Director Notes

THE CONFERENCE BOARD INITIATIVE ON SUSTAINABILITY™

Developing an Effective Climate Change Strategy

by Andrew J. Hoffman

As policy formation begins to gather momentum and the physical impacts of climate change become clearer, climate change mitigation and adaptation strategies are becoming increasingly important. This report details eight steps for developing such strategies and provides examples of companies that have done so.*

Responses to climate change have created a market shift in multiple forms. First, climate change regulation will impact virtually all sectors of the economy to varying degrees, creating both vulnerabilities and opportunities. Market drivers to reduce greenhouse gas (GHG) emissions will affect the price of fossil fuels and the products, services, and sectors that rely on those fuels for energy or feedstock. Second, the environmental implications of climate change will impact supply chain logistics, infrastructure stability, asset allocation, and risk management decisions in certain sectors.

Companies should reassess their energy use, their operational and logistical models, and their resource acquisition strategies to develop effective mitigation and adaptation strategies befitting their cultures and based on various factors such as their timetable, objectives, vulnerabilities, opportunities, and competitive positioning. Mitigation strategies are driven by consumers, investors, suppliers, buyers, and most importantly, government policy. Adaptation strategies are driven by changes in both climatic conditions and insurance underwriting.

* This *Director Notes* is based on Andrew J. Hoffman et al., "Travelers Insurance: Focusing on Climate Change and Natural Catastrophe Risk," case study # 1-429-347, Erb Institute, University of Michigan, July 2013; Andrew J. Hoffman, "Climate Change as a Cultural and Behavioral Issue: Addressing Barriers and Implementing Solutions," *Organizational Dynamics* 39, no. 4, October–December 2010, pp. 295–305; Andrew J. Hoffman and John G. Woody, *Memo to the CEO: Climate Change, What's Your Business Strategy?* (Cambridge, MA: Harvard Business School Press, 2008); Andrew J. Hoffman, *Getting Ahead of the Curve: Corporate Strategies that Address Climate Change* (Arlington, VA: The Pew Center on Global Climate Change, 2006); and Andrew J. Hoffman, *Carbon Strategies: How Leading Companies Are Reducing Their Climate Change Footprint* (Ann Arbor, MI: University of Michigan Press, 2007).

No. DN-V6N4
FEBRUARY 2014
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Climate Mitigation Strategy

For climate mitigation, the question is better stated as when, not if, climate regulation is coming. Compelling science in support of action exists (see box below). In addition, public consensus on the reality of climate change (and therefore political support for climate policy) is growing,[1] and market drivers to reduce greenhouse gas (GHG) emissions are coming into view.[2] Controls on the emissions of GHGs will affect the price of fossil fuels and the products, services, and sectors that rely on those fuels for energy or feedstock. In other words, it will affect virtually all sectors of the economy to varying degrees. There will be winners and losers, so it is wise to assess your vulnerabilities and opportunities and plot a mitigation strategy for addressing this market shift now as it is emerging.

The Weight of Science on Climate Change

Today, a *scientific consensus* exists on the issue of human-induced climate change.

- The thousands of members of the Intergovernmental Panel on Climate Change (IPCC) have been producing successively more definitive assessments on the composite of the science. In 1995, the IPCC concluded that **"the balance of evidence suggests a discernable human influence on the global climate."** In 2007, the IPCC clarified: "Human activities…are modifying the concentration of atmospheric constituents… that absorb or scatter radiant energy…[M]ost of the observed warming over the last 50 years is very likely to have been due to the increase in greenhouse gas emissions." The IPCC defines "very likely" as a greater than 90 percent probability. In 2013, the IPCC stated that "Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased."[a] **This IPCC consensus statement has been endorsed by nearly 200 scientific agencies around the world,** including the scientific agencies of every one of the G8 countries (Canada, France, Germany, Italy, Japan, Russia, the United Kingdom, and the United States).[b]
- This assessment is also supported in surveys of the vast majority of climatologists and scientists that study this issue. For example, in a 2011 survey of 489 scientific members of the American Geophysical Union and the American Meteorological Society, **97 percent agreed that global temperatures have risen over the past century, 84 percent agreed that "human-induced greenhouse warming" is now occurring,** and only 5 percent disagreed with the idea that human activity is a significant cause of global warming.[c]
- In surveys of the academic literature on climate change, **an overwhelming majority of articles supported the notion that human-induced climate change is real.** Most recently, a 2013 analysis of 11,944 abstracts of peer-reviewed journal articles from 1991 to 2011 found that, of those expressing a position on anthropogenic global warming, **97.1 percent endorsed the consensus position that humans are causing global warming.**[d]

Reflecting this overwhelming evidence, both the US National Academy of Sciences[e] and the American Association for the Advancement of Science[f] use the word "consensus" when describing the state of the scientific literature. In short, the world's scientific community is coalescing around the idea that "Earth's warming in recent decades has been caused primarily by human activities that have increased the amount of greenhouse gases in the atmosphere."[g]

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a *Climate Change 2013, The Physical Science Basis. Fifth Assessment Report*, Intergovernmental Panel on Climate Change, 2013 (https://www.ipcc.ch/report/ar5/wg1/).

b State of California Governor's Office of Planning and Research, Scientific Organizations That Hold the Position That Climate Change Has Been Caused by Human Action (http://opr.ca.gov/s_listoforganizations.php).

c Stephen J. Farnsworth and S. Robert Lichter, "The Structure of Scientific Opinion on Climate Change," *International Journal of Public Opinion Research*, October 2011.

d John Cook et al., "Quantifying the Consensus on Anthropogenic Global Warming in the Scientific Literature," *Environmental Research Letters*, 8: 024024, 2013.

e *Understanding and Responding to Climate Change: Highlights of National Academies Reports 2008 Edition*, the National Academy of Sciences, 2008 (http://dels.nas.edu/resources/static-assets/materials-based-on-reports/booklets/climate_change_2008_final.pdf).

f AAAS press release, "American Association for the Advancement of Science Board Statement on Climate Change," December 9, 2006 (www.aaas.org/sites/default/files/migrate/uploads/aaas_climate_statement1.pdf).

g Joint Science Academies' Statement: Global Response to Climate Change (http://nationalacademies.org/onpi/06072005.pdf).

