From Risk to Opportunity:
How Insurers Can Proactively and Profitably Manage Climate Change

Evan Mills, Ph.D.

Eugene Lecomte

Preface by
Mike Kreidler
Commissioner, Washington Office of the Insurance Commissioner

Tim Wagner
Director, Nebraska Department of Insurance

August 2006

Commissioned by

Ceres

"Everybody talks about the weather, but nobody does anything about it."
Charles Dudley Warner (Hartford Courant, 1897)

"We'd be out of our minds if we wrote weather insurance on the opinion global warming would have no effect at all."
Warren Buffett, 2006 Berkshire Hathaway annual Shareholder meeting

"Climate change has the potential to develop into the greatest environmental challenge of the 21st century. The recent period of intense tropical cyclone activity most likely reflects the effects of both natural climate variability and a superimposed global warming trend due to human causes."
Chief Risk Officers of 19 Insurers:
AEGON, Allianz, Aviva, Axa, Chubb, Converium, Fortis, Generali, Hannover Re, Insurance Australia Group, ING Group, Munich Re, Prudential, Royal & Sun Alliance, Scor Group, Swiss Re, TrygVesta, Winterthur, Zurich

"Aetna is concerned about climate change and presently cannot envision a scenario in which a warmer and possibly more polluted planet would benefit anyone including our customers, shareholders and employees."
Aetna – Carbon Disclosure Project -3 submission

"Catastrophes present a significant threat to the U.S. economy and to the domestic property-casualty insurance industry, raising both insolvency and insurance availability concerns."
Ross J. Davidson, Vice President, Corporate Finance, USAA Insurance

"The industry has always felt that the past is the key to the future...With the many changes in society and the potential changes in climate, this will no longer hold true."
Mark Baker, Administrative Services Supervisor
State Farm Insurance Companies

"The insurance industry plays a vital role in identifying and quantifying catastrophic risks so that appropriate loss prevention and risk-spreading measures can be put into place. … Reinsurers who provide a backstop on large losses are engaged on the climate issue, but much more work needs to be done by the primary insurers who consumers rely on when catastrophes hit."
Joe Ario, Oregon Insurance Administrator
and Vice President of the National Association of Insurance Commissioners

"Insurers rely upon their ability to predict the economic consequences of future events. That's how premiums are set; that's the kind of assessment they do of their own exposures. In a period of changing climate, when the very basis of their decisions may be changing, then they need to have a better understanding of climate change. … The fact that future events may not be a linear progression of the past, but in fact may have changed as a result of natural variability, or human activity or whatever, is an important thing to be taken into consideration."
Franklin Nutter, President, Reinsurance Association of America

From Risk to Opportunity:
How Insurers Can Proactively and Profitably Manage Climate Change

Evan Mills, Ph.D.
Eugene Lecomte

Preface by

Mike Kreidler
Commissioner
Washington Office of the Insurance Commissioner

Tim Wagner
Director
Nebraska Department of Insurance

August 2006

Commissioned by

Ceres

About the Authors

Evan Mills is a Staff Scientist at the U.S. Department of Energy's Lawrence Berkeley National Laboratory, one of the world's leading research centers on energy and environment. Dr. Mills works in the areas of energy management and the impacts of climate change on economic systems, particularly with respect to the insurance sector. He has published over 200 technical articles and reports and has contributed to nine books. He served as co-leader of the Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report's chapter on insurance, under the auspices of the United Nations, and is contributing to the Fourth Assessment due for release in 2007. His insurance-related research can be accessed at http://eetd.lbl.gov/insurance.

Eugene Lecomte is President Emeritus of the Institute for Business and Home Safety. A veteran of more than fifty years in the insurance business, Mr. Lecomte has served as President and CEO of the Insurance Institute for Property Loss Reduction, the National Committee on Property Insurance, and the Property Insurance Plans Service Office. He also served as President of the Massachusetts Automobile and Workers Compensation Rating Bureaus, and Executive Director of The Earthquake Project.

Acknowledgments

This report benefited from discussions with Paul Epstein (Harvard Medical School), Paul Kovacs (Institute for Catastrophic Loss Reduction), Alice Leblanc (AIG), Gary Guzy (Marsh), Steven Bushnell (Fireman's Fund), Richard Jones (AIG/Solomon Associates), Richard Roth, Jr. (Bickerstaff, Whatley, Ryan & Burkhalter Consulting Actuaries), and Philip Woods and Barry Lewis (Insurance Australia Group). Lee Gresham (Ceres) provided extensive research on current insurance availability and affordability in various markets. Andrew Logan and Peyton Fleming at Ceres helped conceptualize the report and provided editorial assistance. Chris Clark of Cave Dog Studio provided graphic design and production services. The opinions expressed in this report are those of the authors.

For the most current repository of information on insurance company activities in response to climate change, see http://eetd.lbl.gov/insurance/Insurance-opportunities.html

This report was commissioned by Ceres, a national coalition of investors, environmental groups, and other public interest organizations working with companies to address sustainability challenges such as climate change. Ceres also directs the Investor Network on Climate Risk, a group of 50 institutional investors from the U.S., Europe, and Canada who collectively manage over $3 trillion of assets.

www.ceres.org

Table of Contents

Preface i
Foreword ii
Executive Summary 1

I. 2005: A Tipping Point on Insurance & Climate Change 4
Facing the Katrina Stress Test 4
No More Debate: Global Warming is Real 4
Growing Implications for the Insurance Industry 7

II. Erosion of Insurability 9

III. Advancing Climate Insurance Solutions 14
Promoting Loss Prevention 16
Traditional Risk Management 16
Integrating Energy Management & Risk Management 17
Better Management of Forestry, Agriculture, and Wetlands 18
"Rebuilding Right" Following Losses 18
Crafting Innovative Insurance Products and Services 18
New Insurance Products for Energy Service Providers 18
Energy-Savings Insurance 19
Renewable Energy Project Insurance 19
Green-Buildings Insurance 20
Pay-As-You-Drive Insurance 20
Climate Risk Management Services 21
Participating in Carbon Markets 22
Facilitating Carbon Trading 23
Managing Risk for Carbon-Trading Projects 23
Enabling Customers to Purchase Carbon Offsets 24
Aligning Terms and Conditions with Risk-Reducing Behavior and Capitalizing on the "Halo Effect" 25
Assigning Directors & Officers Liability 25
The "Halo Effect" 26
R&D and Investment in Climate Change Solutions 26
Research and Development 26
Investments 27
Climate-Responsive Funds 27
Building Awareness and Participating in the Formulation of Public Policy 27
Consumer Information and Education 28
Having a Voice in Public Policy Discussions on Climate Change 28
Endorsing Voluntary Energy-Saving Policies 28
Energy-Efficiency Codes and Standards 28
Leading by Example 29
In-House Energy Management 29
Reducing Insurers' Carbon-footprint Through Improved Operations 29
Disclosing Climate Vulnerabilities and Liabilities 29

IV. Challenges 30

V. The Essential Role of Regulators 31

VI. Toward Best Practices 32

Appendix A: Directory of Insurer Activities to Address Climate Change 34

Appendix B: Climate-Change Adaptation-Mitigation Co-Benefits 38

Endnote references 39

Preface

Global warming is upon us, and it poses unprecedented new threats to the insurance industry and vast segments of society that rely on insurance for peace of mind and financial security. This summer's wildfires in the Northwest and record-high temperatures and drought in the Midwest are only the latest reminders of the far-reaching impacts that climate change and extreme weather events pose to insurers still reeling from last year's devastating hurricane season on the Gulf Coast.

As insurance regulators, we are concerned about this topic because climate change is likely having a profound affect on insured losses, which could ultimately lead to a crisis of affordability and availability of essential insurance for consumers, as well as solvency problems for insurers themselves. The National Association of Insurance Commissioners (NAIC) in December formed a Climate Change and Global Warming Executive Task Force that we are leading to study the issue and provide leadership on how to better manage insurance markets for the benefit of consumers and insurers in this increasingly harsh environment. This report provides important information as we move forward with the task force.

As climate change increases the likelihood of weather-related losses, we must seek new ideas and solutions so insurers can minimize these impacts for themselves and consumers, while also addressing the root causes of global warming itself. Just as the industry asserted its leadership and expertise in tackling building fire and earthquake risks in the past, we must capitalize on its present creativity and influence as we confront what is perhaps the biggest threat in the history of this vast industry.

This Ceres report is timely and important because it provides the most comprehensive assessment yet of insurance products available for proactively meeting climate change challenges head-on. Many of the more than 190 activities identified in this report have enormous potential to reduce losses and greenhouse gas (GHG) emissions at the same time. For example, considering that buildings account for about 40 percent of GHG emissions, insurance products that encourage energy efficiency and lower carbon emissions are vital.

Facing this immense challenge requires the insurance industry, regulators, policymakers, investors, and insurance purchasers to contemplate important questions: What insurance activities should we support that will have the greatest benefit to insurers and consumers in high risk areas? What rules and policies must regulators implement in order to encourage the advancement of climate insurance solutions and products? How do we ensure that catastrophe risk models used to price insurance are adequate to reflect a changing climate landscape?

In the pages that follow, authors Evan Mills and Eugene Lecomte examine the many issues surrounding climate change and insurance—not only the risk that climate change presents, but the vast opportunities that may begin to answer the important questions above. We applaud the authors and Ceres for this effort and hope this report will help those who read it to find answers to these important questions.

Mike Kreidler
Commissioner
Washington Office of the Insurance Commissioner

Tim Wagner
Director
Nebraska Department of Insurance

Foreword

Last year's $45 billion of insured losses from Hurricane Katrina was only the latest reminder of why investors and consumers are concerned about the impacts of climate change on the insurance industry.

Twelve months after the devastating storm hit New Orleans, insurers and their shareholders are still feeling the ripples. Record insured losses, rating downgrades, coverage pullbacks and class-action lawsuits are just a few of the reverberations that have been felt across the industry. Meanwhile, consumers are feeling the combined sting of price shocks and reduced availability.

So serious is the issue that 20 leading investors, representing over $800 billion in assets, called on the nation's largest insurance companies to disclose their financial exposure from climate change and steps they are taking to reduce those financial impacts.

But, while most of the attention is focused on the growing risks—an immensely important issue, to be sure—climate change also creates vast business opportunities to be part of the solution to global warming. Just as the industry has historically asserted its leadership to minimize risks from building fires and earthquakes, insurers have a huge opportunity today to develop creative loss-prevention products and services that will reduce climate-related losses for consumers, governments and insurers, while trimming the emissions causing global warming.

This report focuses on the encouraging progress made by insurers to develop these new products and services. It identifies more than 190 concrete examples available, or soon-to-be-available, from dozens of insurance providers in 16 countries. In addition to benefiting insurers' core business and investment activities, these programs afford insurers the opportunity to differentiate their products from their competitors, while also enhancing their reputation with customers who are increasingly looking for all sectors of the industry to come forward with effective responses to the threats caused by climate change.

More than half of the products come from U.S. companies, covering such services as green building design, hurricane-resistant construction, carbon emissions trading and renewable energy. Among the recent offerings that show promise for customers and insurers alike:

- Insurer-initiated hurricane-loss prevention methods used at nearly 500 commercial locations avoided $500 million in property damage from Hurricane Katrina, eight times less damage than properties that did not make the engineering improvements. Insurer FM Global says the $500 million in savings came after customer investments of only $2.5 million, and helped make the company profitable in a year of record claims across the industry.

- Fireman's Fund Insurance is launching first-of-its-kind 'green' coverage, including rate credits and other incentives, for commercial building owners who re-build damaged property using green and LEED-certified building practices. California-based Firemen's Fund will begin seeking state regulatory approvals this month so that the products can be offered in states around the country this fall.

- Carbon emission credit guarantees and other new renewable energy-related insurance products from the world's largest insurance broker Marsh, largest insurer AIG and other insurers are allowing more companies and investors to participate in carbon-offset projects and burgeoning carbon emission trading markets. The carbon trading market in the European Union alone is expected to hit $30 billion by the end of 2006.

Although an encouraging start, greater efforts are needed from insurance companies and regulators to get more of these creative programs into the public arena. Most U.S. insurers are not yet experimenting with these products, nor are adequate resources being invested by the government or insurer-funded associations. The dearth of innovative products that would reduce climate risks and preserve insurability for homeowners is of particular concern, especially when considering the hundreds of thousands of homeowners who have lost private coverage the past two years.

As the world's largest economic sector, and one that reaches virtually every consumer and business in industrialized countries, the prospect for insurance industry involvement in the development and promotion of climate change mitigation strategies stands as an immense but as yet largely untapped opportunity.

Mindy S. Lubber
President of Ceres
Director of Investor Network on Climate Risk

Executive Summary

Global warming and the growing incidence of extreme weather events pose an enormous challenge to the insurance industry. Rising weather-related losses are causing adverse impacts on insurance affordability and availability. In Florida and Louisiana alone, more than 600,000 homeowners' property policies have been cancelled or not renewed in the past year. Left unchecked, other parts of the U.S. could face similar insurance challenges, shifting more of the burden to consumers and governments and slowing the growth of the industry itself.

