businesses that implement sustainable strategies are expected to outperform and gain higher returns compared to those who continue to operate under business-as-usual pretenses. Al Gore's *Generation Investment Management* has stated in its purpose that, "management quality is the

⁵³ Stigson, 2003, pg.6

⁵⁴ Saving Kyoto, pg 4

principal determinant of the financial performance of companies”⁵⁵. Management quality can only be appreciated in the long-term growth value of the company or its stock portfolio.

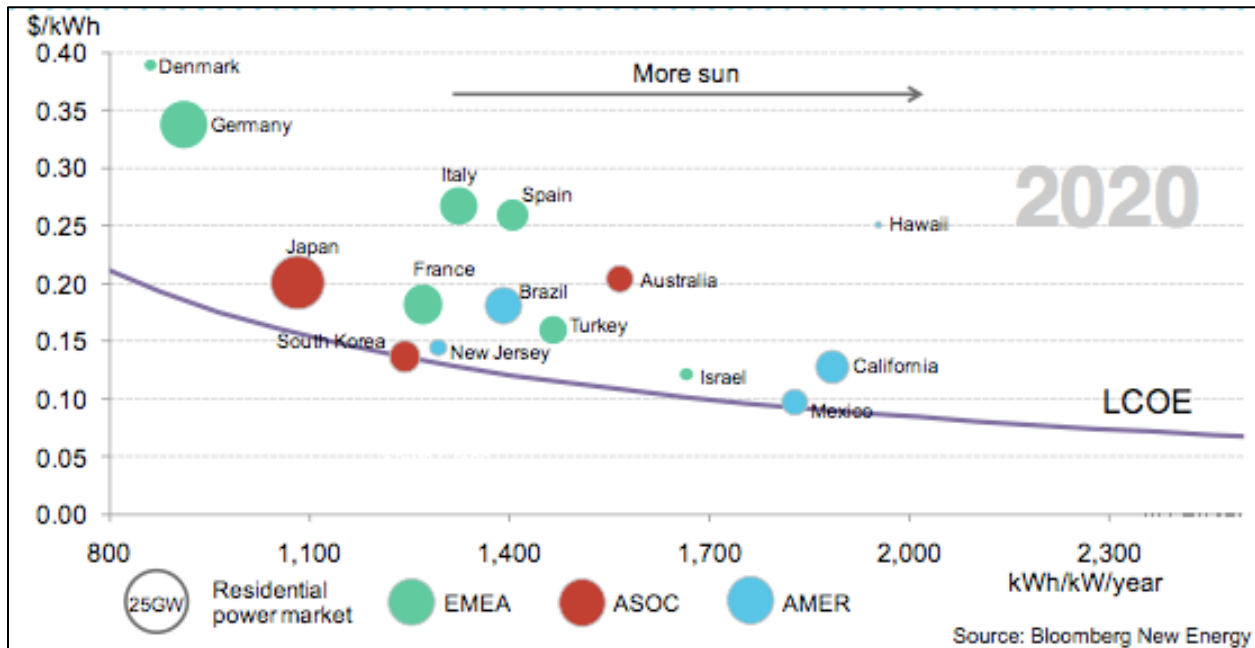
As a common practice, Wall Street aficionados use standard deviation to quantify the “risk” of their portfolios and investments. However, as argued by Nassim Taleb in his novel, *The Black Swan*, one cannot summate uncertainty by a specific numerical value⁵⁶. Black swans (unexpected phenomena) will inevitably occur and the volatility of climate change to affect environmental health or patterns will increase the frequency of black swans. Integrating sustainability analysis or investing in clean technology is an automatic hedging strategy against risk and volatility. Even legendary investor Warren Buffet is diversifying into solar energy. Solar panel installation and projects offer 15% returns and long-term predictable cash flows⁵⁷. Most importantly, after one makes the initial capital investment into solar energy, the panels are essentially paying for themselves – free fuel, low operating costs, and tax credits. This is a potentially revolutionizing asset that can be seen as a safer alternative to bonds. More precisely, this type of strategy will decrease the correlation between beta (a numerical value to assess market risk) and the traditional S&P500 index. Looking at the solar industry as an example, more nations and states are reaching energy price parity to conventional fossil fuel plants. Moreover, solar panels will continue to yield more energy per capacity, while finding ways to reduce resources used and overall product price. This is in stark contrast with fossil fuel plants who are dependent on oil/coal/gas suppliers and increasing costs.

⁵⁵ Investing in a Sustainable World. Pg. 206

⁵⁶ The Black Swan, Nassim Taleb

⁵⁷ Bloomberg, Solar 15% Returns Lure Investments from Google to Buffet

Figure 5: Resident PV Price Parity⁵⁸



In Figure 5 above, with the exception of California, Hawaii, and New Jersey, The United States is lagging behind its competitors who will be able to provide solar panel price parity to traditional energy resources, with lower averaged rates and increasing energy generation (kWh/Kw/year) from improved solar panels. Investing in solar panels may be a risk to investors considering the industry’s early stages in growth. However, Figure # shows that not investing in solar technology will increase risk for the United States as it will be forced to import its solar panels, instead of growing its industry.

There are two ways to measure the impact of extra-financial indicators i.e. climate risk on business valuation. The first method is a direct approach by recognizing the costs of climate risk and their potential effect on earnings and price share. However, it is hard to quantify and qualify the true cost percentage due to climate risk or cost. The second method is using statistical analysis and a beta approach to estimate the financial impact of climate risk or reduction based on ratings. The equation would be:

$$\text{Return on investment} = R_f (\text{risk free rate}) + \text{Beta} \times (\text{risk premium} - \text{risk free rate})$$

⁵⁸ Bloomberg New Energy Finance Summit, CEO Michael Liebreich

To calculate a company's sustainability beta risk, the following formula will take into account corporate governance: The beta of a company's share = beta activity (industry) x the beta of the company x beta management quality of the company. If the quality management beta is greater than one, this means that a company's management is likely to underperform from its target. Since quality management reflects corporate governance, and since the latter is one of the main drivers of sustainability, one can factor in sustainability into analysis. Between the two methods, the second is the more realistic method because it is easier to create a sustainability ratings rubric similar to the bond ratings Standard and Poor implement – AAA for the safest bonds, B for risky/junk bonds instead of quantifying true costs.

Corporate Governance Analysis

Although intangible and incalculable, good management is one of the main drivers to deducing whether investment strategies are able to reduce risk and correlation to markets, while providing superior returns. Many terms, such as social, responsible, or green, are still considered extra-financial factors towards financial and investment analysis. This must change and environmental factors should be fully integrated into standard practice of analysis and decision-making. The Stern Review commented that not internalizing climate risk into analysis or corporate governance might be the biggest market failure to exist⁵⁹.