Table 1 **Stages of climate mitigation strategy development**

	Stage 1 Develop a climate strategy				*Stage 2* Focus inward		*Stage 3* Focus outward	
TASK	**Assess emissions profile**	**Gauge risks and opportunity**	**Evaluate action options**	**Set goals and targets**	**Develop financial mechanisms**	**Engage the organization**	**Formulate policy strategy**	**Manage external relationships**
KEY QUESTIONS AND ISSUES	What kinds of direct and indirect GHG emissions are being created, from what sources, and in what quantities? What metrics can be used to track emissions and what technologies or techniques are required to measure them?	What risks are posed by emissions from operations and GHG intensity of products and services? How may demand for products and services change? What products and services may flourish given carbon constraints?	What options are available for reducing emissions? Are there any "low-hanging" emission-reduction opportunities? Where can we innovate? What long-run steps can be taken? How can climate-related strategies enhance the bottom line?	Why set GHG reduction targets? What kinds of targets should be set and over what time period? How do efficiency improvements relate to GHG reductions? How can targets be connected to business strategy?	What financial instruments are available to support GHG reductions? What are the pros and cons of emissions trading (internal and external), carbon shadow pricing, lower hurdle rates, and special capital reserves?	How can buy-in from the workforce be achieved? How important is senior leadership? Where are the sources of support and resistance? How can resistance be overcome? How can climate-related activities move from the periphery to the core?	How might possible strategies help or hurt business? Ongoing climate-related activities? What policy options are on the table? What is a desirable policy outcome? Is it possible to have an influence over climate policy at the state or national level?	What external constituents are important to the success of climate-related strategies? How should they be engaged?
Reference:	Step I	Step II	Step III	Step IV	Step V	Step VI	Step VII	Step VIII

Feedback and monitoring to refine business case, strategy elements, and tactics.

Source: Andrew Hoffman, *Carbon Strategies: How Leading Companies Are Reducing Their Climate Change Footprint* (Ann Arbor, MI: University of Michigan Press, 2007) and Andrew J. Hoffman, *Getting Ahead of the Curve: Corporate Strategies that Address Climate Change* (Arlington, VA: The Pew Center on Global Climate Change, 2006).

What follows is a detailed and structured approach for plotting a climate change mitigation strategy, based upon the experiences of leading companies that have taken proactive steps to reduce their GHG emissions. Table 1 outlines three stages of climate mitigation strategy development, broken down into eight specific steps. Stage 1 creates the rationale and logical foundation for setting a strategy for reducing GHG emissions. Stages 2 and 3 address the internal and external aspects of making that strategy a success.

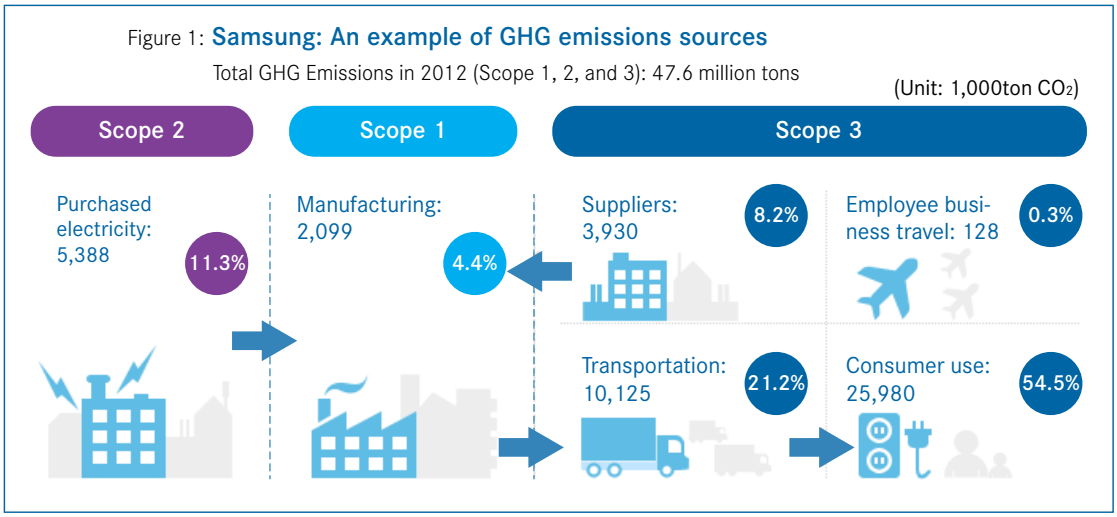
Stage 1: Develop a climate mitigation strategy

Overall, this first stage involves gathering the information that is necessary to connect business strategy and GHG reductions.