But while climate change poses potential threats, it also creates vast new business opportunities. Just as the industry historically asserted its leadership to minimize risks from building fires and earthquakes, insurers have a huge opportunity today to develop creative loss-prevention solutions and products that will reduce climate-related losses for consumers, governments and insurers, as well as the emissions causing global warming. This report shows encouraging progress from insurers in this regard, although much greater efforts are required in the future in order to achieve these goals.

As the world's largest industry—with $3.4 trillion in yearly premium revenue, plus another trillion in investment income—with core competencies in risk management and loss prevention, the insurance industry is uniquely positioned to further society's understanding of climate change and advance forward-thinking solutions to minimize its impacts. It is in the industry's best interests, and fits with its historic, self-defined role as a promoter of loss mitigation, to seize this moment to act on what is likely to become the greatest risk the industry has ever faced.

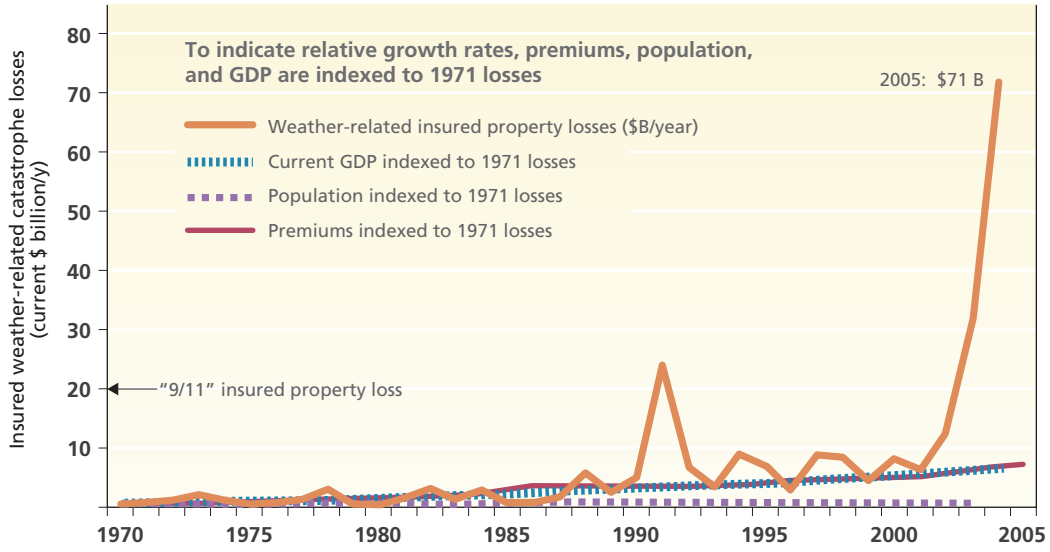


Figure 1. U.S. Insured Catastrophe Losses Growing Faster than Premiums, Population, GDP

Source: Mills, Roth, and Lecomte (2005) updated to show 2005 losses

As we approach the first anniversary of Hurricane Katrina, many insurers point to 2005 as an historic tipping point—a year with insured weather-related catastrophe losses of almost $80 billion worldwide, equivalent to four "9/11s"[1], out of total economic losses of $216 billion.* While the insurance industry is grappling with the fallout and a broader global pattern of rising and less predictable catastrophe losses (see Figure 1), U.S. consumers—both in the residential and commercial

* These are underestimates, as not all events have insurance loss data available and only events with over $77 million in insured losses are included in the Swiss Re data base. Note that 99.7% of all catastrophe losses in 2005 were due to weather-related events

spheres—are feeling the prompt effects on both the availability and affordability of insurance. The rapid exodus of private insurers from Florida, Mississippi, and Louisiana is creating enormous financial exposure for state-operated insurance pools. Long thought of as "insurers of last resort," these pools are fast becoming the "insurers of only resort," and are running into just the solvency problems they were designed to solve. Far from the original intent, Florida's pool will soon be the largest insurer in that state.[2] By pulling up their roots from hurricane-prone areas, the insurance industry is already foregoing about $3 billion per year in income.* Meanwhile, homeowner premiums have risen 20 to 40 percent in many areas, and 10- to 20-*fold* in isolated cases.[3]

While insurers' dominant response to rising catastrophe losses has been to withdraw from at-risk areas and raise prices, both of these reactions have limited potential and could ultimately lead to a shrinking business and a backlash from consumers, investors, and regulators. Insurers themselves acknowledge that a more proactive approach is needed. "We cannot continue to try to react; we have to build in programs that expect [surprise] because the 21st century has had a tough start for this industry." said Kenneth W. Brandt, leader of the Americas and Asia Pacific P&C reinsurance unit with GE Insurance Solutions in San Francisco.[4]

With this in mind, a vanguard of insurers have begun to take concrete actions that generate well-earned profits while maintaining insurability and protecting their customers from extreme weather-related losses, as well as reducing greenhouse gas emissions. Many of these strategies are already in practice, providing benefits and savings for insurers and their customers. We identified 190 real-world examples, provided by 104 insurers, brokers, and insurance organizations from 16 countries employing one or more of these methods. More than half of the examples come from U.S. companies. In addition to offering new products and services, these insurers are leading by example with in-house energy management programs, investments in the clean-technology sector, and climate change disclosures. They are also participating in the process of enhancing scientific understanding of climate change's impacts, building public awareness, and participating in the public policy process. Insofar as these strategies are profitable for insurers, they represent "no-regrets" opportunities irrespective of their climate-related benefits. Examples of the insurer activities include:

- Insurer-initiated hurricane loss prevention methods employed at nearly 500 locations avoided $500 million in property losses from Hurricane Katrina, after customer investments of only $2.5 million. These customers sustained eight-times less damage than those choosing not to implement the recommendations.
- Premium credits are being offered to owners of loss-resistant green-buildings, as are options for building upgrades to the popular LEED (Leadership in Energy and Environmental Design) standards following a loss.
- Pay-as-you-drive insurance products, which encourage drivers to lower the risk of being involved in an accident by reducing miles driven, are being promoted through insurance discounts of up to 50 percent.**
- Insurance-initiated mangrove protection programs operated by Japanese insurers are helping to reduce cyclone-related risks in Asia.

* Estimate based on the number of policies in these pools, also known as the "residual markets" [FAIR and Beach/Wind Plans] in hurricane-prone areas, which is approaching 3 million, and average premiums of approximately $1000 (also growing). Insurers have of course withdrawn voluntarily, based on a conclusion that potential losses will exceed revenues.

** Studies suggest that pay-as-you-drive insurance reduces miles driven by 10% to 15%, potentially resulting in significant climate change and energy security co-benefits.

- A variety of insurance mechanisms that manage engineering and technical risks and thereby increase the attractiveness of investments in carbon-offset projects are allowing more companies to participate in emerging carbon-emission trading markets.
- Energy-savings insurance products are stimulating improved quality control in energy retrofit projects, and the associated guarantee of savings is enabling lenders to offer more favorable financing for such projects.

Although an encouraging start, the enormous potential and opportunity from these forward-thinking initiatives remains largely untapped. Most U.S. insurers have yet to even experiment with these novel ideas, presumably because many companies have not looked closely at the underlying question of climate change. No one insurer has developed what we would consider a comprehensive portfolio of best-practice strategies, nor are adequate resources being invested in these endeavors. In the United States, for example, the insurer-funded Institute for Business and Home Safety's budget for relatively traditional approaches to loss prevention is only 0.003-percent of associated national property and casualty insurance premiums despite its demonstrated impact in reducing insured losses. However, momentum is rapidly building toward a transformation within the industry that would embody the notion that business and sound environmental management go hand in hand.

I. 2005: A Tipping Point on Insurance & Climate Change

Climate change is increasingly recognized as an ongoing, significant global environmental problem with risks to the global economy and ecology, and to human health and wellbeing. AIG recognizes the scientific consensus that climate change is a reality and is likely in large part the result of human activities that have led to increasing concentrations of greenhouse gases in the earth's atmosphere.[5]

AIG (2006)

Facing the Katrina Stress Test

Hurricane Katrina battered and flooded the U.S. Gulf Coast, and sent powerful ripples through the world economy, especially the insurance and reinsurance industries. Many insurers will define history as the periods before and after 2005, a year with insured weather-related catastrophe losses of almost $80 billion worldwide, equivalent to four "9/11s",[6] out of total economic losses of $216 billion.* The loss of 275,000 homes was 10 times that of Hurricane Andrew and insured losses totaled $45 billion, more than doubling the record from all of the previous year's hurricanes combined.[7] In addition to breaking many all-time records—including those for most storms and highest wind speed ever observed—the 2005 hurricane season has prompted some hurricane researchers to suggest adding "Category 6" to their existing 1-to-5 damage scale. The industry's own catastrophe modelers warn that significantly more costly storms than Katrina are possible and, indeed, inevitable. A.M. Best Co. estimates that such storms, with $100 billion in losses, would bankrupt as many as 40 insurers.[8]

Hurricane Katrina can be viewed as part of a recent pattern in storm activity that has created an unprecedented "stress test" of what might be expected under climate change. The event caught many insurers by surprise[9], and losses amounted to 50 to 100 times insurer's typical yearly profit in the affected states.[10] A myriad of losses emerged beyond the initial obvious property damages, including extensive loss of life, business interruption, looting, crop and shellfish losses, widespread mold damages, and hazardous waste releases and subsequent questions about health impacts from "toxic gumbo." From an actuarial perspective, the unanticipated correlations among these losses (e.g. loss of power and shutdown of water pumping stations) are particularly worrisome. From a regulatory perspective, several dozen insurance companies came under regulatory review, watch, or were downgraded. From a shareholder perspective, downgraded companies experienced a median loss of stock value of 66 percent. Downgrades caused at least one insurer, Quanta, to liquidate most of its business.[11] Meanwhile, the industry is beset by multiple lawsuits over its classification of losses as caused by flood (uninsured) versus wind (insured).[12]

The consequences for consumers have been severe, as a crisis has emerged for insurance availability and affordability.[13] With $10 billion in insured losses—including the destruction of 116 oil platforms, and 56 more severely damaged by 2004–2005 hurricanes[14]—offshore oil producers saw insurance price increases of up to 500 percent, and considerable shrinkage of the capacity available to pay for future losses.**

No More Debate: Global Warming is Real

The scientific evidence of climate change became more compelling than ever in the past year. A growing body of evidence links hurricanes to a long-term pattern of warming oceans rather than

---

* These are underestimates, as not all events have insurance loss data available and only events with over $77 million in insured losses are included in the Swiss Re data base. Note that 99.7% of all catastrophe losses in 2005 were due to weather-related events.

** Unless otherwise noted, the data in this paragraph are from the Insurance Information Institute, "Hurricane Season of 2005: Impacts on US P/C Insurance Markets in 2006 and Beyond." Presentation by Robert Hartwig.

a natural historical cycle of intense storms. Meanwhile, stronger scientific linkages have also been identified between climate change and the melting of distant ice caps and glaciers, as well as hazards in the American heartland such as more damaging wildfires, droughts and heat waves, and inland storms. Among the key new findings of the past year:

- Lingering "climate skeptic" assertions that the evidence of warming is flawed have been disproven by a major report to Congress by the National Research Council study.[15] A separate study, commissioned by the Bush Administration, refuted prior claims that satellite data demonstrated no warming.[16]
- There are increasingly persuasive revelations of linkages between rising ocean temperatures and hurricanes, and a doubling of Category 4 and 5 hurricanes around the world in recent years.[17, 18]
- The assumed "natural" hurricane cycle in the North Atlantic appears in fact to be due at least in part to pollutant aerosols, which temporarily cooled the atmosphere and oceans.[19] As we eliminated these aerosols over the past few decades, the previously masked effect of climate change resurfaced.
- New research documents significant shrinkage in the thickness and extent of arctic sea ice, as well as the continued retreat of glaciers around the world.[20] The rate of fresh water flow into the Nordic Seas has been estimated at about that of eight Mississippi Rivers,[21] which has clear implications for sea-level rise around the world.
- New analyses show that the land area burned in the American West by large wildfires increased more than six-fold in the mid-1980s, with higher large-wildfire frequency, longer wildfire durations, and longer wildfire seasons. These trends are strongly associated with increased spring and summer temperatures and an earlier spring snowmelt and are not explained by forest management practices.[22]
- The Great Atlantic currents known as the "North Atlantic Oscillation" (part of which is the Gulf Stream) may be slowing, an eventuality previously believed to be more than a millennium away.[23]
- Thanks to a workshop held by Munich Re, a previous debate[24] has evolved into a consensus that climate change is playing a role in the observed increase in the costs of weather-related damages.[25]

The bottom line: The debate on the complicity of humans in observed and projected climate change is effectively over. As an indication of this, across the nearly 1,000 peer-reviewed scientific articles published between 1993 and 2003 that mention "climate change," not one questioned the reality of human influence in the phenomenon.[26]

In 2005, the G8-countries' National Academies of Sciences (plus Brazil, China, and India)[27] issued a joint statement that climate change is already manifesting, is a material threat, and that it was time to begin mitigating the risks.[28]

Climate Change Hits Investor and Business Communities

A growing number of institutional investors and business leaders now recognize that climate change is real and actions are needed to minimize its impacts.