In sustainability analysis, there are key investment drivers. They are the following: stable/unstable energy demand, fossil fuel prices, fossil fuel supply risk due to securitization, renewable energy trends, climate risk impact on natural capital supplies, water resources, and changing consumer preferences⁶⁰. Companies that manage environmental, social and governance (ESG) issues decrease their risk (beta) and are seen as an automatic strategy for investors to hedge their stock picks. We will explore how there is increasing evidence that corporate strategic planning against climate change is a

⁵⁹ Stern, 2006

⁶⁰ Sustainable Investing, pg. 86

driving factor and proxy for good long-term management. Managers who strategize against climate risk are not in violation of their fiduciary duty to provide financial performance for stockholders contrary to popular belief; rather, there is superior and long-term financial securitization for shareholders as well as brand value creation if a company invests in cleaner operating plans. Sustainability in corporate governance and investments are well ingrained in HSBC's strategy than any other bank's strategy today. HSBC has already initiated a global climate change index, which finds and tracks companies that exemplify sustainable efforts to position themselves strategically. However, negligence will cost companies and industries market share against competitors strategizing towards sustainability. The US automobile industry is losing market share to competitors who have lower carbon emissions operations and more efficient vehicles. Toyota has finally overthrown General Motors as the largest automobile maker while the US automobile industry is still struggling to regain its footing. Another example, due to the oil spill last November, 2011 off the Brazilian coast, Brazil sued Chevron and Transocean for \$11B and is trying to stop both companies from exporting oil outside Brazil⁶¹.

While there will be plenty of struggling companies, there will also be those who will benefit from demands for a carbon-constrained future. China's ENN company is planning to invest \$5 Billion towards a Nevada solar power plant that is expected to create jobs and development in Nevada, one of the most severely hit regions by real estate prices and foreclosures. This investment is also expected to revitalize relevant industries i.e. roads, water systems, transmission lines, and new neighborhoods because of the new solar power plant.⁶²

After controversy over its sweatshops, Nike is implementing a sustainable plan geared towards minimizing waste produced, and redirecting 85% of footwear manufacturing waste from landfills. Nike's

⁶¹ Bloomberg, Brazil Sues Chevron, Transocean for \$11B

⁶² Bloomberg, China's ENN Plans \$5 Billion Solar Plant in Nevada

greatest goal is to create a tightly looped process in which materials can be recycled from old Nike products. When this sustainable strategy was released, Nike's stock appreciated up to 33.42%⁶³.

Although ExxonMobil fluctuates between 1st and 2nd largest market cap in the world, it is important to analyze whether ExxonMobil is exposed to a carbon-constrained future and capable of sustaining its high cash flow streams. This is an important incentive in the transition to cleaner economies, and as mentioned in *Investing in a Sustainable World*, "where successful companies go, successful investors are bound to follow"⁶⁴.

Funds

Corporate pension funds are starting to diversify into renewable energy investments, funds, and acquisitions of companies. General Electric, Shell, Siemens, and Sharp are but a few of the major companies setting sustainable trends within their pension funds⁶⁵.

Howard Pearce, head of environmental finance and pension fund manager of UK's Environmental Agency Pension Fund (EAPF) suggested that there is a strong correlation with the management of a pension fund and the ability to exude positive social influence/externalities to promote a safer, cleaner future⁶⁶. Similarly, CalPERS (the California Public Employees' Retirement System), the largest U.S. public pension fund with more than \$230 billion in assets under management, is one of the leading pension funds investing in renewable markets, has expressed that "how an institution actually invests its assets is a far more telling and influential indicator of its commitment to sustainability than any rhetoric"⁶⁷.

⁶³ Bloomberg, *The Sustainable Advantage: Nike's Wake-Up Call*

⁶⁴ *Investing in a Sustainable World*, pg. 239

⁶⁵ Martinot, 2005

⁶⁶ *Investing in a Sustainable World*, pg. 178

⁶⁷ "Monitoring the Monitor: Evaluating CalPERS' Activism"

As the world's third largest pension fund, APG's mission is not to promote socially responsible investing. However, its managers have recognized that renewable and clean technology companies offer long term outperforming returns, while reducing portfolio risk⁶⁸. The EAPF is even more dedicated towards a sustainable strategy with over 10% of its portfolio allocation towards well-positioned companies. Moreover, the Environmental Agency Pension Fund (EAPF) demands its equity managers to utilize ES research when analyzing its more conventional investments. Thus, although EAPF still invests in conventional strategies, their approach to analysis makes their portfolio 100% hedged against environmental risks.

There are also many institutions creating indexes and funds, which help to aggregate like-minded companies together for investors to invest in all at once. Sustainable Asset Management (SAM) launched the Dow Jones Sustainability Index and several funds that focus on the following – a smart energy fund geared towards upcoming technologies, and a sustainable water fund that tracks water resource management of companies. Similarly, Al Gore is co-founder of Generation Investment Management, a firm that has launched its own 'climate solutions' fund to invest in similar endeavors.

Whereas an estimated one trillion Dollars are needed per year to invest in renewable or clean technology, only \$260 billion were invested in 2011 primarily because of the recession. Instead of the existing approach of incremental investments from whoever can finance sustainable projects, pension funds and mutual funds should be targeted and exposed to ESG research since this market group commands a total of \$80 trillion in assets under management. If there was a group to invest and expedite the proliferation of clean technology, pension funds and fund makers is the group to approach.

There are also funds, which exist for a social purpose, but lack the consideration for sustainable investing. The Bill & Melina Gates Foundation controls nearly \$40 billion in assets under management with an additional potential \$15 billion in funds from Warren Buffet. The fund's goal is to promote global

⁶⁸ Investing in a Sustainable World, pg. 178

sustainable development, global health, and America's development. Despite these endeavors, a January 2007 article in the *Los Angeles Times*, titled "Dark Clouds Over Good Work of Gates Foundation" stipulated that the Bill Gates Fund was investing in companies and assets that were not only contradicting in the fund's goals, but also detrimental to the overall mission, by have a portfolio heavily invested in oil companies⁶⁹. Although it is up to the freedom of the fund's managers and owners to determine portfolio allocation, the article does help to point out that not only does the Bill and Melinda Gates fund expose itself to reputational risk, it also misses out on potentially higher returns from ESG-elected stocks that will be naturally hedged from climate risks in the long term.

Equity and Fixed-Income (Bonds) Financial Assets

The equity investor who is interested in incorporating sustainability factors within investment strategies can approach investing by the following two strategies: the first strategy focuses on the opportunity to seize company X's share whose market price does not reflect the true higher fair value of the stock because the market has not caught up to the sustainable corporate governance company X has positioned itself to have. This technique relies on value investing by purchasing stocks for cheap, and waiting for its market value to appreciate. The second approach is to realize the lagging companies who are comparatively poorly positioned in impending climate risks. Their market price is most commonly overpriced in which the company's market value is higher than its real fair value. Thus, one can use a short-selling hedging strategy by borrowing the stocks of company Y, selling his/her share at the overpriced market value, and wait for the market to realize company Y's risk exposure to downgrade company Y's share prices. At this point, the investor can buy back his/her borrowed shares at a cheaper price and realize the difference between his initial investment and post buyback as profit.

⁶⁹ LA Times, "Dark Clouds Over good Work at Gates Foundation"

There aren't many fixed-income (treasuries, notes, bonds) securities that include sustainable factors; but for those fixed-income investors who factor in ESG issues, are concerned about a fixed-income security's exposure to interest rates, credit quality, and disruptions to cash flow due to climate risk. Climate catastrophe's or market speculation can adversely affect the quality of corporate, municipal, sovereign, and supranational bonds. Climate risk has the potential to disrupt a country's credit quality due to geopolitical tensions and conflicts over natural capital.