Step I: Conduct an emissions profile assessment. The first step in developing a mitigation strategy is to develop an understanding of what climate change means for your organization. It involves an analysis of your company's GHG emissions profile throughout the value chain. This is a fundamental starting point for identifying and prioritizing emissions reduction options, the means to reduce those emissions, the products and services that may be affected by legally binding carbon constraints, and potential strategies that are complementary to the core business. To identify sources, types, and magnitude of emissions, as well as the vulnerability of business lines, employees need a basic awareness of the tools and protocols available to gather such information.

The World Resources Institute/World Business Council for Sustainable Development (WRI/WBCSD) Greenhouse Gas Protocol Corporate Accounting and Reporting Standard developed a step-by-step guide for quantifying GHG emissions and can be used as the starting point for most reporting efforts around the world.[3] Companies can do a Scope 1, Scope 2, or Scope 3 inventory. Scope 1 includes direct emissions; Scope 2 includes indirect emissions from the consumption of purchased electricity, heat, or steam; and Scope 3 includes other indirect emissions from upstream and downstream sources, as well as emissions associated with outsourced or contract manufacturing, leases, or franchises not included in Scope 1 or Scope 2.

Figure 1: **Samsung: An example of GHG emissions sources**



Source: Samsung Electronics (www.samsung.com/us/aboutsamsung/sustainability/environment/climatestrategy/ghgscope_3.html).

Most companies measure Scope 1 direct emissions—those from sources owned by the reporting company that generally include emissions from on-site production processes and the direct combustion of fossil fuels in boilers, furnaces, and on-site power generation. But other companies also measure Scope 2 and 3 indirect emissions that yield interesting conclusions (Figure 1). Some appliance manufacturers, such as Whirlpool, measure the indirect emissions from the use of their home-appliance products and find that these emissions constitute upward of 90 percent of their GHG profile. As a result, they learn that any policy that does not include the use phase of their products leaves valuable opportunities off the table. Other service-oriented companies, such as many financial services firms, account for emissions from material transport, business travel, and commuting. Swiss Re, for example, measured 43 percent of its emissions profile from business travel (direct emissions and indirect office electricity use account for the remaining 13 and 44 percent, respectively). These companies learn that mitigation strategies focus largely on improving the efficiency of their buildings and infrastructure.

Step II: Gauge risks and opportunities. Emissions alone do not reveal a company's exposure to carbon constraints. Emissions must then be connected to the business strategy by considering potential impacts on product and service lines. The next step in mitigation strategy development is consideration for how operations and sales may be affected by climate change-related factors and, as a result, how such factors may alter competitive positioning. As part of this analysis, companies should consider their emissions profile relative to industry peers, the industry's position relative to other sectors, potentially relevant future regulatory developments, trends in input costs, and potential changes in customer preferences. Identifying risks and opportunities must flow from an understanding of the company's current and future GHG footprint in the context of a current and future carbon-constrained economy.

Shell, for example, conducted an internal analysis in 2005 that revealed that its operations emitted 105 million metric tons of CO_2e (CO_2e is a composite index of all GHG emissions), while downstream combustion of the fossil fuels it produces generated another 763 million metric tons. Together these emissions accounted for some 3.6 percent of global CO_2 emissions from fossil-fuel combustion. This fact motivated the company to treat climate change as a significant business issue that, once framed as such, it could begin to address, first with risk management strategies and eventually by moving to an emphasis on business opportunities and top-line enhancements. To fully connect business strategy and climate change, companies need to assess whether and how demand for their current and future product and service lines may be enhanced by climate-related developments.

Alcoa, for example, views future climate policies as market opportunities by expanding demand for recycled aluminum. Considering that aluminum produced from recycled materials requires only 5 percent of the energy needed to make primary aluminum, that the market does not differentiate between virgin and recycled aluminum, and that energy prices will likely rise from carbon constraints, the company sees an opportunity to increase profits by increasing the percentage of its products, other than raw ingot sold to others, that come from recycled aluminum. Another long-term strategic opportunity lies in the expected boost in demand for aluminum as a material in lighter-weight vehicles. According to the company, a 10 percent reduction in vehicle weight typically yields a 7 percent reduction in GHG emissions.

Going even further, some companies have focused their energy and efforts into fundamental technology and cultural shifts for their organization. DuPont, for example, sees carbon constraints as affecting its bottom line through increases in energy and feedstock costs. Therefore, it has identified the most promising growth markets in moving away from fossil fuels and toward the use of biomass feedstock that can be used to create new bio-based materials such as polymers, fuels, chemicals, applied biosurfaces, and biomedical materials. This is not a subtle shift, but rather a significant change in product lines, research focus, and culture for DuPont.

Step III: Evaluate options. After developing an emissions profile and considering its strategic importance, the next task is to evaluate options for reducing GHG emissions. Some companies set goals and then search for ways to achieve them. Others consider their options for reducing emissions and then set goals accordingly. The precise ordering is a matter of individual management style.

Many companies have been able to identify a variety of low-cost options for reducing their GHG emissions. These "low-hanging fruit" opportunities often include behavioral or technological changes that challenge taken-for-granted assumptions, improve efficiency, and reduce energy consumption. For example, the first step in Swiss Re's three-tiered approach to reducing GHG emissions involved turning down heating, cooling, and lighting systems in office buildings during nonworking hours, something that was never considered before. As a second step, the company focused on small investments, such as motion sensors and compact fluorescent light bulbs, and on reducing emissions from business travel by curtailing short-distance trips for internal meetings and by providing employees with the latest telephone or videoconferencing technology. The final tier of Swiss Re's approach involved refurbishing company-owned property and buildings by, for example, replacing cooling towers, generators, insulation, or windows. For nonmanufacturing companies like Swiss Re, substantial reductions from building-related conservation efforts are often quite easy.