In November 2005, Goldman Sachs Chairman Henry Paulson warned, "We don't have a lot more time to deal with climate change" and "voluntary action alone cannot solve the climate change problem." Paul Anderson, the chairman of Duke Energy, one of the nation's largest emitters of greenhouse gases, has taken the position that the government should tax industry's carbon dioxide emissions. Anderson maintains that, "if we approach this rationally, it will not be disruptive to the economy and will not turn the world upside down and will, at the same time, address the problem."[29]

Investors are also pushing for action. In December 2005, 20 leading investors sent letters to the top 30 insurance companies in North America, expressing concern about the potential impacts of climate change on shareholder value in the insurance sector and requesting disclosure of climate change risk exposure and preventative strategies.[30] Investors also filed over two dozen global warming shareholder resolutions with companies in 2005—more than triple the number of filings in 2000 and 2001. Some of the resolutions received the highest voting support levels ever—a direct result of pension funds, labor funds and other institutional investors boosting their involvement in the climate issue.

Meanwhile, more than 150 institutional investors are now participating in the Carbon Disclosure Project, which has been conducting annual surveys on climate practices at the world's leading companies. Of the companies that responded to last year's survey, 90 percent cited climate change as posing commercial risks and/or opportunities. However, few U.S.-based insurance companies provided sophisticated responses. This is particularly striking when compared to European and Japanese insurers. Only 50 percent of the U.S. insurance companies that were contacted responded to the questionnaire compared to the 100 percent response rate of those insurance companies domiciled outside of the U.S. (Figure 2). Of the U.S. insurers that did respond, AIG is the clear thought-leader on the issue.

US Insurers		Response Status CDP1 (2003)	Response Status CDP2 (2004)	Response Status CDP3 (2005)
	Ace	⊘	✔	✔
	Aetna	Not in CDP1	⊘	✔
	Allstate	✔	✘	✘
	AIG	✔	✔	✔
	Chubb	✘	⊘	*i*
	Cigna	⊘	Not in CDP2	Not in CDP3
	Prudential Financial	✘	✘	✘
	Hartford Financial	✘	✘	✘
	Metlife	⊘	⊘	⊘
	St. Paul Travelers	⊘	✔	✔
	Wellpoint	Not in CDP1	⊘	✘
Non-US Insurers				
Japan	**Mitsui Sumitomo**	Not in CDP1	Not in CDP2	✔
Netherlands	**Aegon NV**	✘	⊘	*i*
France	**AGF**	Not in CDP1	Not in CDP2	✔
Germany	**Allianz AG**	✔	✔	✔
France	**AXA**	✔	✔	✔
Belgium	**KBC Bank Insurance**	✔	✔	✔
Germany	**Munich Re**	✔	✔	✔
Italy	**RAS**	✔	✔	✔
Switzerland	**Swiss Re**	⊘	✔	✔
Switzerland	**Zurich Financial**	⊘	✔	✔
United Kingdom	**Aviva**	✔	✔	✔
United Kingdom	**Legal & General Group PLC**	✔	✔	✔
United Kingdom	**Prudential PLC**	✔	✔	✔

✔ = Answered Questionnaire ✘ = Declined to Participate
i = Provided Information/CSR Report/Website Link ⊘ = No Response

Figure 2. Insurer responses to the Carbon Disclosure Project (CDP) questionnaire on climate change risks and opportunities.

Source: http://www.cdproject.net

Growing Implications for the Insurance Industry

The insurance sector serves as a national—and increasingly global—integrator of impacts across all sectors of the economy, and messenger of these impacts through the terms and price signals it projects to its customers. It provides a critical function within the global economy by helping create the certainty that businesses need to invest and grow.

The direct implications of climate change for insurers and their customers are significant,[31, 32] and have become particularly apparent since Ceres issued a report[33] on the insurance/climate change issue in September 2005, just as Hurricane Katrina was approaching the Gulf Coast.

Climate change has the potential to affect virtually all segments of the insurance business—including those covering damages to property, crops, and livestock; pollution-related liabilities; business interruptions, supply-chain disruptions, or loss of utility service; equipment breakdown arising from extreme temperature events; data loss from power surges or outages; and a spectrum of life and health consequences.

Additional vulnerabilities include various dimensions of reputation, litigation, competitiveness, shareholder, and regulatory risks that can be expected to arise from disputes on pricing[34] or insurer inaction on the issues. Large emitters of greenhouse-gases already face new liability claims, which, in turn, will become an issue for their insurers. Similarly, insurers themselves could face litigation under the Sarbanes-Oxley Act for not adequately disclosing their own exposures to climate change[35], and insurance agents are becoming the subject of errors and omissions claims for allegedly mishandling claims.[36] Goldman Sachs has said that carbon emissions could create corporate liability comparable to asbestos.[37] Lastly, climate change also creates risks for the huge investment portfolios that insurance companies manage.

U.S. insurers have experienced growth in weather-related catastrophe losses from levels of about $1 billion per year in the 1970s to an average of $17 billion per year over the past decade—far outstripping growth in premiums, populations, and inflation during the same period (Figure 1). With $71 billion in losses, 2005 was the single worst year on record:

- Louisiana property insurer losses following Hurricane Katrina were $3 billion more than all premiums collected in the state for the preceding 22 years.[38]
- Lloyd's posted a profit of about $2.4 billion in 2004 and a loss of $180 million in 2005 which equates to $1.12 paid out for ever $1.00 in premium revenues, thanks largely to hurricane losses.[39]

Projections for the coming years are worse still. An in-depth insurance industry analysis linking climate models with insurance loss models shows a 44 percent expected annual increase in winter storm economic losses in Europe due to more frequent and intense storms under climate change (Figure 3).[40]

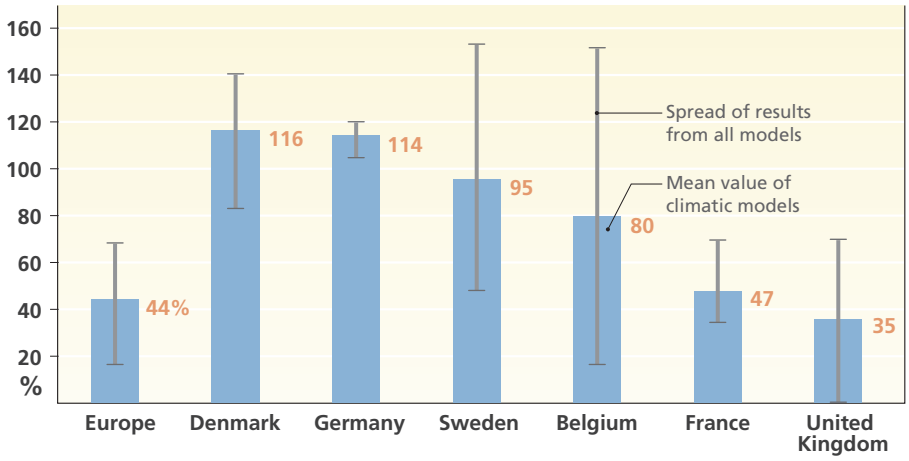


Figure 3. Expected increase in annual winter storm losses in Europe due to Climate Change: 1975–2085.

Excludes losses from associated floods as well as amplifying demographic changes.
Source: Swiss Re. 2006. "The Effects of Climate Change."

In the wake of last year's hurricanes, all major catastrophe modelers identified deficiencies in their models, and made corrections ranging from better accounting for construction material cost inflation during rebuilding to the contribution of warming seas to hurricane intensity.[41] One estimated that expected average annual losses from Atlantic hurricanes should be boosted from $7 billion to $10 billion, and that 10 to 60 percent of this increase is attributable to climate change, or up to $1.8 billion/year.[42]

A growing number of insurance companies are recognizing the enormity of the climate change challenge. Over the past year, the world's largest insurer (US-domiciled AIG)[43] and the largest broker (US-domiciled Marsh)[44] issued statements recognizing the threat of climate change, and its relevance to their business. Prior to this, U.S. insurers had been largely silent on the issue.

Outside the U.S., insurers have continued their long-term engagement on climate change, including the publication of Climate Change Futures, a major study on the health and economic impacts of climate change sponsored by Swiss Re.[45] Munich Re released an entire book on the subject,[46] the Insurance Australia Group has also examined the issue in great detail,[47] The Association of British Insurers assessed the financial risks of climate change,[48] Allianz looked at risks and opportunities,[49] and Lloyds of London issued a broad warning about the potential threats climate change poses to the industry's long-term solvency.[50] Concern is spreading to insurance institutions in the developing world, as exemplified by recent coverage of the issue by the Malaysian Insurance Institute.[51] A common thread running through each of the examinations is that climate change poses material business risks to insurers. As the insurance market becomes globalized, U.S. domiciled insurers are increasingly vulnerable to climate changes and lack of preparedness in other regions and countries. Companies like AIG and Chubb already do business in virtually every country. Chubb derives almost 20 percent of its premium income from non-US markets.

Following suit, 17 state insurance regulators who are part of the National Association of Insurance Commissioners are studying the problem, and several state insurance commissioners (e.g., Connecticut, Washington, New Jersey) have convened or are planning individual fact-finding meetings. Their concerns extend well beyond the question of headline-catching hurricanes. The commissioner from Oklahoma, for example, cites the escalating insurance consequences of drought, wildfire, wind, and hail in her state as a case in point.[52]

II. Erosion of Insurability

"This (insurance crisis) could bring our economy to a screeching halt."

Alex Sanchez, Chief Executive Officer, Florida Bankers Association

If available and affordable, insurance is grist for economic development and the financial cohesion of society, as well as security and peace of mind in a world where the knowledge of hazards lags their evolution. Unanticipated changes in the nature, scale, or location of hazards are among the most important threats to the insurance system, and thus to the health of the global economy.

Insurers have an obligation to their customers and shareholders to maintain solvency. In this context, they have reacted to a legacy of non-actuarial rates, rising losses, and a decreasing predictability of losses in a business-as-usual manner—i.e., by elevating prices and restricting the scope of coverage. This is a rational short-term business response, but one which has led to a crisis of insurance availability and affordability in the United States. The Insurance Information Institute issued a study in 2006 identifying climate change as a manageable concern for U.S. insurers, but does not delve into questions of availability and affordability.[53]

After seven costly hurricanes in two years, insurers are questioning how much risk they can take in vulnerable coastal areas. The shortage of available coverage is particularly acute in the reinsurance sector. In 2005, U.S. reinsurers incurred $1.29 in claims and operating expenses for every $1.00 in premium revenue.[54] In response, higher reinsurance prices—reported to have increased by up to 200 percent in some areas of the country[55]—have pushed up the cost of primary insurance coverage and contributed to decisions by primary insurers to cut back on coverage in risky areas.

As outlined in Box A later in this section, the most visible responses are price increases or the non-renewal of homeowners' policies. However, terms are also being tightened. For example, many insurers in hurricane-prone states are selling homeowners insurance policies with percentage deductibles for storm damage, instead of the traditional dollar deductibles used for claims such as fire and theft. Percentage deductibles vary from one percent of a home's insured value to nearly 15 percent, depending on many factors that differ by state and insurer.[56] These responses place a greater financial burden on the consumer, and have the potential to slow reconstruction after a major loss event.

Among the impacts of reduced insurability is a stronger reliance on governments as insurers of last resort. As insurers refuse to take on new policyholders, decide not to renew existing policies or raise rates, mandated state-run insurance "pools" are created in an attempt to fill the coverage void, and to redistribute the losses across a larger number of insurers (including those experiencing no direct losses from the event) (see Box B).

Historically, U.S. flood and crop/hail insurance risks were deemed largely uninsurable by the private market, which resulted in major government-sponsored insurance programs. Losses from another weather-related risk—mold and mildew—have also recently swelled to levels such that exclusions are approved in more than 30 states.[57] With an outlook predicting more intense weather catastrophes, one can only expect the availability and affordability problem to become more acute.

As insurers of last resort, governments have had a poor track record in attempting to operate actuarially sound insurance programs. With more claims in 2005 than in its entire 37-year history,[58] the U.S. flood insurance program was bankrupted 10-times-over by Hurricane Katrina, and the crop insurance program often pays out more in claims than it receives in revenues. These programs also typically offer limited coverage, with a maximum of only $250,000 for the flood program and no coverage for temporary living expenses or business interruptions. These concerns are serious enough that the Government Accountability Office is investigating these questions. Society cannot take for granted that government will assume the exposures that insurers jettison.

Government-run insurance pools are not a cure-all for price increases, as reinsurance prices are increasing for these pools too. The Mississippi Windstorm Underwriters Association's reinsurance costs increased by 488 percent in 2006.[59] Meanwhile, individual reinsurers are offering "thinner" layers of coverage to their primary insurer customers, e.g. in $5-million increments versus $25- to $50-million increments in the past.[60]

It might be assumed that the problem is limited to the household sector and stems simply from insurance regulation, i.e., that insurers are not allowed to charge actuarial prices to households, for political reasons, while they are far freer to do so for commercial customers. Yet, news reports state that even some unregulated "surplus lines" homeowner insurers are staying away,[61] even though they are free to charge any price.