Figure 6: Bond Rating vs. ESG Rating

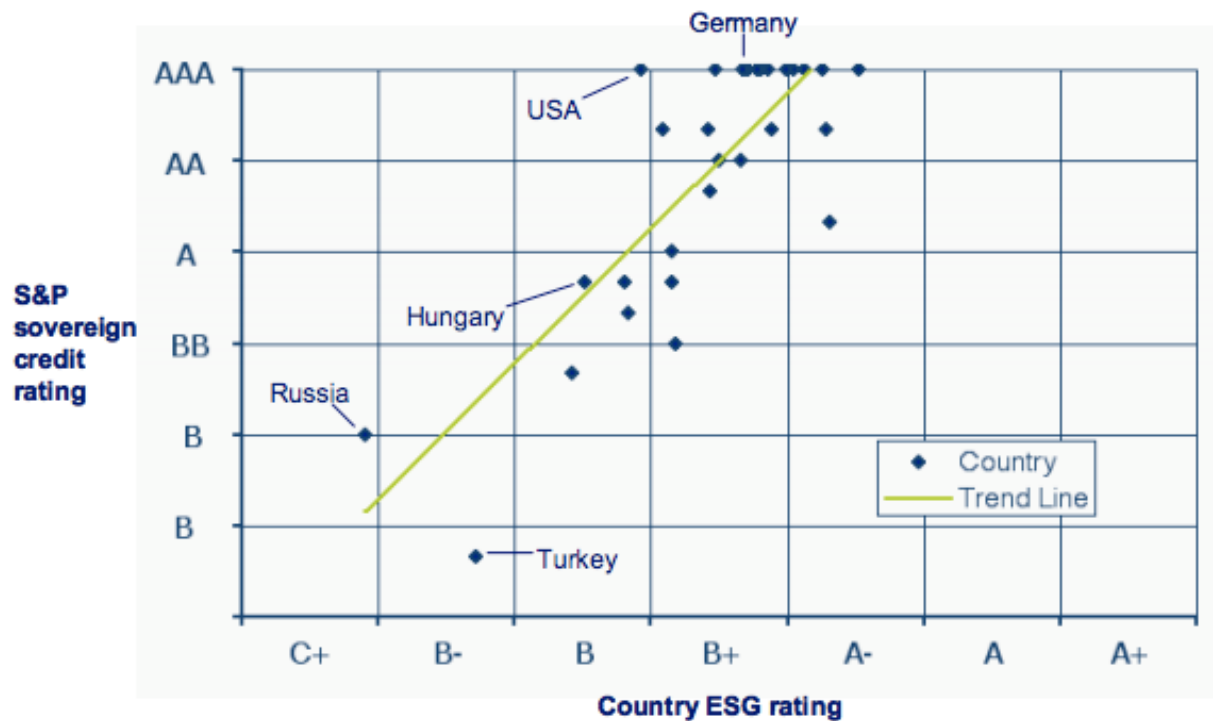


Figure 6 above shows how ESG performance of a country is linearly correlated with a country's credit ratings⁷⁰. This table seems to suggest that there is a positive correlation between both factors. At the top of the table is Germany, a country renowned for high environmental standards, large investments in renewable energy (wind and solar), and stable bond ratings. Financial institutions, such as BNP Paribas Asset Management and HSBC Investments, have launched their own fixed-income strategies that take

⁷⁰ Mistra

into account ESG analysis of securities (treasuries, notes, bonds)⁷¹. Bank Climate Bonds are a new phenomenon being developed by Citi Group. These climate or “green” bonds are structured and function like conventional “brown” bonds. However, Citi hopes to change an investor’s approach to fixed-income securities by helping investors recognize the “sweet-spot” of being climate hedged with a green bond versus a brown bond⁷².

Carbon Markets

The “Cap-and-Trade” mechanism works as the following – the government sets emission caps, which are then distributed respectively to a company’s emissions records. Companies that emit less than their allocated carbon caps can realize and sell their carbon surplus as “carbon credits”. These carbon credits can be sold via a carbon market system, to other companies who have high marginal abatement costs and struggling to emit below their emissions cap. This market-based approach is effective in internalizing carbon emission costs, and incentivizing lagging companies to invest in sustainable development or risk paying fees. In a coauthored study between Massachusetts Institute of Technology (MIT) and the International Energy Agency (IEA), the European Union Emissions Trading Scheme (EU ETS) has successfully reduced carbon-emissions by up to 100 million tonnes of CO₂ per year since its inception of 2005⁷³. The EU ETS currently covers the following industries – pulp and paper, glass, and metals. Other industries, such as transportation (airlines emissions trading), are expected to follow but are harder to implement since these are non-point sources (cannot be controlled from one location). This system rewards companies who minimize and decrease their carbon footprint, while punishing those who emit excessively.

⁷¹ Sustainable Investing, pg. 111

⁷² Bloomberg, Climate Bonds Initiative’s Kidney on Green Bonds

⁷³ Ellerman and Buchner, 2006

In 2005, the European Union Emissions Trading Scheme (EU ETS) setup the world's first carbon market which covers five carbon emitting sectors and 27 countries. Carbon emissions are now becoming a newly recognized asset class in which special investment vehicles are being made to trade carbon-emissions in capital markets. Investment banks have taken notice of these new markets and securities and are starting to scale their environmental/sustainable investing departments. Most banks, such as Deutsche Bank, Bank of America, and BNP Paribas have emissions trading desks and expanding investment-banking divisions⁷⁴. When the EU ETS formed, carbon's starting price was estimated at \$30 per tonne. This carbon price signals how costly, in monetary terms, emissions are to the economy and how much it would cost to remove these from the atmosphere. Multiplying this price to the sum total of emissions per ton in one year, the global market can generate \$900 billion each year⁷⁵. This amount is roughly total to 1% of the global GDP, which is on par with the value needed to invest or redirect into renewable or clean technology per year, to avoid reaching the threshold by 2050. By finally attaching a price to emissions, which were previously unaccounted for, the carbon market has created a new source of income. The net cost to the global economy would be zero since the carbon market is a zero-sum game between market pioneers and laggards. However, the carbon price must be set high enough to realize the high costs of emissions, and for cleaner alternatives to be a more cost effective solution. This follows simple supply and demand dynamics – the lower the supply of caps, the higher the emission price. The carbon price is the one aspect of the market that can never be known in advanced, but is determined by real-time demand and supply. This level of risk and uncertainty is in contrast to carbon taxes that, while fixed amounts, are not economically fair to companies and a disincentive to invest in research and development. Likewise, a global entity to mandate taxes would be needed, unlike the carbon markets which are self-determining. Equally important, emissions caps are continuously lowered

⁷⁴ Sustainable Investing, pg. 69

⁷⁵ Saving Kyoto, pg. 42

in the next round of negotiations amongst countries, which helps reduce uncertainty unlike the unforeseeable nature of an emissions tax, which may continue to exist or be tabled.