Other companies developed breakthrough technology solutions that facilitated a dramatic reduction in their GHG footprint. Such "silver bullet" opportunities are often the focus of new technology development but have also been realized in existing operations. For example, Shell managed a sizable reduction of its pre-2002 emissions by reducing the venting of associated gas (methane) from its exploration and production facilities, again a solution that had been overlooked before GHGs became a business issue.

Step IV: Set goals and targets. A company's motivations for taking action are influenced strongly by corporate history and culture, core competencies, and the competitive environment. For example, Shell had been watching the climate change issue since the early 1990s through its Issues Management Team within Corporate Affairs. In 1998, Jeroen van der Veer (then group managing director) championed a more formal study of climate change and its potential impact on the company's businesses globally. Similarly, DuPont's actions were foreshadowed by its experience with stratospheric ozone depletion in the 1970s and 1980s and the impact that the Montreal Protocol (the treaty that constrained chlorofluorocarbon production) had on a major company product line. When the Intergovernmental Panel on Climate Change (IPCC) issued its first assessment report in 1990, DuPont's then-CEO Edgar Woolard saw a familiar scenario playing out and directed the company to become an early adopter of climate mitigation strategies.

Table 2 **Absolute and intensity targets**

Companies may select either an absolute emissions target or an intensity target. Absolute targets track reductions in the total emissions of an organization. Intensity targets track reductions per unit of output of the organization, and may be applicable where growth of the organization may offset efficiency improvements or other reductions. The table below compares the two types of targets.

Parameter	Absolute target	Intensity target
Reduction type	Specified quantity of reductions to the atmosphere	Reductions per a business metric No guarantee that there will be less GHG emissions to the atmosphere – absolute emissions may rise even if intensity goes down (and output increases)
Metric definition	Not applicable	May be difficult to define a single common business metric for companies with diverse operations If a monetary variable is used for the business metric (i.e., dollar of revenue or sales), it should be adjusted for changes in product prices, product mix, and inflation – adds complexity to the tracking process
Confidentiality	Not applicable – no business metric assigned to target	May be an issue – data on the metric needs to be reported
Effects from base year recalculations	Significant structural changes and complexity to tracking progress over time	GHG changes due to production fluctuations are usually not required
Relation to organic growth or decline	Recognizes a company for reducing GHGs by decreasing production or output	Unrelated
Comparisons of GHG intensity/efficiency	Does not allow for comparison of GHG performance between companies, if they choose to do so	Comparability of GHG performance between companies may be increased

Source: Environmental Protection Agency Climate Leaders GHG Inventory Protocol, September 2013, p. 60 (www.epa.gov).

As befitting their cultures, companies have made a wide range of commitments to reduce GHG emissions, the specifics of which differ in such aspects as timetable, objectives, baseline year, and types of emissions covered (see Table 2). Goals and targets can also move beyond a strict focus on GHG reductions to include strategic initiatives and adaptation strategies. A company may, for example, commit to increase the renewable share of its energy purchases, hold energy consumption to baseline levels, or set revenue targets for new carbon-reducing products and services.

Most companies establish short- and long-term goals that they review regularly and that align with their strategic objectives. Some companies solicit opinions from individual business units but then push further, creating a stretch goal to make significant progress. In fact, for many companies, stretch goals are considered critical for creating real culture change and out-of-the-box thinking.

Stage 2: Focus inward

Once a climate strategy is developed, the second stage involves integrating climate goals and targets inside your organization by developing supportive structural mechanisms and by engaging employees.

Step V: Develop financial mechanisms to support climate programs. To gain meaningful action on carbon mitigation, strategies must be connected to the financial mechanisms of the firm. Many companies are currently using a combination of internal financial mechanisms to support their GHG-reduction efforts and evaluate prospective investments, including special pools of capital, lowered internal hurdle rates, and internal shadow prices for carbon. ExxonMobil, for example, makes future financial projections based on the expectation that carbon will be priced at about $60 per ton.[4]

Shell uses three different internal shadow prices for carbon: one for the European Union, a second for other developed countries, and a third for the developing world. With these shadow prices, Shell requires that energy efficiency and GHG-reduction projects meet the same internal hurdle rate as other investments. The exact numbers used can significantly alter energy-efficiency decisions. For example, one barrel of oil produces about 0.36 tons of CO_2. A European Union Emissions Trading System (ETS) CO_2 price of €25 is like adding a further $11 per barrel to the price of oil, which makes an energy-saving project even more compelling. The company uses long-term premise values for both oil and carbon when valuing internal efficiency projects.

The expertise and knowledge gained by developing these financial mechanisms can help companies to understand when climate programs make sense with an external carbon price and when they can be sustained without one. In the end, climate mitigation projects must compete with other initiatives for funding through standard funding metrics and evaluation processes. Capital investments to reduce energy consumption often meet resistance because they are not viewed as "sexy." But the key to developing an effective mitigation strategy is to lay all the options out and trigger each when the market conditions are right. The process starts with quality information.

Step VI: Engage the organization. Employee buy-in is crucial to the success of any climate mitigation strategy. Employees will devise innovative ways to achieve clearly stated goals when they understand the linkage with the company's vision and values. Efforts to gain buy-in should include educating the workforce by linking climate change to the organization's dominant metrics, language, and reward structures; ensuring that senior leadership is visibly supportive of the efforts; identifying sources of organizational resistance and support; and developing specialized teams to support the issue as among the organization's core priorities.