A crisis of availability and affordability has also emerged for commercial customers. Allstate dropped 16,000 commercial customers in Florida in 2005,[62] and some commercial businesses in the Gulf are being forced to "go bare", i.e. are unable to find insurance at any price. Commercial insurers are seeing wind deductibles of 5 percent in some cases, which can correspond to $25 to $50 million per loss.[63] Florida State Chief Financial Officer Tom Gallagher declared that commercial insurance "is where the crisis is now."[64] Florida's insurer of last resort (Citizens) will only provide commercial coverage up to $1 million per customer.

The RSUI Group is the major player for general commercial insurance in Florida and Louisiana, and experienced a $133 million underwriting loss in 2005. Noting the shortfall of reinsurance coverage, it has stopped writing new wind insurance for properties between North Carolina to just south of Houston, Texas. Policyholders able to get $400 million or even $1 billion in commercial property limits prior to Hurricane Katrina may now encounter sub-limits for wind peril totaling perhaps $100 million.[65] Moreover, reinsurance pricing is essentially unregulated and yet it, too, has been beset with problems of availability and affordability.

The impacts on non-household customers are also exemplified by the recent imposition of relatively negligible $50 million aggregate windstorm claim limits for energy insurance (e.g., offshore oil platforms) where none existed previously, and this is coupled with up to 500 percent increases in premiums for facilities in the Gulf of Mexico.[66] This response is reflective of losses between 2004 and 2005 that were ten-times the premiums collected, and that reinsurers have pulled back the coverage offered to primary insurers. The mutual insurer (OIL) covering 100 oil producers, is expected to pay only about half of the claims incurred by its members and has lowered maximum payouts, increased deductibles, and tightened the terms (e.g. for business interruption) going forward. OIL has lowered its upper limit on aggregate payable claims from $1 billion to $0.5 billion.

Insurers are being pinched by higher reinsurance prices (or poorer terms), upward revisions in projections from catastrophe losses, and expectations from rating agencies to establish more capital in anticipation of rising future losses. One of the leading catastrophe modeling firms, RMS Consulting, has roughly estimated that the projected upward trend in losses corresponds to a potential gaping hole of up to $120 billion in the capital required by the U.S. insurance industry to be able to pay losses.

As a result, it is not surprising that the natural reaction of insurers has been to cut their exposure to the riskiest areas and to alter the pricing and terms of coverage. The effectiveness of this response in the long-term, however, is likely to be limited. The Tyndall Center for Climate Change Research has estimated that insurance premiums would have to increase many fold in order to keep up with rising losses.[67]

While some industry observers state that insurers can always adapt to rising losses, one must keep in mind that adaptation can be slow. In the case of Hurricane Katrina, the American Association of Managing General Agents stated that it could take as long as two years before insurers return to the market (assuming no further catastrophes in the region).[68] A related nuance is the often-cited aggregate capacity of insurers to pay losses, which currently exceeds $400 billion. This number however is misleading for two important reasons. First, segments of this surplus are limited to insurance categories loosely if at all related to climate change (e.g. medical malpractice). Second, individual insurers can only tap their own individual resources; the industry-wide resources are not pooled. According to the Wharton School, more than 80 percent of the top insurers have less than 0.5 billion in net worth and 200 have a net worth of less than $0.05 billion and are thus quite vulnerable to large disasters.[69]

Insurers may protect themselves by withdrawing from markets, tightening terms or increasing prices, but this can have a chilling effect on construction and real estate markets, as well as business investment broadly. In fact, unavailability of insurance is already impeding the reconstruction of New Orleans.[70]

Because insurance is key to a healthy economy, insurers face unusual levels of scrutiny and public pressure. As a result, continued efforts to restrict coverage could be slowed or thwarted by a backlash from consumers, investors, and regulators. This, along with other factors (e.g. the broad geographic and business scope of climate change impacts), means that insurers are not likely to be able to simply "wall off" the problem.

Box A: Withdrawal of Homeowners Insurance

Homeowners coverage in at-risk coastal areas along the Gulf Coast, Florida and parts of the East Coast has been hit especially hard, with bigger impacts still to come. Events of the past year show that insurers cannot take for granted that regulators will allow them to raise prices[71] or withdraw[72] from at-risk markets. Among the trouble spots:

In Florida, as of March 2006, 225,971 homeowners' property policies were cancelled and 224,868 non-renewals were issued, while 489,418 new policies were written within the past year (by both private insurers and Citizens, the state-operated insurance company).[73] Allstate plans not to renew 120,000 policies in Florida by the end of November 2006, instead offering new policies to another insurer.[74] This decision comes on the heels of Allstate's decision to cancel 95,000 policies in Florida in 2005.[75] State Farm (the state's largest property insurer) won't renew 39,000 windstorm policies in 2006 and plans to cancel all condominium building policies, which total 1,500 statewide. Additionally, State Farm is asking the Florida Insurance Commission to approve a 74-percent rate increase.[76] Owners of 1,500 square-foot homes are seeing their premiums double to $10,000 or more for windstorm insurance, facing a total home insurance cost of more than $13,000 on average.[77] For the same-sized home, some Florida customers face a deductible upwards of $18,000.[78]

Along the Gulf Coast, Allstate is aggressively cutting its exposure after Hurricane Katrina led the insurer to post a third-quarter loss of $1.55 billion in 2005, an amount its chief executive called "simply unacceptable."[79] Allstate, which expects to handle 300,000 Katrina and Rita claims, said it would seek to raise premiums, boost policy deductibles, and reduce the insured temporary living expenses available to dislocated policyholders in areas prone to disasters.[80] In 2006, Louisiana Farm Bureau Mutual Insurance announced it would drop wind and hail storm coverage from more than 7,000 customers in South Louisiana.[81] In Mississippi, Allstate and State Farm, two of the state's largest insurance firms, have not yet requested a rate increase, but they have restricted the areas they cover.[82] Allstate plans to drop 140,000 customers in 18 coastal parishes across Louisiana, although this has been challenged by lawmakers.[83]

In New York, Allstate, the largest provider of homeowners insurance in the state, is no longer offering new policies on Long Island, New York City, or Westchester County in order to "better manage its exposure" to anticipated coastal storms.[84] As of June 2006, Allstate, with a 25-percent market share in metropolitan New York, also decided it won't renew approximately 30,000 policies because of hurricane risk, even though nearly 70 years have passed since a hurricane last struck the U.S. areas.[85] In 2005 Allstate cancelled 28,000 policies in New York.[86]

In Massachusetts, Hingham Mutual Group, one of the leading homeowners insurers' on Cape Cod and surrounding islands, does not plan to renew about 6,500 homeowners' policies in 2006. The company decided to retreat from the Cape and other coastal areas after brokers reported that reinsurance costs would be rising 20 to 30 percent in 2006. The Andover Cos., the state's largest home insurer, decided in May 2004 that it would not renew all 14,000 of its policies on Cape Cod and the islands. NGM will be dropping 2,300 homeowners on Cape Cod.[87]

In Rhode Island, some insurance companies plan to discontinue homeowner coverage in coastal neighborhoods altogether.[88] Others are cutting back on the number of coastal houses they will cover or refusing to offer new policies to houses within a few miles of the ocean.[89] The Rhode Island superintendent of insurance regulation has been allowing companies to cancel policies in some neighborhoods so the companies don't feel compelled to leave the state altogether.[90]

In South Carolina, local insurance agents have banded together to form a new organization because they are worried about the dwindling number of companies writing homeowners policies along the coast.[91] Lexington Insurance is only writing policies for homes valued at more than $500,000 and is not renewing many policies.[92] The Insurance Group in Myrtle Beach has turned away many homeowners who have homes valued at $250,000 or less.[93] As already noted, the insurance giant Allstate has stopped writing policies for new businesses up and down the East Coast, including South Carolina.[94]

Box B: Growing Financial Exposure for State Insurance Pools

As more private insurers scale back coverage in high-risk areas, special insurance plans known as residual, shared or involuntary markets are coming under increasing pressure to act as insurers of last resort. These markets, currently operating in 32 states, are set up by state regulators working with the insurance industry. FAIR (Fair Access to Insurance Requirement) Plans, the largest of the property insurance pools, have grown both in the number and value of insurance policies written. Yet, these pools are not immune to the very problems they are designed to address.

Residual markets are rarely self-sufficient. Where the rates charged to high-risk policyholders are too low to support the program's operation, insurers are generally assessed according to their share of the voluntary property market to make up the difference. These additional costs are typically passed on to policyholders in the plan in the form of higher rates, and in some states to policyholders in the conventional insurance markets as well. It is worrisome that some plans have had to turn to outside sources, e.g. a $1.5-billion bond measure in Florida.[95]

These insurance pools are under especially strong pressure in Florida, the Gulf Coast and the Northeast. In the past two years, state-operated insurance pools in Florida, Louisiana and Mississippi have added more than one million new homeowners' policies, creating additional financial exposure as deficits have already ballooned to billions of dollars. Florida's insurance pool, for example, already has a combined $2.2 billion budget deficit over the past two years and in 2006 it needed a $715 million bailout from the Florida legislature.[96, 97] In Mississippi, the insurance pool is using $100 million of federal block grant money to pay off its losses.[98]

Florida, which has been hit with seven major hurricanes in the past two years, faces the biggest insurance pool crisis. American Superior Insurance Company, with 60,000 policyholders, was the first to become insolvent.[99] Poe Financial Group, Florida's fourth largest personal insurer, collapsed in April 2006, leaving 316,000 policyholders in need of coverage.[100] Many of customers left stranded by Poe Financial will likely be absorbed by Florida Citizens Property Insurance Corp., the State's insurance plan of last resort. The Citizens Plan already has 881,808 policyholders, and is adding about 40,000 new customers each month.[101] Citizens expects to have added 470,000 policyholders by the end of summer 2006.[102] If this prediction is correct, Citizens will end up with 1.5 million policies, up 850,000 from April.[103] According to Mike Dooley, President of the Florida Association of Realtors, "Citizens is no longer the insurer of last resort. Citizens is becoming the insurer of only resort."[104] Even after the state legislature bailed out Citizens with $715 million from a state surplus, homeowners are picking up the rest of the tab through assessments to their policies, which are in some cases are twice as expensive as last year.[105] In late 2005, the head of Citizens warned of triple-digit premium increases in coastal locations.[106]

In Mississippi, the state's Windstorm Underwriters Association, which insures people who live in coastal counties, reports that its reinsurance costs went up 488 percent in 2006.[107] The increase came after the state's Wind Pool suffered a $745 million loss from Katrina, four times more than its $175 million in assets.[108] All insurers writing policies in Mississippi are assessed losses from the Wind Pool, and thus insurance companies paid $545 million to the Mississippi Windstorm Underwriters Association for losses from Katrina.[109] Even after the fund used $100 million of federal block grant money to pay for losses, homeowners are still going to face a 100 percent increase in their premiums.[110] Since Hurricane Katrina, the number of Wind Pool policyholders jumped from 1,000 to more than 17,000.[111]

In Louisiana, approximately $250 million will have to be paid by policyholders to pay off losses the State's Citizens Plan due to Hurricanes Katrina and Rita.[112] As customers are forced to the residual market, they must pay 10 percent more, and, in turn, insurers remaining in the market must increase their contributions to the pool to pay claims. Louisiana's pool is expected to swell to 200,000 insureds in 2006.[113]

III. Advancing Climate Insurance Solutions

As the world's largest industry*– with $3.4 trillion in yearly premium revenue, plus another trillion in investment income—with core competencies in risk management and finance, the insurance industry is uniquely positioned to further society's understanding of climate change and advance creative solutions to minimize its impacts. Just as the industry has historically asserted its leadership to minimize risks from building fires and earthquakes, insurers have a huge opportunity today to develop creative loss-prevention solutions and products that will reduce climate-change-related losses for consumers, government and insurers.[114]

We have identified a wide spectrum of insurance opportunities, with 190 real-world examples from 104 insurers, brokers, and insurance organizations from 16 countries. More than half of the examples come from U.S. companies. These activities support a wide range of strategies that would help reduce climate-related risks, including energy efficiency programs, green building design, sustainable driving practices, and carbon emissions trading.

Many of these activities have the potential to materially reduce GHG emissions in some of the most energy intensive parts of the economy. For instance, motor vehicles create about 25 percent of all U.S. greenhouse gas emissions, and insurance policies like pay-as-you-drive and incentives for hybrid vehicles could reduce that amount by 10 percent or more if broadly implemented. Buildings account for 38 percent of U.S. GHG emissions, according to the EPA. Green building practices can reduce energy use, thereby emissions, by up to 50 percent in many cases, and well beyond that when coupled with increasingly popular green power purchases.

As expert messengers on risk, insurers can also play an important role in alerting policymakers to the need to proactively deal with climate change at the national and global level.