Since climate change does not recognize political borders, a tonne of carbon emissions reduced in the United States is as valuable as reducing a tonne of carbon in the Philippines, for example. The Kyoto Protocol relies on world cooperation. However, the Kyoto Protocol, or its future derivatives, can only be salvaged if developing countries are protected from the costs of switching energy resources or technologies, while maintaining their development and industrialization. In this regard, developing countries have argued that responsibility falls on the behalf of developed countries since the latter are the world's greatest emitters.

To respond to this concern, the Clean Development Mechanism (CDM) was enacted to reward carbon credits "in the form of Certified Emission Reductions (CERs)" to companies who invest projects in developing countries that usually do not have emission reduction targets⁷⁶. With the Carbon Development Mechanism project (CDM), Africa has the ability to reduce significant amounts of emissions from the atmosphere even if Africa emits comparatively less than other continents and regions. Negative carbon is a relatively new and improving type of technology, which directly reduces carbon from the atmosphere. Graciela Chichilnisky and Eisenberger have developed a breakthrough in carbon sequestration technologies. Called the Global Thermostat, this functional structure can produce electricity while simultaneously capturing carbon from the atmosphere via air filtration⁷⁷. This technology can turn a fossil fuel plant into a 'net carbon sink'. These structures are being constructed in Africa. Thus, although Africa only emits 3% of the world's carbon emissions, foreign clean technology investments (i.e. carbon sequestration) provide Africa the opportunity to reduce world emissions by up to 20%. The CDM helps to solve this friction between developed and developing countries. The initiative lets OECD countries to invest and transfer their clean technology into developing countries while

⁷⁶ Sustainable Investing, pg. 62

⁷⁷ Saving Kyoto, pg 110

collecting foreign carbon credit to offset their own emissions limitations⁷⁸. It is a win-win situation for both parties. While developed countries can capitalize on international investments in lower taxed countries, developing nations will benefit from the influx of new technologies, job opportunities, investments, and a cleaner environment all the while maintaining their propensity for economic development. Also, after the investing nation collects its credits, these can be traded in the emissions market, while the developing nation does not have to suffer from emissions limits. The CDM helps developing countries take a giant leap towards sustainable economic growth.

Although developing nations cannot trade in the carbon market because they do not have allocated emission caps, they can indirectly benefit from the Clean Development Mechanism (CDM). The carbon market rewards the good companies, penalizes the bad companies, and minimizes government oversight. Before, there was no market to come to an equilibrium and price carbon-emissions. Most importantly, the carbon market will drive new carbon asset classes. Unfortunately, the perception that environmentalists have of bankers and environmentalists is that the latter are evil self-concerned people. The Wall Street culture focuses on finding the next ‘thing’ to make a profit from. In this regard, there are plenty individuals who realize the benefit of sustainable investing, but have no existing outlet or markets to make a profit from socially endearing causes.

Table 3: Carbon Asset Classes⁷⁹

Carbon markets	Structured emissions products, carbon funds, emissions price indices, EUA/CER swaps, synthetic portfolios of carbon credits
Equities	Portfolio screening, SRI funds, low-carbon technology stocks, index products
Bonds	Portfolio screening, tropical forestry bonds
Private equity/venture capital	Carbon venture capital, carbon-driven principal investing
Real Estate	Energy efficiency/green-building real estate investment trust
Hedging instruments	Weather-derivative products, catastrophe bond, insurance products

⁷⁸ Estrada Oyuela, 2000.

⁷⁹ Karmali, 2007

Table 3 above is the bridge between environmentalists and financiers. The development of the carbon asset classes aforementioned will drive the investments needed in pollution abatement and clean technology which environmentalists need from financiers.

Water Opportunities

While our water crisis worsens and increases risks to businesses, this will also present opportunities for companies to foster innovation and answer increasing demand for products or services that offer solutions to dwindling water supplies. Some innovations in water include water recycling, desalinization, filtrations, and water funds to provide capital. For example, Sustainable Asset Management (SAM) initiated a water investment fund in 2001⁸⁰. The fund invests in sector and companies that perform the following – water source management and distribution, filtration, water & food availability, and water efficiency. SAM’s water fund goes beyond fulfilling SRI company needs and into strategic management of water that is sure to reap financial benefits for SAM and its shareholders.

Lauder, Chairman of RWL Water Group, discusses how the company’s water investment strategy is based on the assumption that “water will become more valuable than oil in the 21st century”⁸¹. The company is investing in water resources and wastewater management. Although 2% of the world’s water is drinkable, 1% is accessible while the other percent is in ice form in the North and South Pole. RWL Water Group has realized that its water investment (i.e. desalinization plants) can be funded for 1/5th the standard price as well as expediting project timeframes from 2-3 years to six months.

Companies that improve their water efficiency and management are in a position to realize cost savings. Also, by staying ahead of foreseeable regulations and increasing pressure from the public, companies will be able to market themselves apart from their competition – they will be recognized as being socially responsible, which will not only add value to a company branding, but will also attract

⁸⁰ SAM, 2003

⁸¹ Bloomberg, Billionaire Lauder’s Water Investment Strategy

socially minded customers. On the political platform, since wars have been fought over water, one can only imagine future conflicts due to commodity hoarding. Investing in water helps to achieve peace.

Real Estate

Socially responsible real estate developing has the potential to lower greenhouse gas emissions, lower operating costs, increase tenant incomes, and help appreciate property value. Factoring in energy conservation into real estate will decrease property investment risks, which, when factored into discounted cash-flow models, will improve property values. These risks take into account energy price fluctuations, policy risks (i.e. future energy conservation regulations), and long-term climate change risk aversion. Green real estate is a growing industry that, while generally priced at a premium compared to ordinarily planned real estate developing, offers long-term appreciation of real estate prices. Cleantech Ventures is a company leading by example – its headquarters in Melbourne is 100% powered by clean energy and technology. Research has shows that green buildings are reaching price parity with conventional real estate developing. French company, ICADE, has lowered costs for its 10,000 square metre property by 20% without increasing its capital expenditure⁸².

Other Strategies

Aleksandra Rybczynska, an analyst with Bloomberg New Energy Finance (BNEF), comments, “Landfill space in the U.S. is getting more and more limited”⁸³. There are several companies positioning themselves to take advantage of this. Fulcrum and Enerkem have new strategic operations in disposing waste, while Genomatica forecasts high-revenues in acquiring disposed chemicals. Most notably, Waste Management Inc. (WM), the largest trash hauler for the United States, makes a \$12.3 billion profit for disposing of America’s waste into landfills. However, the company’s management deduced that the

⁸² Sustainable Investing, pg. 122

⁸³ Bloomberg, Trash Saved by Waste Management Worth Up to \$40 Billion

potential biofuel and chemicals, which can be extracted from its collected trash, could be worth up to \$40 billion per year⁸⁴. Since Waste Management Inc. already has 17 onsite waste-to-energy plants from its 131 landfill locations, the company is operating like a venture capital by investing in renewable technologies to place on its remaining 100+ landfill sites.