To begin, educating the workforce can be challenging. Other environmental issues are often more acute and therefore easier to justify as strategically important. Companies that have struggled to generate internal support for GHG reductions emphasize the importance of an effective, easily understandable communication strategy. Knowing the audience is critical. Companies can engage employees in the discussion by linking it to what they already know. Whirlpool, for example, ties climate change to long-standing company priorities around "energy efficiency" and avoids using the term "climate change" in many internal discussions.

Beyond framing, companies have used traditional and innovative programs to build internal awareness and incentives. DuPont, for example, tied related performance metrics to employee bonuses and created an award program that recognizes exceptional environmental achievements throughout the company. Alcoa purchased trees from local suppliers and distributed them to employees, who were then encouraged to plant them in their communities or on Alcoa property. The company also encouraged employees to participate in local and regional programs to increase the use of public transportation and reduce their personal carbon footprint. Swiss Re hosted a variety of internal marketing events, including on-site demonstrations that allow employees to test-drive hybrid vehicles.

While engaging the workforce is important, managers note that senior-level leadership, support, and engagement are the most critical components of any successful climate mitigation strategy. That includes not only senior management, but also the board of directors, who need to understand the business impacts and opportunities associated with addressing climate change.

Once buy-in is established, climate change will diffuse from the periphery to the core of the organization and, in the process, become an issue of strategic importance to the company. To help this process along, some companies developed new teams to identify and implement climate-related strategies; such teams may be cross-functional or may have particular expertise and be devoted to a narrow goal. Then, once on the agenda, companies often develop new teams to focus on climate strategies or energy-efficiency opportunities.

Ultimately, the goal is to develop specific expertise and integrate it into existing organizational structures. Swiss Re, for example, created a Greenhouse Gas Risk Solutions (GHGRS) department. The group was dissolved in 2005 and its mature offerings, including carbon trading, insurance products, and weather derivatives, were redistributed to mainline product groups. A centralized logistics department was created to oversee office-space management and carbon neutrality. By successfully integrating its climate activities into its various mainline businesses, such as capital markets and advisory (trading products), risk awareness (directors and officers insurance), and carbon/clean energy asset management, Swiss Re could more effectively engage climate change as a strategic bottom-line issue going forward.

Stage 3: Focus outward

This stage of climate mitigation strategy development involves engaging important external constituencies that directly impact strategic success.

Step VII: Formulate a policy strategy. Since regulatory policy (city, state, national, and international) will be one of the strongest drivers for mandatory change within corporations, companies must be aware of the policy options being considered and decide which would most benefit their own business strategy. Ideally, companies will want to gain a seat at the table when future regulations are designed and influence their final form.[5] For large companies, this may be accomplished through direct lobbying efforts. For small to medium-sized companies, this can be accomplished through trade groups that have influence within the policy realm.

The present stall in climate policy creates uncertainty for corporate executives who are ready to make the necessary changes in infrastructure and operations. According to Deloitte, executives in the power and utility sector stated "the lack of specific policy guidance makes voluntary remedies a guessing game."[6] They need sound energy policy to secure stable, long-term energy supplies; sound and predictable technology policies for long-term investment planning; clear, coherent industrial policies that recognize these executives operate in a globalized marketplace where they are competing against countries that heavily subsidize their domestic industries; and a knowledgeable public that can make informed purchasing decisions.[7]

As the available portfolio of policies to reduce GHG emissions expands to include renewable portfolio standards, energy-efficiency performance standards (appliances, buildings, autos, and industrial facilities), grid improvements (smart grid, national grid, demand management), and others, the corporate voice in state and federal discussions becomes ever more important. The time is ripe for business leaders to add their political weight to the momentum that has begun, support the inevitable, and assert their interests in the national debate.[8] In the words of Unilever CEO Paul Polman, "We are entering a very interesting period of history where the responsible business world is running ahead of the politicians."[9]

Step VIII: Manage external relations. One final component of a successful climate mitigation strategy is engaging external constituents beyond the government that are critical to the success of any internal initiative. Corporate external outreach efforts must be aimed at employees (a somewhat counterintuitive focus), nongovernmental organizations, investors, and future recruits. Each audience requires a different form of outreach. For many, these amount to maintaining their "license to operate" on local, regional, and national scales.

But beyond this more generalized notion, specific business partners can help make climate-mitigation activities successful. For example, Whirlpool worked with retailers, including Lowe's and Sears, and with consumers to address misconceptions about the efficacy of energy-efficient appliances and to educate people about their benefits, including their average five-year payback period. Whirlpool also worked with detergent producers to ensure that detergents suitable for their more efficient machines were available and to educate consumers on their use. Finally, the company notes that it was pivotal in convincing *Consumer Reports* magazine to include energy efficiency in its appliance rankings. All of these efforts supported its strategy of producing more energy-efficient appliances for an increasingly interested consuming public.

Climate Adaptation Strategy

The many forms of existing and potential climate regulation require a prudent mitigation strategy. But many companies have been developing adaptation strategies to manage the physical and environmental impacts of climate change as well. Climate adaptation strategy is not just a variant on weather adaptation. Uncertainty about environmental conditions has led to a step change in how businesses address potential new threats to physical assets both directly, through changes in logistical and operational considerations, and indirectly, through changes in insurance coverage and availability. In the face of climate change, future weather events are not predicted using past weather trends. These changes call for new corporate strategies (alternatively termed resilience, preparedness, or adaptation) that protect vital physical assets and supply chains in the face of newly uncertain environments.