Insurers seizing these opportunities will improve their market position. To be sure, rising losses will create more demand for conventional forms of insurance, as well as new products such as weather derivatives and catastrophe bonds. This will be welcomed only if the changing risks can be understood and managed. There will also be demand for new forms of insurance, as well as for conventional insurance for new assets (e.g., renewable energy technology installations[115]). Innovative products like micro-insurance and new public-private partnerships will allow markets to grow to serve the billions of people in the developing world today lacking insurance.[116, 117]

Described below are creative services and products that are already available, along with selected examples. We organize the information under the headings shown in Figure 4, along with selected examples (the full list is found Appendix A.) These activities represent an encouraging start, but only the tip of the iceberg when compared with what the industry could be doing and what is needed.

* The world oil market, for example, is US $1.9 trillion/year at current production levels of 76Mbpd and a unit price of $70/bbl price; world electricity market in 2001 was US $1 trillion at 14.8 trillion kWh generation assuming a unit price of US $0.07/kWh; tourism receipts US $434 billion; agriculture US $1.2 trillion (2002); telecommunications US $1.2 trillion (2002); world military expenditures US $770 billion. Source: 2004-2005 Statistical Abstract of the United States.

Type of Activity	Insurance Industry Participant	Description
Promoting Loss Prevention		
Traditional risk management	Institute for Business and Home Safety	*Promoting best practices for hazard resistance in buildings through its "fortified... for safer living" program*
Integrating energy management and risk management	FM Global	*Replaced fire-hazardous halogen light fixtures in student dorms at Northeastern University with ENERGY STAR fluorescent fixtures, achieving 75% lighting energy savings while eliminating the fire hazard.*
Better management of forestry, agriculture, and wetlands	Tokio Marine	*Mangrove protection*
"Rebuilding Right" following losses	Fireman's Fund	*Forthcoming products to pay for post-loss reconstruction upgrades to "green" building standards and commissioning to ensure energy savings*
Crafting Innovative Insurance Products and Services		
New products for energy service providers	Lockton Risk Services	*Group property and liability insurance for RESNET-member building energy auditors*
Energy savings insurance	Lloyds of London	*Insurance for predicted energy savings or renewable energy technology performance*
Renewable energy project insurance	Munich Re	*Geothermal exploration risk insurance*
Green-buildings insurance	Fireman's Fund	*Forthcoming products to provide premium credits for green building features*
Pay-as-You-Drive insurance	GMAC	*Mileage-based insurance discounts for customers using OnStar global positioning systems*
Climate risk management services	AIG/Solomon Associates	*Range of services for identifying carbon-reduction opportunities and risks*
Participating in Carbon Markets		
Enabling customers to purchase carbon offsets	Insurance Australia Group	*Web-based calculator with option to purchase offsets to compensate for passenger car emissions.*
Facilitating carbon trading	Aon	*Assessment of risks associated with participating in carbon trading markets*
Managing risk for Clean-Development Mechanism (CDM) projects	Swiss Re	*Kyoto-CDM Risk Insurance*
Aligning Terms and Conditions with Risk-Reducing Behavior and Capitalizing on the "Halo Effect"		
Assigning Directors & Officers Liability	Swiss Re	*Indications that the company may exclude climate change impacts from policies*
The "Halo Effect"	Travelers	*10% insurance premium credit to drivers of the Toyota Prius hybrid passenger car.*
R&D and Direct investment in Climate Change Solutions		
Research & Development	Allstate	*Roofing Industry Committee on Wind Issues, working to analyze the mechanisms of roof failures during windstorms.*
Equity investments	Swiss Re	*Investment in new solar photovoltaic technology*
Building Awareness and Participating in the Formulation of Public Policy		
Consumer information and education	USAA Imsurance Company	*Published a detailed guide to energy efficinecy for homeowners, including do-it-yourself audit tool and cost-benefit worksheets.*
Voice in public policy	UNEP Finance Initiative	*Insurers from around the world participating in climate change policy deliberations*
Voluntary programs	American Insurance Association	*Advocacy for reduced speed limits, public transportation, and telecommuting as means for reducing driving-related insurance claims and greenhouse gas emissions by saving energy*
Energy-efficiency codes and standards	Insurance Institute for Highway Safety	*First insurance organization to support the stalled Corporate Average Fuel Economy (CAFE) standards, citing new technologies to improve fuel economy without compromising safety through reduced vehicle weight*
Leading by Example		
In-house energy management	AIG/Hartford Steam Boiler	*The headquarters of Hartford Steam Boiler (now a subsidiary of AIG) was among the first buildings to receive the ENERGY STAR label for superior energy efficiency.*
Reducing insurers' Carbon-footprint Through Improved operations	American Modern Insurance Group	*Utilized solar-powered trailers to expedite claims handling in post-disaster situations where the electrical grid is not functional*
Disclosing Climate Vulnerabilities and Liabilities	Saint Paul Travelers	*Provided submissions on climate change vulnerability and opportunities to the Carbon Disclosure Project*

Figure 4. Types of opportunities for insurers and selected examples.

Promoting Loss Prevention

> *"… energy efficiency improvements also reduce fire, explosion, or winter storm hazards. Insurers can support improvements in energy efficiency as long as they do not create new, unanticipated risks to human safety and property, particularly when energy efficiency strategies measurably improve safety and loss control.*
>
> **American Insurance Association**[118]

Managing risks and controlling losses is central to the insurance business, and is evident in the industry's history. While the primary focus in recent years has been on financially managing risks (through exclusions, price increases, derivatives, etc.), physical risk management is receiving renewed attention from insurers, and could play a large role in helping to preserve the insurability of coastal and other high-risk areas. Improved building codes and land-use management are important starting points. Beyond that, innovations include a whole genre of energy-efficient and renewable energy technologies that also make infrastructure less vulnerable to insured losses. Improved management of forests, agriculture and wetlands also offers dual benefits, i.e. withdrawal of carbon from the atmosphere and storage in biomass and soils coupled with increased resilience to drought, coastal erosion, and other products of weather extremes.

Traditional Risk Management

As exemplified by the work of the insurer-funded Institute for Business and Home Safety in the U.S. and the Institute for Catastrophic Loss Reduction in Canada,[119] there are many strategies for improving the disaster resilience of homes and businesses. The engineering-oriented FM Global has stated that the nearly 500 locations damaged by Hurricane Katrina that had implemented all of their recommended hurricane-loss-prevention methods experienced only one-eighth the losses of those who had not done so.[120] These benefits came at a bargain, with $500 million in losses avoided via customer investments of only $2.5 million.[121] FM Global was one of the most profitable U.S. insurers during the year of Hurricane Katrina.

Other studies have corroborated that mitigation is highly cost-effective.[122]

Improved building codes are one of the key strategies for reducing losses, and their benefits have been well documented. To be effective, building codes must be enforced, and the Insurance Services Office Building Code Effectiveness Grading Scale has been used to reward effective codes via insurance discounts.

The risks and opportunities extend well beyond the buildings sector to include crops, roadway safety, marine settings, and life/health risks. The insurance industry could put considerably more resources into these endeavors—IBHS' budget is a mere 0.003 percent of associated national property/casualty insurance premiums.

Integrating climate change considerations into land-use planning is another natural role for insurers, although the public sector clearly has lead responsibility. A post-Katrina analysis by planning expert Raymond Burby revealed that per-capita economic losses were three-times lower in areas where building codes and comprehensive land-use planning were in use.[123] Allianz reviewed examples from many countries.[124] In 2004, the Insurance Australia Group (IAG) developed a partnership with local government planners in New Zealand to determine the most appropriate flood planning levels for the future. IAG provided modeling results indicating changes in extreme rainfall, which the local government then used to determine the likely changes to future flood levels. This was then incorporated into their flood mitigation program, e.g., planning for higher levee banks. IAG also conducts wind and hail-related research intended to help improve roof designs and construction, observing that insurers are not adequately included in the broader public policy discussion about hazard management.[125] In the UK, the Association of British Insurers has also advised local planning authorities on better integrating rising flood risks in East London.[126] In the U.S., AIG is serving on the steering committee of the Heinz Center's "The Nation's Coasts: A Vision for the Future", which seeks to create a more viable approach to sustainability for coastal communities and surrounding regions.

Integrating Energy Management & Risk Management

In the context of climate change, win-win approaches to risk-management include a whole class of strategies that capture the insurance loss-prevention benefits of certain energy efficiency and renewable energy strategies.[127] The U.S. Department of Energy chronicled nearly 80 technologies and practices (see Figure 5 for a selection) that can lower greenhouse gas emissions while reducing the direct risk of property damage from mechanical equipment breakdown, professional liability, builders' risk, business interruption, and occupational health and safety.[128] A clear example pertaining to fire safety—a familiar concern for insurers—is the elimination of fire hazards with energy-efficient lighting solutions that give off less heat. A subset of these measures can directly enhance disaster resilience (Appendix B),[129] e.g., the ability of facility-integrated solar power systems to avert business interruptions following outages on the electricity grid or the resistance of foam insulation (as opposed to less-efficient fiber-based products) to water-logging after floods.[130]

Strategy	Relevant insurance line(s)
Cementitious Structurally Insulated Panels (CSIPs). The Federation of American Scientists has been evaluating one such technology. These concrete-clad, highly insulating walls have withstood earthquake simulation tests of 9 on the Richter scale (up to 2 stories), are wind-, fire-, and mold-resistant, and suffer much less damage in flooding conditions than typical "stick-built" walls.	***Property; Business interruption; Mold liability; Health/Life***
Efficient refrigeration. Loss of power can cause significant insured business interruptions and damage to property. High-efficiency food and pharmaceutical storage systems will maintain critical temperatures longer in the absence of power, and run longer on backup generators.	***Refrigeration interruption***
Data Centers powered with direct current. A recent demonstration project with Sun Microsystems, Intel, HP, and other companies documented about 20% energy savings by eliminating AC-DC power conversions in data centers. The insurance-relevant side benefit is increased reliability. In another example, a fuel-cell vendor (Sure Power) has bundled a high-reliability (and energy-efficient) fuel cell with business interruption insurance underwritten by American International Group.	***Business interruption***
Energy-efficient windows. During a fire, heat-stressed windows can shatter as a result of differential expansion near the frames, and the increased supply of air flowing through a broken window accelerates the spread of fire and toxic fumes. Efficient windows reduce the likelihood that fire will cause breakage. Efficient multiple-pane windows or windows with retrofit films can reduce energy losses by half or more and are also more resistant to breakage by thieves or windstorms. They also block damaging UV radiation, and enhance occupant comfort. Tests conducted by Lund University's Institute of Fire Technology for the Swedish company Pilkington Glass AB identified superior performance of windows with low-emissivity (energy-efficient) coatings. Double-glazed units with one low-e coating took three- to four-times longer to break than did ordinary double-glazed units. In addition, units performed as well or better than double units with one laminated glass layer.	***Property***
LED traffic lights. New light-emitting-diode (LED) traffic lighting technology achieves dramatic energy savings (over 90%), while improving visibility in bad weather. The lights also offer dramatically longer service life, thereby reducing the frequency and replacement cost of lamp outages. Their low power requirements make it feasible to install solar or battery backup power supplies, to ensure that intersections are lit even during power outages.	***Personal and commercial auto***
Duct sealing. Eliminating heating system duct leaks can help avoid dangerous pressure imbalances in a building, which can lead to fires or health and life risks from carbon monoxide back-drafting of combustion appliances. Suction-like home depressurization can also accelerate the entry of cancer-causing radon gas from surrounding soils. The hot air released by leaky ducts located in attics also precipitates ice dam formation.	***Property; Liability; Health***
Urban heat island mitigation. Lowering urban air temperatures by increasing the solar reflectance of roofs and roads and planting urban trees has been shown to reduce air-conditioning costs by up to 50%. Light-colored materials for walls and roofs can be designed to offer the added benefit of increased fire resistance and durability. Reducing urban air-shed temperatures also slows the formation of smog, which in turn reduces health insurance claims. Lighter roof coloration has reduces the likelihood of heat deaths during urban heat waves. Similarly, lighter roads reduce ambient temperatures, and contribute to improved roadway visibility and pavement durability.	***Property; Personal and commercial auto***
Fuel-switching from electric to gas cooking. Gas cooking is approximately twice as energy efficient than electric cooking. Cooking is the number-one cause of house fires in Canada. In the Alberta Fire Commissioners analysis of cooking-related fires in Canada, cooking oil was found to be responsible for 65-75% of kitchen fires, depending on house type. These fires were four times more common in homes with electric stoves (238 per 100,000 houses) than for gas stoves (58 per 100,000 houses). The same ratio has been observed in the UK.	***Property***
High-Performance Laboratory Fume hoods. A typical fume hood uses as much energy as four homes, and excessive air flows can present a threat to worker safety. A new generation of hoods with optimized ventilation, achieve up to 75% energy savings, while maintaining or enhancing worker safety.	***Health; workers comp***

Figure 5. Energy-efficiency measures with insurance loss-prevention benefits.