Venture capital and sustainable private equity are two investment strategies, which for this context, typically invest in the early stage development of start-up companies in renewable energy or clean technology. Both investment strategies are crucial in helping to stimulate demand for cleaner companies not only for their capital investments, but also for their influence on corporate governance. Since venture capital and private equity inject initial capital into entrepreneurial endeavors, they have significant influence to select and promote managers or management that integrate sustainability into a start-up's corporate governance or investment strategy. For example, emerging markets private equity firm, Actis, makes it a standard approach amongst its invested companies to perform energy efficiency audits, operations protocols, and investments in carbon reduction technology⁸⁵.

Last but not least, microfinance investing is a growing asset class that offers diversification for investors away from capital markets. Microfinance endeavors usually focus efforts to help low-income individuals or communities, and offer capital loans with smaller interest charges. Clean technology is starting to enter the microfinance sphere.

Changing Geopolitics and National Security

In today's criticism of global corporatocracy, very large businesses are quickly becoming political and economic entities of their own, with some earning more in total revenue than small countries. Companies influence politics, and therefore it is important to focus on systematic change with companies.

⁸⁴ Bloomberg, Trash Saved by Waste Management Worth Up to \$40 Billion

⁸⁵ Sustainable Investing, pg. 131

The political landscape is also starting to change and be influenced by climate risk. OECD countries, such as the United States, are losing credibility as the world's security providers because of their dubious political schemes to aggressively import natural capital from developing countries – in the 1980s, the United States via the World Bank, initiated the 'debt-for-nature' program where debt forgiveness was permitted in exchange for natural capital⁸⁶. Today, it is the developing nations such as China, India, and Brazil that are starting to flex their growing economic importance and control of commodities (water, corn, iron). Unfortunately, the United States of America is becoming a laggard in the race for renewable energy and clean technology. Indonesia and China are already pushing to remove subsidies for non-renewable energy sources. Mexico, Thailand, and the Philippines have renewable portfolio standards that demand energy share from clean sources. Also, Argentina, Brazil, and India are heavily pushing for its transportation vehicles to switch to ethanol or natural gas⁸⁷. Surprisingly the countries aforementioned are developing countries expected to experience the most growth in the near future. These countries have learned their lesson from America's overdependence on fossil fuel.

Governmental climate policy is like an insurance policy. To compare both, an insurance policy is an act of prudence to protect oneself against loss, i.e. theft, assault, or property damage. The world already spends 3.1% of Global GDP on insurance premiums to protect against human made and natural disasters. In the same line of thinking, wouldn't it make sense to insure oneself (from the government's perspective) against the effects of climate change?

National Security

Since oil trade is based on fear and rumors concentrated in the Middle East, recent volatility in oil is attributable to the geopolitical tension between the United States, Iran, and Israel regarding Iran's nuclear ambitions. If fears and rumors surmount to Iran closing the Strait of Hormuz, Israel ramping up

⁸⁶ Confessions of an Economic Hitman

⁸⁷ Biagini, 2000.

military, or Iran testing a nuke, oil prices can skyrocket to \$147 per barrel. The volatility, at present, in the oil markets may also be seen as a strategy for Iran to destabilize financial markets in the United States, hence a form of currency wars. High oil prices force the United States Army, Navy, and Air Force to scale back on security efforts and training, thereby weakening national security.

Lockheed Martin Corporation's Chief Technology Officer, Ray Johnson, has criticized the US Defense Department for spending 5% of the nation's GDP on oil⁸⁸. Moreover, Johnson noted that energy is one of the biggest threats to national security since the United States has gone as far as to rationalize war for oil needs from the Middle East. Johnson reports that Lockheed is investing in research and development to diversify its products by using biotechnology and biofuels, especially for aircraft.

U.S. Navy Secretary Ray Mabus showcased how the US Navy is making strides towards renewable energy and fuel efficiency. The change in resource strategy proves that renewable energy does not have to be socially endearing. Rather, the practical switch is being made to lessen costs and protect national security. Price spikes in petroleum will cost the Navy \$31 million, and when Libyan instability regarding Gadhafi was at its prime, the Navy lost \$1 Billion in oil operational costs⁸⁹. To make up for this loss, resources were redirected from training and equipment, which is at the disadvantage of America's soldiers to perform. Likewise, for every 50 convoys of fuel transported into Afghanistan, a marine is killed in action. Thus, the U.S. Navy has invested in a green fleet of ships and aircraft to be powered 50% by petroleum, and 50% by biofuels (each ship will save \$2million in fuel costs) in 2016. Further constructions include a Navy shore base powered by alternative resources, which will provide a gigawatt of energy, enough to sustain Orlando, Florida.

⁸⁸ Bloomberg, Lockheed's Johnson on U.S. Government Energy Use

⁸⁹ Bloomberg, U.S. Navy Secretary on Energy Use, Renewables

China

China's rapid economic expansion has seen its energy demands doubling to 4 billion tonnes of coal by 2020, and has transformed China from an oil exporter to the world's second largest oil consumer⁹⁰. China needs to invest in alternative resources. Thus, although China has a poor environmental track record, China is becoming one of the world's leading investors into renewable energy and socially responsible planning. In effect, there has been a green boom in the renewable sector, particularly solar energy. China's private companies are being aided by strategic governmental 5-year policies that are finally attracting socially responsible investors who once ignored China.

China has become the leading supplier of certified emission reductions (CERs) since utilities and energy generators are able to facilitate low-cost emission strategies. This is a prime example of China positioning itself well within future markets. The World Bank estimates that China will be able to control and trade \$3-\$5 billion of CDM⁹¹. Today, China is dominates wind energy investing more than any other country.

Figure 7: Wind Energy Generating Capacity by Country 2011¹



In 2012, China dominates 47% of the entire wind energy market (as seen in Figure 7), with all other countries amounting to the other 53%. China's government realized that wind energy uses

very little water in the process, and wind turbines can be structured out in the open sea, which will not infringe on land space. Likewise, China's government states that there is no point in solving the energy problem if water sources will continue to worsen in the process. China is even taking a more direct approach against climate risks by formulating a green credit-rating system used by the Bank of China.

⁹⁰ Credit Suisse, 2006

⁹¹ World Bank, 2007

The environmental compliance records of would-be borrowers are made public, with laggards denied bank loans⁹². This is a clear signal and effort on China's behalf to limit and stop emission-intensive firms. China's energy policy reforms in the late 1990s have helped reduce its emissions by 19% while still maintaining a 15% economic growth rate – the carbon emissions reduced is equal to the entire US transportation industry⁹³.

There's no silver bullet, or straight path that will direct us towards a cleaner future in a straightforward fashion. The carbon market is today's best solution to force companies to internalize carbon emission costs and incentivize better management in resource efficiency. The effect of realizing the true value of carbon emissions not only makes fossil fuel dependency more expensive, it also answers public demand for less environmental externalities on the behalf of companies. Environmental sustainability and capital markets do not have to be at opposite ends.

The time horizon of transitioning from fossil fuels to renewable or alternative sources will be a lengthy process that may exceed our lifetime. Yet, the transition is already creating new segments of the European and Chinese economies. There are now about 60 renewable and clean technology firms publicly traded on the London Stock Exchange. For the United States, being a laggard in this movement means the opportunity cost for producing new jobs and having to depend on foreign products.