The "new normal" The first decade of the twenty-first century was the hottest decade on record. As a result, extreme weather events in the US have become both more frequent and more intense, with a large decrease in the number of extreme cold waves and an increase in both extended heat waves and extreme rainfall events. Nationally the freeze-free season (the number of days with temperatures above 32 degrees Fahrenheit) increased by two weeks over the last century. The West and North experienced the greatest warming, while parts of the Southeast, Great Plains, and Midwest regions did not experience a statistically significant warming trend.[10]

The Eastern US experienced a significant increase in extreme precipitation events, with the greatest number of episodes taking place during the 2000s.

Business implications These are changes in weather patterns that require new forms of preparedness and planning. As Jane Lubchenco, former administrator of the National Oceanic and Atmospheric Administration (NOAA), noted, "Very few environmental conditions affect our economy, natural resources, or citizens' lives more than climate. Up to one-third of the US gross domestic product is directly influenced by weather and climate."[11] The Millennium Ecosystem Assessment also warned that "higher operating costs or reduced operating flexibility should be expected due to diminished or degraded resources" as a result of climate change.[12]

These diminished or degraded resources might be in the form of material availability, logistical supply routes, or vulnerable physical assets. As an example of lost resources, TransAlta's hydro reservoirs have experienced century low-water conditions due to receding glaciers and erratic snowpack in the Canadian Rockies that have reduced the generating capacity of some of their hydroelectric facilities. Reflecting this vulnerability, the company chose not to proceed with a thermal power project in the US Southwest due to an assessment that available water rights for cooling were not sustainable given climate change and other factors. As an example of diminished logistical supply routes, Diavik Diamond Mines Inc. has experienced a decrease in the available "ice bridges" needed to move equipment and materials to the northern regions of Canada. In Alaska, the allowable period for heavy truck travel on the tundra shrank from 220 days in 1970 to about 100 days in 2006. The only alternative is to absorb the additional costs of shipping materials by helicopter or developing means to replace needed materials with local supplies (such as installing wind turbines rather than shipping diesel fuel). As an example of vulnerable physical assets, increased hurricane severity on the Gulf Coast has forced energy companies to absorb cleanup costs and reinforce existing assets, such as power plants, transmission and distribution systems, and other facilities, to withstand future storms. One company, Entergy, was forced to absorb $1.5 billion in restoration costs for Hurricanes Katrina and Rita alone.[13]

Insurance market shifts As business risks increase due to climatic shifts, so, too, do insurance risks, particularly in the areas of property and casualty, business interruption, directors and officers, and natural catastrophe insurance coverage.

Since 1980, worldwide natural catastrophes have been on a steady upward trend in number (see Figure 2, p. 10) and costs. In the US, 2012 was the second costliest year since 1980, according to NOAA's National Climatic Data Center (NCDC). Damages for that year totaled more than $110 billion, due in large part to 11 weather and climate disaster events, each with losses exceeding $1 billion (Figure 4, p. 11). The 2012 total damages rank only behind 2005, when events including four devastating land-falling hurricanes inflicted damages of $160 billion.[14] Just as important as absolute costs as a strategic concern, natural catastrophe losses have become more volatile in the last 20 years (Figure 3, p. 10), increasing the complexity of planning for events related to climate change. This volatility was due to a combination of (a) climate change trends, (b) changes in exposure (for example, more population and property in harm's way due to the development of coastal and floodplain properties), (c) natural annual variability, and (d) other variables.

This is the "new normal" for insurance companies. R Street, a conservative think tank with a particular focus on insurance issues, notes that "every large property insurer…considers climate change-linked catastrophes to be a future operational threat."[15] According to Ina Ebert, a liability and insurance law expert at Munich Re, "Climate liability is considered one of the emerging risks that could gain in importance for the insurance industry in coming years."[16] And Ceres' 2012 *Insurer Climate Risk Disclosure Survey* indicates that: "More frequent and/or severe hurricanes could impact the creditworthiness of issuers in the Southeastern United States. In addition, regulation could force insurance companies to create adaptive measures to insure customers in a catastrophe prone area. In turn, customers may face higher rates and demand greater information from their insurers on how to best ameliorate climate-related risks."[17]

These kinds of concerns are compelling governments to intervene in insurance markets. For example, the Florida legislature passed a bill in 2013 limiting the insurance coverage that could be provided by state-run Citizens Property Insurance Corp. and restricting Citizens from writing new policies in environmentally sensitive coastal regions.[18] In February 2012, California joined Washington and New York in requiring insurance companies with $300 million or more in direct written premiums (90 percent of the insurance market) to respond to the National Association of Insurance Commissioners' Climate Risk Survey. In the survey, insurers disclosed to regulators the financial risks they faced as a result of climate change, as well as actions they were taking to respond to those risks.[19]