With rising concerns about occupational health and safety, as well as business interruptions, risk managers will find particular opportunities in industrial and high-technology settings. Recent work in data laboratories[131] and data centers[132] has identified strategies that enhance safety and reliability

while reducing energy use and greenhouse-gas emissions.[133] Downtime in these facilities can yield large business-interruption insurance claims.

Better Management of Forestry, Agriculture, and Wetlands

While most greenhouse-gas emissions arise from the energy sector, substantial reductions can also be achieved in forestry, agriculture, and wetlands. Better forest management can reduce emissions by minimizing wildfires (a major source of carbon dioxide and associated public health problems), and lower the risk of flooding and mudslides that typically follow deforestation. Sustainable agricultural practices tend to help sequester carbon in the soil, while increasing drought resistance. Wetlands and mangrove protection also offers win-win benefits. Hurricane Katrina would have been less damaging had it not been preceded by decades of wetlands destruction. Well aware of cyclone-related risks, the Japanese Insurer Tokio Marine & Nichido Life has been active in mangrove protection. It has reforested 7,500 acres of mangroves in Indonesia, Thailand, Philippines, Myanmar, and Vietnam, and is working towards an additional 5,000 acres.[134]

"Rebuilding Right" Following Losses

Insurers can promote risk-prevention strategies in the context of rebuilding after losses.[135] "Rebuilding Right" in the aftermath of Hurricane Katrina is an immediate opportunity, which could involve everything from wetlands restoration to energy-efficient and disaster-resistant housing to renewably based distributed energy supplies that are less vulnerable to disruption from future extreme weather events. Fireman's Fund will soon be offering insurance terms that encourage rebuilding to meet current "green construction" standards. Cementitious Structurally Insulated Panels (CSIPs) are a promising technology being championed by the Federation of American Scientists, as part of the post-Katrina rebuilding effort.[136] With their wind-resistant cladding and "styrofoam" cores (see description in Figure 5), this technology combines high energy efficiency and disaster resilience, while reducing the amount of wood required for construction.

Crafting Innovative Insurance Products and Services

> *Climate changes could change the profile of risks that we are paid to assume, including weather-related property damage and other natural disaster-related property and casualty losses. … Potential opportunities for us could be the development of new risk management products for clients concerned about climate-related risks to their businesses.*
>
> **St. Paul Travelers Insurance Company (2005)**[137]

In order to avoid the worst physical impacts of climate change, the world will need to dramatically upgrade the way it produces and consumes energy. Insurers have an enormous opportunity to develop new profit centers by providing innovative insurance products for energy users or providers of clean energy services. They can also tap their core competencies to offer new services to assess and mitigate climate risks. Such activities would naturally develop into new business lines in energy auditing, retrofit evaluation, installation and management, as well as a host of quality-assurance services (e.g. commissioning, as described in Figure 5) that manage the performance risks of energy saving projects.

New Insurance Products for Energy Service Providers

Various specialist groups that provide energy-efficiency services often lack access to appropriate insurance coverage. In one example of filling this void, Lockton Risk Services[138] in Kansas City, MO has developed a package of professional liability, general liability, and property coverage for professional home energy auditors.[139] Eligible providers must be members of RESNET, the leading national professional organization of building energy performance certifiers. Commissioning providers are another group for whom a "program insurance" package could be crafted.

Energy-Savings Insurance

Energy savings insurance is an innovative product in which policies protect the installer or owner of an energy efficiency project from under-achievement of predicted energy savings. A prior study identified 12 past and present providers, and a potential $1 billion market in the U.S. alone.[140] There are some market drivers for ESI. For example, some state statutes (e.g. D.C. Code § 2-303.22 (a)(3)) require a contractor to obtain a performance and payment bond relating to the installation of energy efficiency measures in an amount equal to the predicted savings.[141] The Canadian government requires ESI or performance bonds to guaranty the energy savings on all energy saving projects conducted in government facilities.[142]

Renewable Energy Project Insurance

The global market for renewable energy is projected to grow from $40 billion in 2005 to over $150 billion in 2015.[143]

A recent survey found that many insurers interviewed offered at least one of eight forms of insurance for renewable energy projects, but many barriers were also noted (Figures 6a-b). For example, Munich Re offers exploration-risk insurance for geothermal energy companies.[144] Growth in availability of such insurance is contingent on improved technical expertise within the insurance industry, processes for commissioning installations (to catch and correct problems at project startup), improved actuarial and performance data, and bundling of small scale projects and packaging of risks to achieve economies of scale, risk diversification and underwriting profit.

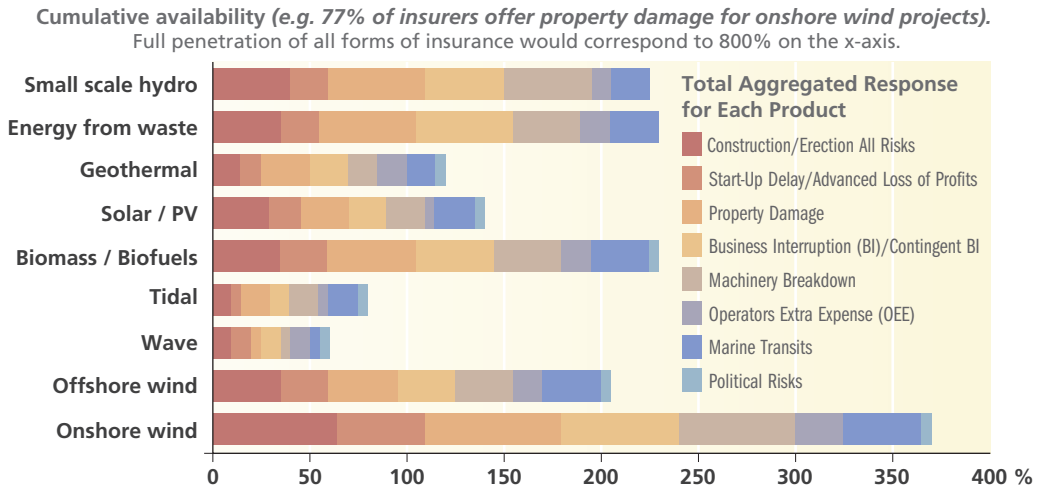


Figure 6. Availability of insurance products for different renewable energy technologies

Source: Marsh. 2006. "Survey of Insurance Availability for Renewable Energy Projects." March, 15pp.

New products can be envisioned to manage performance risk for renewable energy systems. One example is wind power derivatives, in which payments are made to the producer if revenues fall below a pre-determined level, and, conversely, payments made to the derivative provider if performance exceeds expectations.[145] By increasing certainty around revenue, such products can make it easier for renewable energy projects to attract investment and financing. Renewable energy projects are, of course, also susceptible to conventional risks, e.g. equipment breakdown, business interruptions, or losses from natural hazards. In some cases with relatively high risks (e.g., offshore wind) insurance availability will be very limited, and in other cases the emerging nature of the technologies will correspond to higher perceived risk.[146]

Green-Buildings Insurance

With the rise in popularity of "green building" practices (residential green building alone is expected to be a $19 billion to $38 billion market by 2010), insurers have begun to consider new products for this arena. Many risk-management benefits have been associated with green buildings,[147] (ranging from improved indoor air quality to enhanced disaster resilience) and there are numerous ways in which insurers could capture these benefits.[148] An oft-cited case study of the loss-prevention benefits of green buildings (in this case reduced risk of business interruption) is the Harmony Resort on the island of St. John, which weathered Hurricanes Marilyn, Bertha, Georges, and Lenny with no loss of (solar) power or (solar) hot water, while operations on other facilities on the islands were disrupted for weeks or months.[149]

Fireman's Fund plans to introduce several new "green" products in 2006. The package includes a provision to replace conventional property damaged or destroyed in a covered loss with improved green and/or energy-efficient property, as well as funding a specialized quality-assurance process (known as "commissioning") to ensure that repairs following a loss do not inadvertently erode energy efficiency, and coverage specifically designed for certified green buildings. Fireman's Fund will also introduce a rate credit for certified green buildings. The rationale is that buildings with these features are less susceptible to future losses.

One of the Lloyds of London syndicates launched a "Naturesave" commercial property policy, emphasizing the compatibility of sustainable development and risk management, with 10 percent of premiums being donated to environmental projects and environmental performance surveys offered to policyholders.[150]

Addressing the challenging issue of mold and moisture is also related to the green buildings arena. Insurers have traditionally refused to insure mold risks, but some are recognizing that this risk is insurable if appropriate risk-management measures are taken (many of which also enhance energy efficiency).[151] By making a previously uninsurable risk insurable, insurers open a large new market for themselves while also benefiting consumers.

Pay-As-You-Drive Insurance

Proposals have circulated for over a decade[152] to link automobile insurance to the price of gasoline or miles driven, with the intent of encouraging reduced driving in order to achieve safety and environmental benefits. While some conventional auto policies take account of approximate mileage driven, they use very crude methods. It has been estimated that pay-as-you-drive (PAYD) insurance could reduce miles driven by 10 to 15 percent, and lower accident rates.[153] This has significant implications for climate change, as automobiles account for a quarter of U.S. GHG emissions. Progressive Insurance (U.S.)[154] and Norwich Union (UK) have conducted pilot tests with 5,000 policyholders in Minnesota, who received up to 25 percent premium discounts depending on their driving habits.[155, 156] Market tests are also underway in Massachusetts, Oregon, Pennsylvania, Texas and Washington. In 2003, the Oregon legislature enacted a $100/policy tax credit to insurers who offer PAYD insurance. The U.S. Environmental Protection Agency is promoting the concept at the national level.

In 2004, General Motors' GMAC insurance began offering mileage-based insurance discounts of up to 40%, utilizing its OnStar technology to keep track of driving patterns (Figure 7). Japan's Aioi Insurance, Israel's Aryeh, and the Netherlands' Polis Direct also introduced PAYD products in 2004. Pay-per-K insurance company offers the product in South Africa. In Germany, premiums have been reduced by up to 50 percent for smaller cars driven shorter distances;[157] Rheinland Versicherungen offers premiums that are proportional to miles driven.[158] Gerling offers similar incentives.[159]

An important side benefit of these products is that they use technology to verify distance driven and thereby reduce intentional or unintentional misreporting by insureds, which is believed to be common in the self-reporting systems more widely used today.

The American Insurance Association has opposed "Pay-at-the-Pump" insurance, which differs from the above-mentioned strategies in that it collects premiums via the gasoline price rather than as a function of distance driven, and thereby does not allow for other risk factors (driver age, gender, location, etc) to be properly reflected in the price.[160]

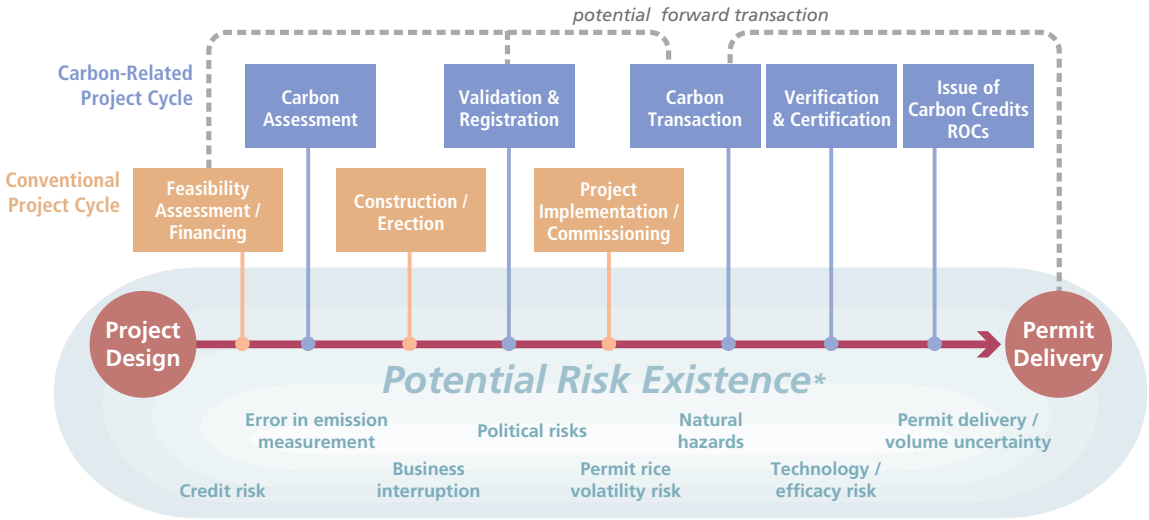
Miles/year	Discount offered
1 – 2,500 miles	**40%**
2,501 – 5,000	**33%**
5,001 – 7,500	**28%**
7,501 – 10,000	**20%**
10,001 – 12,500	**11%**
12,501 – 15,000	**5%**
15,001 – 99,999	**0%**

Figure 7. General Motors Acceptance Corporation (GMAC) auto insurance discounts. Motorist who drive less than specified annual mileage receive insurance premium discounts of up to 40%, as indicated above. Offered in most states (contingent on regulator approval).