Quantifying the advantages of avoiding climate change catastrophes is hard to appreciate since the benefits of curbing carbon emissions is maintaining today's quality of life and access to resources. What can be quantified is the environmental degradation if we do not act, and governmental policies are tied to the economic powerhouses of oil industries. The government and capital markets work hand in hand, influencing one another. For the government to enact sustainable policies, we need capital markets to redirect cash flow to renewable energy and clean technology, not only with within existing

⁹² Economist Intelligence Unit – Business China, 2007

⁹³ Zhang, 1999

frameworks of the carbon market, but also the proliferation of sustainable security assets to attract a wider scope of investors.

Chapter Four: Simulating Climate Risk and Sustainability

The first argument of this thesis is that existing analytical processes when evaluating investments, portfolio allocation, corporate governance, or governmental policies are severely limited for two reasons: firstly, existing protocols are designed to value risk as a numerical value separate from the state of the environment. Lastly, existing procedures to analysis, whether specific companies and analysts take non-financials into consideration, analyze company/policy data separate from one another, and can only roughly forecast near-term effects. More often than not, analysts are wrong about their equity valuations on individual equities, bonds, and commodities despite fancy instruments. In the Black Swan, author Nassim Taleb dictates, “we do not know what we will know”⁹⁴. This means that while prediction requires knowledge of the future, the very act of having that knowledge will allow society prepare for the future – either by developing technologies or hedging against forecasted risks. Hence, we cannot absolutely protect ourselves from risk, and anticipated risk will have been prepared for to some extent. Nonetheless, it is the job of analysts, and government to run as many scenarios as possible, but their existing methodologies fall short of what is important to hedge against. The European heat wave crisis aforementioned was an example of government policy shortcoming because European institutions did not factor in climate risk. Even so, many ESG approaches, such as socially responsible investing (SRI) rating agencies, and sustainability analysis methods still use the conventional research and reporting frameworks. Climate change has taught us that everything is highly correlated and affected by climate risks. The central argument of this thesis is that although sustainability factors help

⁹⁴ Black Swan, Nassim Taleb

to create a fuller investment analysis of equities, bonds, and other financial assets, I am suggesting for a new approach to analyzing climate risk and factoring sustainability, by simulating outcomes.

In James Rickard's novel, "Currency Wars: The Making of the Next Global Crisis", the author talks about being employed by the Pentagon to simulate how financial markets have become a new battleground in which countries can destabilize each other's economies, therefore no longer requiring a hot war (physical battle between peoples). The results were very interesting, yet horrifying to learn that for all of the military supremacy commanded by the United States, its financial market are heavily exposed and correlated to the oil market in the Middle East, and that China can partner with Russia to create their own markets, thereby threatening the supremacy of the Dollar⁹⁵. The 'financial war games' worked by simulating experts as country representatives and supranational institutions (World Bank) and pitting one against the other given certain political or economic developments.

In the same nature, my argument calls for a new institution responsible for simulating a type of 'sustainability war games' amongst governments and corporations. This would call for copious amounts of public data from companies and governments, and cross-fertilizing industries with geopolitical regions. Secondly, analyzing policies and companies will require formulating measurements using a balanced scorecard approach of financial indicators as well as ESG non-financial indicators. Lastly, when simulating market developments and governmental policies, the essential factor of this analytical simulation would be to pair institutions against one another as a competition in which market share of respective industries will change, or political catastrophes will be opportunities for better-positioned nations. This simulation will offer an overall market report, regarding a specific challenge, with losers and winners. Most analysis on capital markets and policies are independent of one another, and therefore hard to compare companies to companies, or governments with each other. All too often, investors and policy makers do not recognize the financial and political bridge between the oil industry

⁹⁵ Currency Wars: The Making of the next Global Crisis

and climate change, as well as alternative resources. This new reporting standard will be able to simulate how markets and governments react to changes in financial indicators, economic developments, and most especially, climate risks. Standard analytical frameworks can delve into the effects of rising unemployment figures or real estate market foreclosures. However, there is a lack of understanding and factoring of non-financial environmental indicators, such as if ocean temperatures increased by one degree Celsius. Certain fishing regions would be most impacted, not to mention the biodiversity of reefs, and how the latter may not only affect eco-tourism, but also industries dependent on the health a nation's coastal resources. Although this is an ambitious project because it focuses on the correlation and strength/weaknesses of institutions, this endeavor will help solve the disconnect between economic health and environmental sustainability.

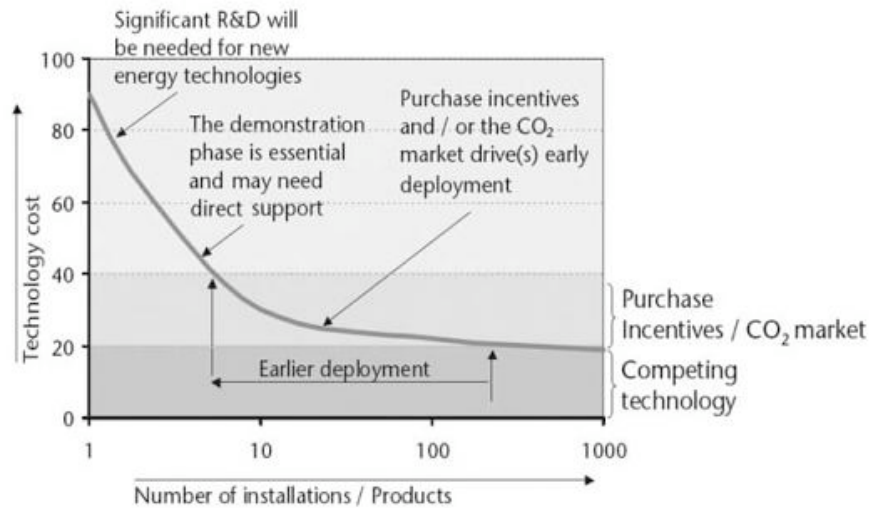
Today's approach to analysis is the collection and processing of data to evaluate recent performances, describing risk exposure, and forecasting financials, in which it is up to managers and politicians to make do with the information. My suggested framework urges to take analysis to its next level by including simulations given the data available, therefore providing and describing possible outcomes in comparison to rival industries and political bodies. The following section will describe real examples that could benefit from this extra component of analysis.

Simulating Outcomes for a Real Example: USA vs. Germany

The World Business Council on Sustainable Development report has recognized that the biggest challenge is convincing capital investors to shift their investments into the technologies aforementioned in Table # (different sectors + technologies)⁹⁶. Data on performance is still arguably arbitrary depending on the drivers one uses to factor in analysis, and especially because there are no benchmarks or standards. Let us examine the development of new clean technologies.