Figure 2: **Worldwide natural catastrophes, 1980-2013**
Number of events

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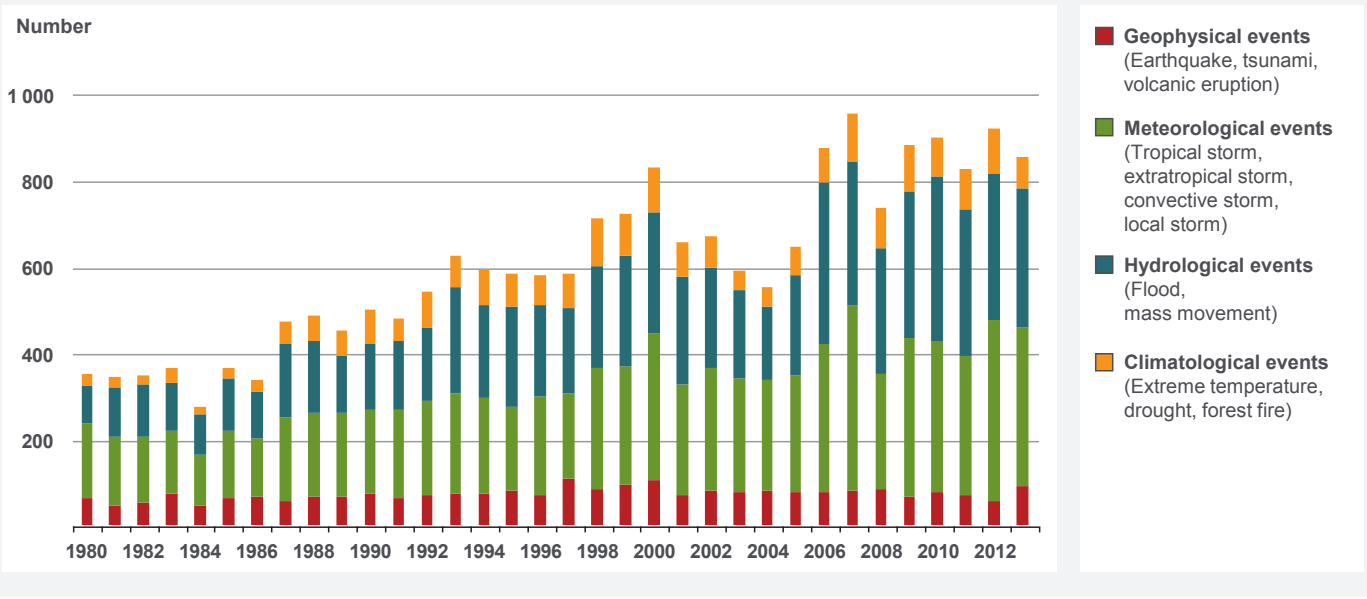

Figure 3: **Economic losses from worldwide natural catastrophes, 1980-2013**
Overall and insured losses

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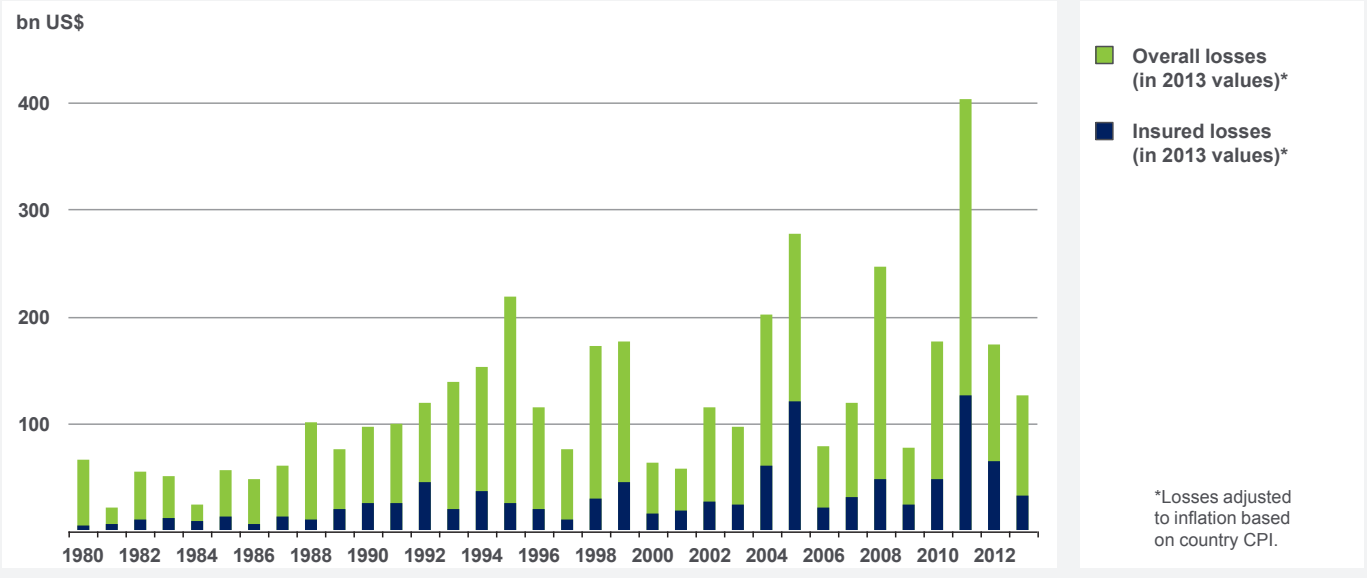


Figure 4: **US weather and climate disasters causing $1 billion or more in losses in 2012**

Source: National Climatic Data Center, 2013 (www.ncdc.noaa.gov/news/ncdc-releases-2012-billion-dollar-weather-and-climate-disasters-information).