Source: http://www.vtpi.org/tdm/tdm79.htm

Climate Risk Management Services

A variety of business and performance risks are associated with projects designed to achieve reductions in carbon emissions (Figure 8). In a recent study, the world's largest broker (Marsh) drew upon its core competencies in insurance and risk management to develop a roadmap of sorts to help businesses assess their climate vulnerabilities and opportunities. This document, *Risk Alert—Climate Change: Business Risks and Solutions*, exemplifies the natural "fit" between the insurance industry and climate change solutions. This is particularly relevant for brokers like Marsh, which function as risk advisors to their corporate clients. The impact of such advice can be considerable. Marsh's client base, for instance, includes 75 percent of the Fortune 500 companies. As corporations move to reduce their emissions, brokers and insurers stand to benefit.



** Many of these risks may exist individually or in combination throughout the project cycle.*

Figure 8. Carbon-reduction project lifecycle risks.

Source: Marsh. 2004. "Responding to Climate Change Risks and Opportunities." Topics Letter Number XVI.

Solomon Associates, an AIG company, offers an integrated set of engineering, benchmarking, project development, and risk-management services for developing and executing energy- and emissions-reduction projects (Figure 9).[161] While not yet attempted, the creation of "super audits," combining risk- and energy-management inspections and using tools such as infrared thermography,

pressure testing and indoor-air-quality measurements, could prove to be a powerful and cost-effective way of bundling services that simultaneously improve energy efficiency and disaster resilience.

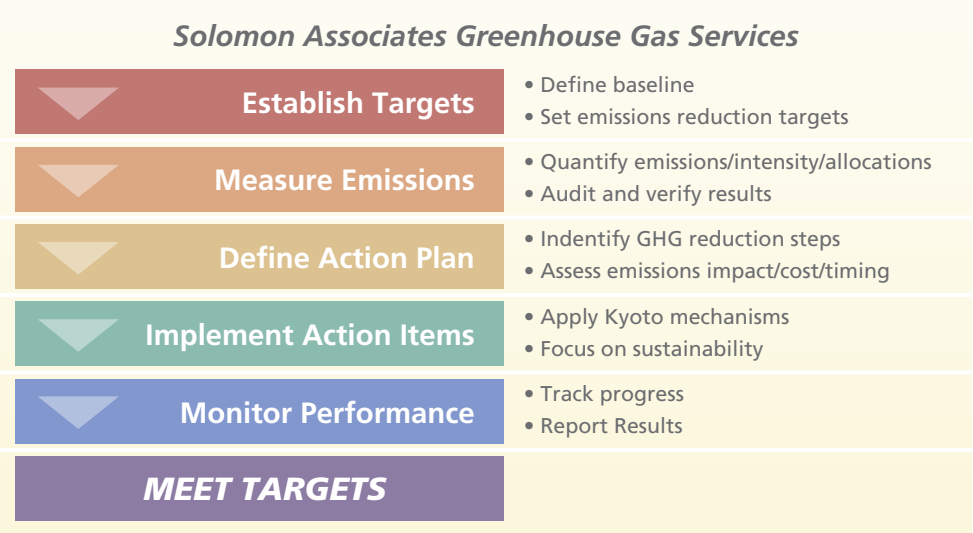


Figure 9. Carbon-reduction project performance-assurance services offered to companies deveoping carbon-offset project by Solomon Associates
(Subsidiary of AIG's Hartford Steam Boiler Inspection and Insurance Company).
Source: http://www.solomononline.com/

Insurers and U.S. catastrophe modeling firms, such as RMS and AIR, are finding new business opportunities in helping their customers understand risks of extreme weather and climate change. In recognition of increasing insight from the scientific community, the insurance industry's catastrophe models are being realigned with profound results. Insurers also conduct or commission research on climate change. Arkwright Mutual (now part of US-based FM Global) examined climate change and trends in flooding.[162] Insurance Australia Group is working with the University of Oklahoma on high-resolution climate modeling. Swiss Re[163] and the Association of British Insurers[164] have also coupled climate models with insurance loss models.

Participating in Carbon Markets

> *Providing structured insurance and financial products for [carbon trading] risk is significant because it validates the market-based approach to reducing greenhouse gas emissions and in tackling climate change.*
>
> **Swiss Re**[165]

Most of the regulatory frameworks (such as the Kyoto Protocol) that have been proposed for managing greenhouse gas emissions on a global, national, or regional level rely on a "cap-and-trade" system that allows emissions to be reduced in the most cost-effective manner. Insurers have the potential to spur the burgeoning market for carbon trading by providing mechanisms for participants to better manage risk while securing additional business for themselves. Combined expertise in risk analysis and finance makes insurers natural participants in the emerging markets for carbon offsets and trading. Insurers can also be involved in providing property and liability insurance for carbon-reduction capital projects, as well as consultative services in designing and managing such projects so as to maximize their technical and financial upside. A growing number of insurers are moving into this business area, and the opportunity could be large, with the carbon market in the EU alone projected to reach $30 billion by the end of 2006.[166]

Facilitating Carbon Trading

Many risks are associated with carbon trading (Figure 10), and new insurance products and services are being developed to manage them. Under the European Union Emissions Trading System, over 6,000 companies face mandatory emissions-reduction targets and stringent penalties for non-compliance. Signatories of the Kyoto Protocol (all industrial countries with the exception of Australia and the U.S.) also have obligatory emission reduction targets. Even companies in the U.S. are voluntarily reducing their emissions to—and even beyond—Kyoto levels, responding to local initiatives (e.g. a voluntary commitment championed by 200-plus mayors) or otherwise seeking to get a head start in working towards increasingly likely mandatory targets.

The market for carbon credits under the Kyoto Protocol's CDM and JI mechanisms provides additional opportunities and risks for companies that attempt to develop carbon credits under these programs. As emissions-trading markets grow and mature, a number of risks related to the EU ETS and the CDM/JI projects can be expected to arise, including:
✦ carbon-regulatory risks, such as those associated with host-country and international policies governing emissions-reduction projects such as project approval, validation, and verification;
✦ host-country investment and political risks that could alter climate change policies and obligations, such as host-country instability, expropriation of credits, contract frustration, credit confiscation, and more;
✦ technology-performance risks associated with operational aspects of the project activity;
✦ carbon-financing risks, including an inability to secure financing based on projected carbon-revenue streams;
✦ carbon-performance risk associated with variability in the generation, permanence, and ownership of emissions reductions;
✦ counterparty credit risks, including the failure to deliver credits as contracted;
✦ volumetric-related weather risks that adversely affect earnings;
✦ noncompliance risks, such as fines and other sanctions resulting from missed targets;
✦ price and liquidity risks, such as volatility in energy and carbon prices;
✦ legal liabilities, such as those stemming from legal action by shareholders, investors, or third parties;
✦ resource supply risks, such as possible fluctuations in fuel and resource supplies; and
✦ appropriateness of existing insurance policies—such as property and business interruption—and their ability to deal with the inclusion of CO_2 allowances and related improvements in profits and contingent losses and liabilities.

Figure 10. Carbon-trading risks.

(reprinted from Climate Change: Business Risks and Solutions (Marsh, 2006))

In an early example, Aon was retained by the BG Group, a global energy company, to assess the effect of climate change on both its assets and operations. Aon helped BG understand the European Union's carbon trading system and potential business opportunities arising from the use of natural gas to reduce emissions.[167] Aon has established a Climate Change Solutions group that helps customers develop carbon risk-management strategies for participating in emissions trading markets. In 2003, Swiss Re introduced a product, "Contingent Cap Forward for Emissions Reduction Trades," to help ensure that carbon transactions are completed within a certain cost range. Swiss Re offers another project to manage carbon credit price volatility,[168] and collaborated with the Austrian insurer Garant in developing a carbon-delivery insurance product.[169]

Managing Risk for Carbon-Trading Projects

RNK Capital LLC and Swiss Re claim to have jointly implemented the carbon markets' first insurance product for managing Kyoto Protocol-related risk in carbon credit transactions.[170] The insurance provides coverage for risks related to Clean Development Mechanism (CDM) project registration and the issuance of Certified Emission Reductions (CERs) to RNK under the Kyoto Protocol. These risks include failure or delay in the approval, certification and/or issuance of CERs from CDM projects by United Nation Framework Convention on Climate Change (UNFCCC). RNK states that the availability of this insurance removes a key barrier to their ability to maximize investment in this area.

AIG is considering the following means for participating in carbon emissions trading and compliance, by providing products that serve clients who are either investors in carbon credits or operators of projects that generate carbon credits:[171]

Financial Products

- Acquisition of rights to develop Clean Development Mechanism (CDM) and Joint Implementation (JI) projects in developing countries and economies in transition that earn carbon credits recognized within the EU emissions trading system or other trading systems;
- Development of risk management/derivative products to support the carbon market, including serving as an intermediary for risk transfer;
- Adding carbon credits to the Dow Jones-AIG Commodity Index;
- Providing brokerage and GHG management services to AIG companies' have compliance obligations.

Insurance

- Customization, "bundling" and/or targeted marketing of existing insurance for developers of renewable energy (e.g. wind, biomass, solar), other technologies and projects that generate carbon credits within the EU emissions trading systems;
- Development of new products that support the carbon market—for example, against the failure of a project to generate tradable carbon reductions.

Consulting

- AIG, through its HSB Solomon Associates, LLC subsidiary, provides an approach to drive energy improvements in the refining, petrochemical and power sectors, performance benchmarking, best practice reviews, action plan development and implementation support. It is actively marketing to clients a program to identify efficiency improvements that translate directly into carbon reductions, supporting the registration process for CDM and JI projects, exploring funding and assisting with the sale of carbon credits.
- AIG Consultants, Inc. is pursuing additional consulting opportunities to provide support to rating agencies, project developers and other relevant businesses in various projects that generate tradable carbon credits for the carbon market.

Enabling Customers to Purchase Carbon Offsets

Australia's NRMA Insurance Climate Help Program enables customers to calculate the carbon dioxide emissions from their vehicles, and provides options for customers to buy carbon credits to offset those emissions (Figure 11).[172] Another initiative brings together a set of insurers who, for every vehicle or travel policy bought through online broker Climatesure, contribute a percentage of the premium to the company Climate Care, which operates carbon-offsetting projects.[173] Among the insurers offering policies through Climatesure are Axa, Norwich Union, Groupama Insurances, and Premier Underwriting; premiums are lower for fuel-efficient cars.[174]

Figure 11. Web tool produced by the Insurance Australia Group to enable consumers to quantify their vehicle-related carbon-dioxide emissions and purchase offsets.

Source: http://www.climatehelp.com.au/

Aligning Terms and Conditions with Risk-Reducing Behavior and Capitalizing on the "Halo Effect"

> *"Chris Walker of Swiss Re … notes that energy giant Exxon Mobil accounts for roughly 1 percent of global emissions and has aggressively lobbied against any efforts to reduce greenhouse gases. 'So,' said Walker, 'we might go to them and say, "Since you don't think climate change is a problem, we're sure you won't mind if we exclude climate-related lawsuits and penalties from your [Directors & Officers] insurance."'"*
>
> **Swiss Re, as quoted by Eugene Linden (2006)**[175]

While the previous section described less desirable aspects of the tightening of terms and conditions, insurers can use this approach to send constructive signals to their customers. New kinds of insurance policy exclusions—designed to instill behaviors that reduce greenhouse-gas emissions, as well as appropriate efforts to prepare for the impacts—can be expected in the face of climate change. Among the most discussed possibilities is the liability of corporate directors and officers for actions (or lack of action) regarding climate change risks. Conversely, customers with a tendency to reduce climate vulnerabilities are increasingly being seen as "good risks" (e.g. drivers of hybrid cars) and are being rewarded accordingly by their insurers.

Assigning Directors & Officers Liability

One of the leading insurance trade journals, Business Insurance (August 14, 2006) devoted a major cover story to the liability of corporate directors and officers for climate change impacts of their actions (or inactions) on shareholders. Swiss Re has indicated that it may exclude climate risks from their Directors and Officers (D&O) liability customers' coverage in cases where their customer does not take prudent steps to prevent the relevant losses. While the tightening of terms and conditions can be viewed largely as a "reactive" rather than "proactive" measure, in this case advanced warning of the potential for loss of coverage could promote more responsible behavior. It should be noted that Swiss Re has yet to implement this strategy, but merely "floating" the idea could begin to have the desired effect. Conversely, insurers themselves could be found liable for not disclosing climate risks—both from their insurance business and their investments—to their shareholders.

The world's largest insurance broker, Marsh, has articulated the following questions with respect to assessing climate change and D&O risk:[176]

- Management accountability/responsibility: Does a company allocate responsibility for the management of climate-related risks? If so, how does it do so?
- Corporate governance: Is there a committee of independent board members addressing the issues?
- Emissions management and reporting: What progress, if any, has a company made in quantifying, disclosing, and/or reporting its emissions profile?
- Regulatory anticipation: How well has a company planned for future regulatory scenarios?

The "Halo Effect"[177]

Some insurers perceive a sort of "halo effect," in which adopters of climate-change mitigation technologies are viewed as low-risk customers. This acknowledges an overlap between behaviors that are risk-averse with those that are environmentally responsive.