⁹⁶ WBCSD, (2007)

Figure 8: Development, demonstration, and deployment cycle⁹⁷



Governmental policies focus on short-term profit instead of long-term strategies to combat climate change. This approach does not help to jumpstart and get sustainable industries on their own feet. As shown in Figure 8 above, long-term policy support, through tax subsidies or grants, is needed to artificially support clean technology to reach price parity with readily available sources of energy (fossil fuels). While public and private capital is still learning to catch up onto the benefits of sustainable investing, governmental policy is quintessential in the birth and early development of these emerging technologies. The United States has weakened its policies towards sustainable reform, by denying renewal of tax grants for certain renewable sources, while Germany has been strengthening its renewable energy industry due to continued support from its government. The following comparison shows of different trajectories for American and German markets if both are compared and simulated. Germany will be able to sustain growth in renewable energy markets, specifically its solar industry, due to continued support via tariffs and subsidies.

⁹⁷ WBCSD (2007)

Figure 9: Germany Solar Price

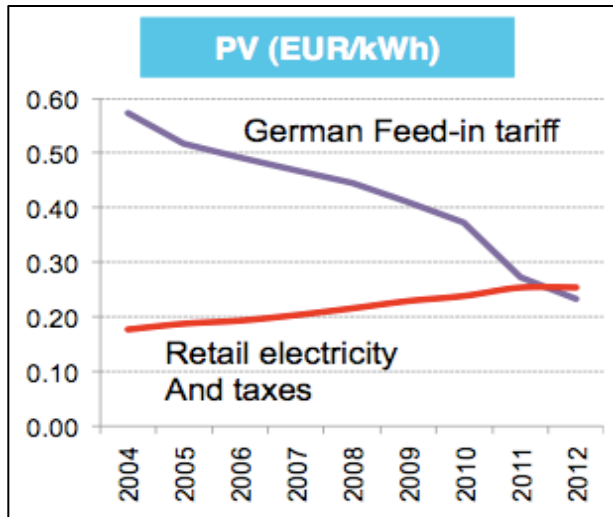
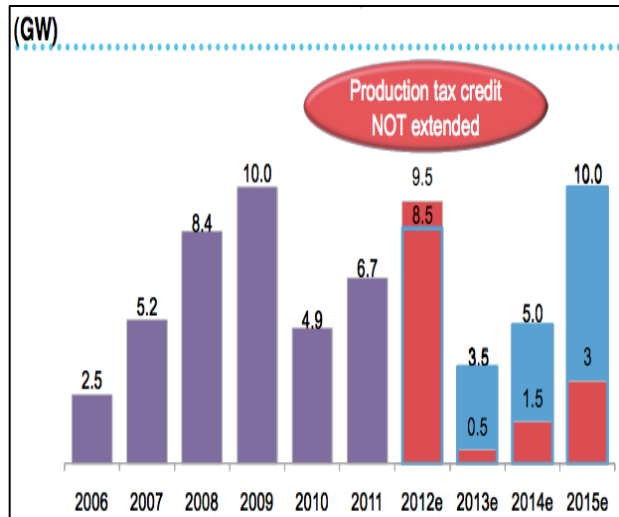


Figure 10: US Wind Capacity 2008-2015



Sources: Bloomberg New Energy Finance

If simulation were to occur between the renewable energy markets of the United States and Germany, with tariffs and subsidies as the deciding factor, figures 9 and 10 above show the divergence in development between both nations, respectively. In Figure 9, Germany's feed-in tariff helps its solar panels reach price parity in 2011, with solar panels eventually becoming cheaper than retail electricity due to rising non-renewable resource costs. In figure 10 however, If the United States were to stop its tax credit incentive for solar and wind development, one can see the immediate drop in project financing and development of renewable plants. Germany's economy would benefit from a self-sustaining energy resource as well as a booming wind industry, while the United States experiences its opportunity cost of diversifying into renewable resources, and will risk worsening fossil fuel dependency. Note that this has only been one comparison between Germany and the United States. By comparing both countries to other powerhouses or developing nations, one can simulate the potential for Germany to export its solar panels to the international market while the United States continues to lose political power and international market share. Furthermore, if the United States should decide to finally switch to renewable resources, it will be forced to import from countries who already have the technology and market power to provide clean technology at cheap prices. The Energy supply

breakdown of Germany and the United States will be significantly different, and offers risks as well as opportunities for the countries respectively.

Figure 11: Germany Energy Supply 2035

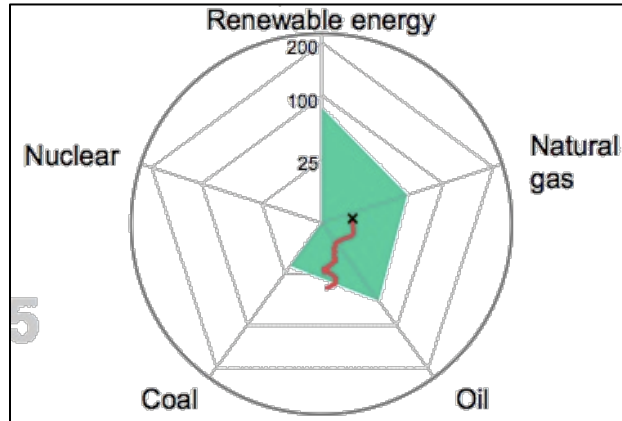
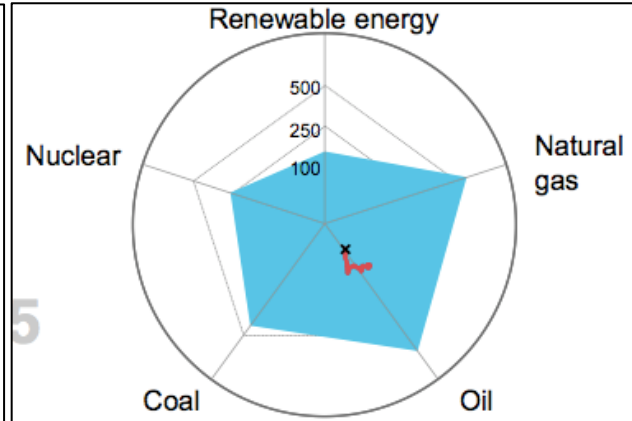


Figure 12: USA Energy Supply 2035



Source: Bloomberg New Energy Finance

Figure 11 above-left, shows that by 2035, most of Germany’s energy supply will come from renewable energy, whereas Figure 12 above-right, depicts the United States heavily invested into coal, oil, and natural gas in the same time period. Going back to the original driver of the simulation, government tariffs and subsidies are essential to initially redeploy capital to renewable markets until technologies can reach price parity and capital markets will be incentivized to invest. What both figures above reveal is that the continued use of governmental support in Germany would have probably supported its financial markets to enter into the renewable energy race and develop relative securities, whereas the United States’ decision to halt government support would have also halted potential financial flow from Wall Street.