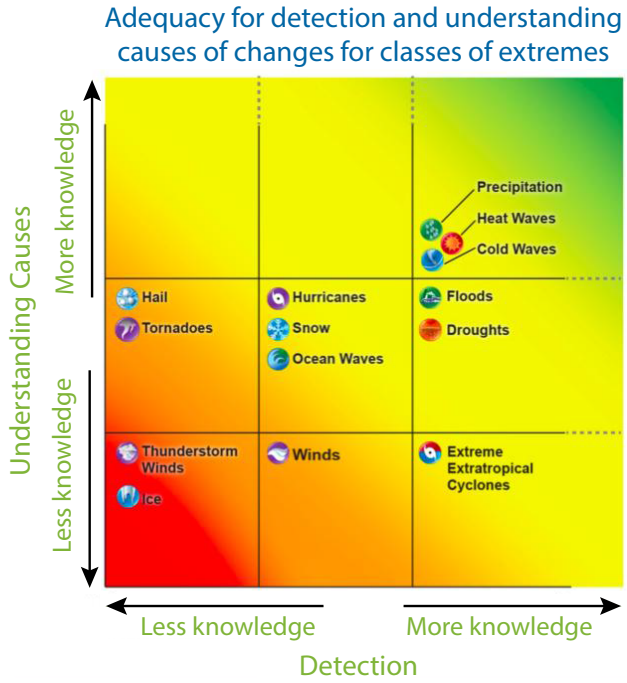
Adaptation strategies The combination of direct operational risks and indirect insurance risks compels business executives to consider their company's vulnerability to climate adaptation risk. Key questions include: In what regions do your operations lie, and what are the present and future climatic impacts that you can expect? If you are building a new asset that is water dependent, do you have data that can assure that the water will be there in 20 or 30 years? If you have existing assets in regions where more severe storms can be expected, how must you upgrade your systems to assure uninterrupted operations? If you have coastal assets, how will more frequent and severe storm surges require changes in infrastructure, operations, and adaptation? If you have supply chains that involve suppliers in more storm-prone regions (especially sole source providers or just-in-time logistics), how prepared will you be for disruptions in the supply of key materials? If you are an electricity provider, how will rising temperatures alter operational and market forecasts for electricity demand and supply, especially peak consumer demand? And, in the face of all these questions, do you have adequate insurance for property and casualty, business interruption, directors and officers, and natural catastrophe coverage?

The answers to these questions require quality data and analysis, and the development of an adaptation strategy can be overlain on the structure and process designed for your mitigation strategy:

1. *Develop your strategy*: conduct a vulnerability assessment, gauge risks and opportunities, evaluate options for technological solutions, and set goals and targets.
2. *Focus inward*: develop supporting financial mechanisms and engage the organization.
3. *Focus outward*: formulate a policy strategy and manage external relations.

Scientific data and adaptation strategies There is one additional consideration that differentiates adaptation from mitigation strategies: the use of scientific data and forecasting. Scientists are working to clarify and predict the implications of rising temperatures with varying degrees of certainty based on the type of weather event. For example, sophisticated modeling techniques can be much more certain about the causes of precipitation patterns, as well as heat and cold waves, but are less precise about thunderstorm winds and ice (see Figure 5, p. 12).[20]

Figure 5: **The state of scientific understanding around climate change and weather events**



Source: Kenneth E. Kunkel et al., "Monitoring and Understanding Changes in Extreme Storm Statistics: State of Knowledge," Bulletin of the American Meteorological Society 94, no. 4, April 2013 (http://journals.ametsoc.org/doi/pdf/10.1175/BAMS-D-11-00262.1).

What scientists can tell us is that, by the end of the century, heavy downpour events that once occurred every 20 years are expected at a frequency of every 4 to 15 years depending on the region, with wetter areas (such as the Northeast) expected to get even wetter, increasing the chance of severe flooding. The number of consecutive days with less than 0.1 inch of rain is expected to increase across much of the Southwest, taxing areas already prone to water shortages.[21] Higher temperatures across western mountain ranges are anticipated to reduce snowpack, summer stream flows, and groundwater recharge but lead to more winter flooding. Cities already prone to heat waves can expect the events to become more frequent, longer, and more intense over the next several decades. Rising sea levels will magnify storm surge flooding and shoreline erosion, placing additional stress on coastal communities and habitats.[22] The intensity of tropical cyclones is a particular cause for concern for the Eastern US, as climate simulations find that a 1 degree Celsius rise in global temperature will translate to a twofold to sevenfold increase in the frequency of Katrina-magnitude hurricane events.[23]

Companies with vulnerable assets must become more adept at managing the science of such data and models to reduce uncertainty in supply chains. One source of such data and analysis is the NCDC, the United States' primary provider of climate science, information, and data. NCDC had more than 6 petabytes of data in 2013 and is expected to exceed 15 petabytes by 2020 (a petabyte is written as 1,000,000,000,000,000 or 10^{15} bytes). NCDC stores land-based observations collected from instruments in locations on every continent. Observation data include weather, temperature, dew point, relative humidity, precipitation, wind speed and direction, visibility, and atmospheric pressure. It also collects local climatological data, US hourly precipitation, hourly global integrated surface data, and cooperative data. The organization has begun exploring ways to make this information available to business executives.[24] Such data can be invaluable for developing an effective climate adaptation strategy.

Conclusion

Climate mitigation and adaptation strategies are becoming increasingly important to specific firms and sectors. Companies that use high amounts of energy, that possess physical assets in storm-prone regions, or that rely on resources affected by climate change (most notably water) will find such strategic development to be critically important now. As policy formation begins to gather momentum and the physical impacts of climate change become clearer, mitigation and adaptation strategies will become necessary for the shifting market reality.

Social and political signals point to this coming market shift. For example, public belief in climate change has increased steadily over the past four years to levels that now range from 62 percent[25] to 76 percent.[26] In fact, a 2013 survey of business executives found even higher—85 percent—belief that human-induced climate change is real.[27] The primary motivator of this upward trend among the public has been experiences with more extreme weather.[28] This shift in public opinion will be reflected in market shifts related to greater support for climate-related policies and greater interest in carbon-reducing products and services. This shift will also be reflected in corporate strategies that will be more aware of and concerned about the physical, political, and market implications of climate change mitigation and adaptation. The time is now to prepare for this coming market shift.

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