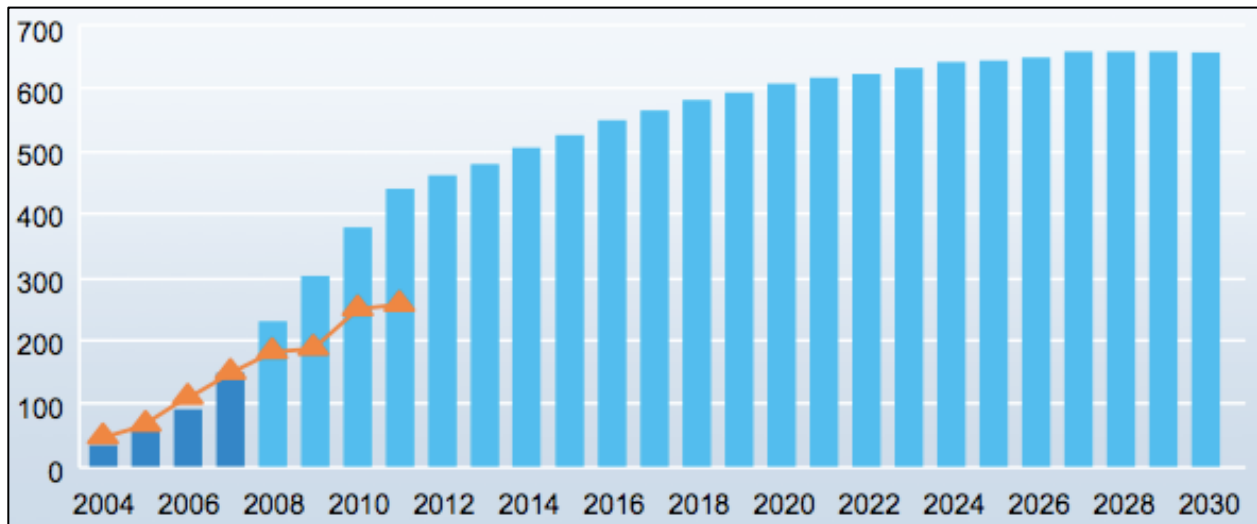
Simulating Outcomes for a Hypothetical Example

The example above uses a current political situation since the United States’ 1601 grant is set to expire this year. However, for this new framework of sustainability analysis, hypothetical situations are encouraged to help companies and governments realize potential threats and climate risks. Although

black swan situations are bound to occur, the more situations simulated, the better-prepared institutions can become to insulate themselves from risk. For this hypothetical situation, we will pretend that the velocity of CO₂ concentration in the air is quickly reaching the threshold of 500 parts per million (ppm), the EU ETS and soon-to-be North American carbon markets have tightened next year's cap of emission allowances beyond forecasts. As a result, fewer caps will drive up the price of carbon credits and permits. For this example, company X and Y are the following: a fossil fuel plant, a company that has diversified its energy portfolio with natural gas and fossil fuel plants that have up-to-date carbon sequestration technology. Company X will find itself operating under higher operating and input costs maybe because coal suppliers are also inflating their prices to even out a lack of demand due to steeper capped emissions. Also, Company X will have to buy carbon credits from companies that have a surplus of credits, to fulfill Company X's promised energy capacity. Likewise, Company Y will be in a better situation to take advantage of other competitors who will be adversely affected by more stringent caps. As a result, company Y will be able to offer its energy retail services for a cheaper price, thus gaining market share in the energy industry. Also, since management's choice to install carbon sequestration technology lets company Y operate below its mandated emissions capacity, it can sell its excess of carbon permits and credits to institutions like company X.

Similarly, if the velocity of carbon concentration has increased beyond forecasted data, that might imply that actual investments in renewable energy and clean technology are falling short of the necessary funds to curb climate change. Given this situation, we will use company A and B as two

Figure 13: Capital Requirement to 2030: \$BN



Source: Bloomberg New Energy Finance

investing firms. Company A decides to invest in a traditional portfolio, whereas company B allocates to renewable energy and clean technology markets. Due to the shortage of funds allocated towards these industries, as shown in Figure 13 above, the government may provide incentives and grants to technological firms to further stimulate financial flow into these new industries. In this case, company B, who has already positioned itself with stock in related technological companies, will not only experience an appreciation in price for these stocks due to firms being incentivized to increase their production via taxes and grants, company B will also have the backbone to further increase shares in these companies. Company A, however, will have a full portfolio in invested stocks within conventional industries, such as oil and coal. However, since there will be a global demand to ramp up renewable energy production and development, the oil and coal industries may suffer due to lost demand. Furthermore, Company A, who has invested in non-renewable energy sources, may have its selected companies exposed to possible taxes, or may have subsidies removed from oil production. This may be in response to governments trying to dissuade further cash flow into the oil industry to curb CO₂ concentrations.

Why Simulate Situations

Simulating situations runs its own risks, since interpretation and performance of companies or governments will all be arbitrary depending on the representative and data provided. However, it is a simulation that should not be ignored because it does provide possible outcomes to events that can be considered as black swans, and black swans are bound to naturally occur. Furthermore, each situation should run through what is called a Monte Carlo approach in which 1000 simulations will run through to deduce a percentage value of different outcomes to a particular situation. Traditional analysis will give a risk exposure numerical value assigned to companies, security assets and policies, but analysis usually stop there for individual managers to process and analyze by themselves. However, individuals tend to see the financial short-term risk-return tradeoff instead of understanding possible outcomes. Furthermore, traditional analysis does not delve into climate risk, as we have seen. This new framework will help to expose potential opportunities and threats for companies by providing simulated based outcomes to current situations or hypothetical situations. This method will provide a much more enriching understanding of companies, governments, and trends. When one sees a 1.5x beta exposure to the market, he/she will not usually process the correlation and exposure that value has to environmental risks and black swan situations. This new framework works to provide that insight into decision-making.

Conclusion

Our over-cultivation of the world's natural capital is leading to unprecedented levels of environmental degradation. Furthermore, the manner in which we process and consume natural capital is grossly inefficient and damaging to the environment. However, we fail to understand that our over-consumption of resources folds within a closed loop in which CO2 concentration and pollution will threaten our survival. This link is crucially missed by many, or ignored by others because economic

stability and growth are deemed more important. This focus on short-term reward is reinforced by the method in which we analyze financials, policies, and situations. Existing analytical frameworks not only focus on financial rewards, but also generally tend to focus on financial drivers. Existing analytical frameworks do not provide insight to climate challenges in which, risks will “pose profound strategic challenges to the United States in coming decades, raising the prospect of military intervention” for example⁹⁸.

Environmental stewardship is key to long-term financial security since GDP growth and production is reliant on the state of natural capital. Industries that are geared towards environmental stewardship are renewable energy and clean technology. These industries are at their birth and growth stages, thus requiring a lot of capital flow to be redirected from traditional industries and sectors that emit pollutants. Investing in these endeavors will not only fulfill a social cause necessary to safeguard our survival, it will also provide better investing strategies and higher returns. Those who choose to invest in renewable and clean technology companies are already naturally hedged against a growing demand for a carbon-constrained economy in the future. In this regard, black swans, where extreme situations such as natural catastrophes exacerbated by climate risk, will further increase demand for sustainability. The trick is how to convince investors and others, who hold the most capital, to invest in sustainable efforts.

My proposed framework for a new type of analysis will help investors and policy makers to realize and make the necessary connection between sustainability and economic growth. By not only including ESG non-financial indicators into a balanced-scorecard framework, but also providing simulations to existing or hypothetical situations, investors, policy makers, and individuals will be able to recognize real outcomes in which geopolitical or financial situations will either show risk or opportunity.

⁹⁸ NY Times, Climate Change Seen as Threat to U.S. Security

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