For example, in 2006, Travelers—the original U.S. auto insurer—announced 10-percent premium credits for drivers of hybrid vehicles, citing the "preferred" characteristics of these drivers as well as a desire within the company to develop business associated with this "innovative" trend in technology and to play a part in accelerating the transition to more efficient vehicles.[178]

The emerging practice of "building commissioning" to ensure the expected performance of energy efficiency features has also been found to help detect and remedy risk-related issues such as indoor air quality problems or equipment breakdown risks.[179] The largest U.S. professional liability insurer for architects and engineers—DPIC—has offered a 10-percent premium credit for its customers that receive training in commissioning.

R&D and Investment in Climate Change Solutions

> *We expect climate change not only to produce extreme capital damaging events, but also to increase uncertainty around corporate business plans and potentially reduce asset values. … We also see industry players having increased opportunity to use their influence as investors, in order to encourage responsible and climate proof behaviour from the boards of corporations in which they invest, and with which they do business.*
>
> **Lloyds of London (2006)**[180]

Insurers are among the most significant players in the financial markets, with $1.3 trillion in financial assets in the U.S. alone,[181] and can participate in the commercialization of new technologies or the development of new markets. In keeping with their history in developing fire and vehicle safety technologies, insurers can play a role in bringing to market new technologies that help increase customers' resilience to climate change impacts, as well as curbing greenhouse gas emissions.[182] The business driver for doing so is to be part of the pipeline of clean technology innovations, and, thus, better positioning themselves to participate as investors. Although Swiss Re[183] as well as the Reinsurance Association of America called for R&D initiatives along these lines a decade ago, the insurance industry has made negligible progress on this front.

Research and Development

An example of such R&D is an initiative of the Roofing Industry Committee on Wind Issues,[184] which includes all major roofing trade associations in North America and various insurance partners (including IBHS, RMS, and Allstate). One of the project's aims was to analyze mechanisms for roof failure during severe windstorms and identify specific ways in which energy-efficiency features can enhance roof structural integrity. Other promising areas include topics such as ice dam formation and mitigation or the causes of and remedies for sick building syndrome.

Investments

Climate change has significant implications for the investment strategies pursued by insurers, which in turn has significant implications for insurers' long-term financial health and solvency. As a result, the National Association of Insurance Commissioners plans to examine the issue of insurers' invested assets as part of its executive task force on climate change.

Tremendous concern has been expressed about the potential for "correlated risks" from climate change that simultaneously increase an insurer's underwriting losses while also negatively impacting the invested assets that the insurer uses to pay off those claims. While adverse impacts on investments may be temporary in some cases, considerably liquidity problems could nonetheless arise.

Climate change also brings huge new opportunities for investors. Legendary venture capitalist John Doerr has called clean technology "the largest economic opportunity of the 21st century."

The largest U.S. insurer, AIG, has committed to allocating equity investments to "projects, technologies or other assets that contribute to greenhouse gas (GHG) emission mitigation. The company's intent is to include projects that generate tradable carbon credits. For example, the allocation may include forestry assets; renewable energy resources; energy efficiency and other GHG mitigation technologies; "green" real estate; and equity funds that include carbon emissions as a screening criteria."[186] The company already has hundreds of millions of dollars invested in renewable energy projects, and is directing a team of master's degree students at the Bren School of Environmental Science and Management at the University of California at Santa Barbara in research to support evaluation of new investment strategies.

Swiss Re participated in an $18.4 million round of financing in Evergreen Solar, a U.S.-based solar photovoltaic panel manufacturer.[187] Gerling, a UK-based insurer, founded the Gerling Sustainable Development Project, through which they operate a $100 million initiative that includes venture capital for new technologies to help address climate change risks.[188] French Allianz subsidiary AGF has invested some 10 million euros in the European Carbon Fund and plans to increase its investments in renewable energy by 300 to 500 million euros over a five-year period.[189] German Allianz has stated that it will invest between $350 and $600 million in renewable energy sources by the year 2010.[190]

Climate-Responsive Funds

Several insurers have initiated new publicly traded funds with energy and environmental criteria in their selection screens. The "Gerling Select 21" fund[191] and the Storebrand Principle Global Fund are examples.[192] Recently, together with JF Asset Management, AIG's American International Assurance Company Ltd. subsidiary launched the first Green Fund in the Hong Kong Mandatory Provident Fund Market to invest in environmentally friendly companies. AIG's Japanese SRI equity fund includes environmental selection criteria.

Building Awareness and Participating in the Formulation of Public Policy

> *"The issue of climate change is real, and we believe a domestic regulatory response is both necessary and inevitable. With this perspective in mind, we believe that we are better off as a company, and industry, if we develop and implement an effective moderate response now. If we wait 5–10 years, we may discover the need for a much more drastic and difficult response."*
>
> **Chris Walker, Swiss Re**
>
> Testimony before the US Senate Committee on Commerce, Science and Transportation[193]

Insurers regularly engage in public policy discussions, whether they be concerning terrorism, public health, or natural hazards. It is in the business interests of insurers to support policy that reduces risk and makes risks more predictable. As a result, many insurers have begun to extend their self-assigned mandate to include the issue of climate change and energy policy, and are interjecting their views into the national and international discussion. For example, Swiss Re, the world's largest reinsurer,

has publicly supported the McCain-Lieberman Climate Stewardship Act. Insurers can also utilize their existing relationships with customers to instill loss-prevention behavior.

Consumer Information and Education

If a survey conducted in Canada is any indication, insurance customers do not feel that their insurers do enough to help them understand and prepare for natural disasters.[194] Opportunities clearly exist to do better.

Insurers have engaged in various direct consumer education activities relevant to the question of climate change. This is exemplified by an energy-efficiency guide prepared by USAA Insurance Company for its customers. Several Massachusetts insurers gave 10-percent premium credits to homeowners taking a six-hour course on topics such as energy weatherization, home repair, and lead-paint hazards.[195] Insurance Australia Group (IAG), in partnership with the Australian Financial Review newspaper, has developed education materials on climate change for the high-school curriculum.[196, 197] In addition, IAG already offers an interactive web-based consumer education tool.[198] The Munich Climate Insurance Initiative (led by Munich Re), is identifying insurance-related climate change solutions and conducting pilot projects and education within the industry.

In a very concrete integration of the strategies discussed in this report, the Institute for Business and Home Safety (IBHS) has laid out a program to foster new home construction that surpasses the minimum performance practices embodied in building codes. According to IBHS, their "Fortified … for safer living" home is:

- Energy efficient, using 1/3 to 1/2 less energy,
- Healthier, ensuring excellent indoor air quality,
- Stronger/Safer, paying attention to construction details like connections and using disaster-resistant materials, and
- Environmentally friendly, preventing the release of greenhouse gases and using long-lasting, even recycled materials.

One "Fortified…" home built recently in New Jersey is said to use 80 percent less energy, while being considerably more hurricane-resistant. South Carolina Farm Bureau Mutual Insurance Company, American National Property and Casualty Company, AAA Chicago Motor Club, and Travelers of Florida, and the South Carolina Hail/Wind Pool are offering premium discounts (ANPC is offering 25% off the wind premium in Louisiana) for "Fortified…" homes in some states.[199]

Having a Voice in Public Policy Discussions on Climate Change

For about a decade, the United Nations Environment has convened dozens of insurers from most continents to discuss their industry's vulnerabilities to climate change and recommend constructive actions.[200] The group has directed its informational campaigns to international policymakers, as well as to peers throughout the financial services sector. The Reinsurance Association of America has called for increased federal research and development on climate change and energy issues.[201] Insurance Australia Group is involved in formal advocacy for climate change policies in Australia.[202]

Endorsing Voluntary Energy-Saving Policies

The American Insurance Association (AIA) and Advocates for Highway and Auto Safety (whose members include most major auto insurance, health insurance, and public health and safety organizations) support increased funding for public transportation, which conserves energy and thereby reduces greenhouse gas emissions.[203] AIA has also endorsed telecommuting.[204]

Energy-Efficiency Codes and Standards

In early 2002, the Insurance Institute for Highway Safety became the first insurance organization to support the stalled Corporate Average Fuel Economy (CAFE) standards, citing new technologies to improve fuel economy without compromising safety through reduced vehicle weight.[205, 206] AIA and Advocates for Highway and Auto Safety also support tightened federal controls on speed limits.

Leading by Example

Any insurance company that is not focusing on climate change and related possible damage is not being realistic in looking at their future profitability. As an investor, a lack of disclosure always troubles me.

Richard Moore, North Carolina State Treasurer (2005)[207]

Leadership by example is one of the most potent means of affecting change. While insurers are not major emitters of greenhouse gas emissions, the energy used by their vast real estate holdings is significant—probably valued at several billion dollars per year in the U.S. alone. U.S. life insurance companies are owners of 22 percent of all institutional real estate. Swiss Re recently pledged to become entirely greenhouse-gas neutral across its operations through a combination of in-house efforts to reduce energy use and investment in the World Bank Community Development Carbon Fund. The company has already reduced fuel consumption in its headquarters by 30 percent. By the year 2012, Allianz is planning to reduce carbon dioxide emissions by 20 percent compared with the base year 2000. Disclosing climate risks to regulators and shareholders is another way of exemplifying responsible behavior for other industries.

In-House Energy Management

Participation in voluntary programs such as ENERGY STAR, sponsored by the U.S. Environmental Protection Agency and the U.S. Department of Energy or the Leadership in Energy and Environmental Design (LEED) labeling program, can yield substantial energy savings—50 percent or more in many cases. Hartford Steam Boiler (an AIG company) was the first insurer to receive the ENERGY STAR building performance label, and many insurers have followed suit. AIG's statement of "Policies and Programs on Environment and Climate Change" notes that the company will develop LEED-compliant buildings. Swiss Re offers incentives to employees who devise innovative energy-management strategies.

Reducing Insurers' Carbon-footprint Through Improved Operations

Improving energy efficiency can lead to operational benefits beyond lower energy bills. In a carefully controlled research study, West Bend Mutual Insurance Company reported a 7-percent increase in productivity (numbers of files processed pertaining to applications, endorsements, renewals, and quotes) following implementation of a number of energy- and non-energy-related environment improvement measures.[208] In another example of operational efficiencies, American Modern Insurance Group has tested the use of grid-independent solar photovoltaic cells for powering their portable claims-handling offices, which are deployed in the field following natural disasters.[209]

Disclosing Climate Vulnerabilities and Liabilities

As insurers are increasingly looking to their customers to disclose climate-related risks, a few are beginning to lead by example in disclosing their own exposures. Five U.S. insurers have responded to the Carbon Disclosure Project surveys,[210] as well as thirteen from other countries (Figure 2). It can be expected that customers, investors, and rating agencies will press for this information in the future. Participating insurers will likely benefit in terms of managing shareholder and reputation risks associated with their responses to climate change.

A review of the 2004 annual SEC filings of 106 publicly-traded property and casualty insurers determined that while many insurers generically describe risks due to severe weather events or catastrophes, only five companies (about 5 percent) referenced climate change issues in their reporting.[211] These companies are Allianz, Aspen Insurance, Chubb, Cincinnati Financial Corporation, and Millea.

IV. Challenges

Insurers cannot be expected to capture all of these opportunities single-handedly. In many cases, linkages are called for with other initiatives outside the insurance industry. Improving building codes so that they make maximal use of hazard-resistant technologies and practices, while minimizing energy use is an example of a strategy that requires the leadership of local government. In this regard, a specific opportunity is the reduction in rooftop "ice dams" caused by excessive heat loss. Energy efficient construction mitigates the ice dam hazard (a major source of insurance claims in northern climates) while reducing the greenhouse-gas emissions associated with heating energy use. With these types of benefits in mind, the Institute for Business and Home Safety (IBHS) and the Canadian Institute for Catastrophic Loss Reduction (ICLR)—both insurance-based organizations—have endorsed energy-efficient building codes.[212]

Some initiatives would rely on alliances with energy utilities (e.g. offering financial incentive programs that simultaneously reward hazard-resilience and energy efficiency), as was done in a collaborative promotion of fire-safe, energy-efficient light fixtures with FM Global insurance company and Boston Edison.[213]

It is of course important to anticipate and avoid inadvertent adverse side effects of carbon-reduction strategies.[214] A well-worn example is degraded indoor air quality due to over-tightening of buildings. In many cases, these concerns are unfounded, but in others they are legitimate (but surmountable). An example of the latter is that small/light cars exist that are as safe or safer than SUVs.[215] Concerning energy supply issues, questions have arisen[216, 217] about un-quantified liabilities associated with the rising popularity of proposals to capture carbon dioxide at the point of production (e.g. power plant stacks) and inject it, hopefully safely and permanently, into the earth or seabed. The insurance sector will probably be unwilling to insure a rebirth of nuclear power, argued by some as an important part of the response to climate change.

The development of innovative insurance products can meet with challenges. As shown in Figure 6, insurers have successfully made coverage available for renewable energy systems. However, Figure 12 enumerates a number of remaining challenges.

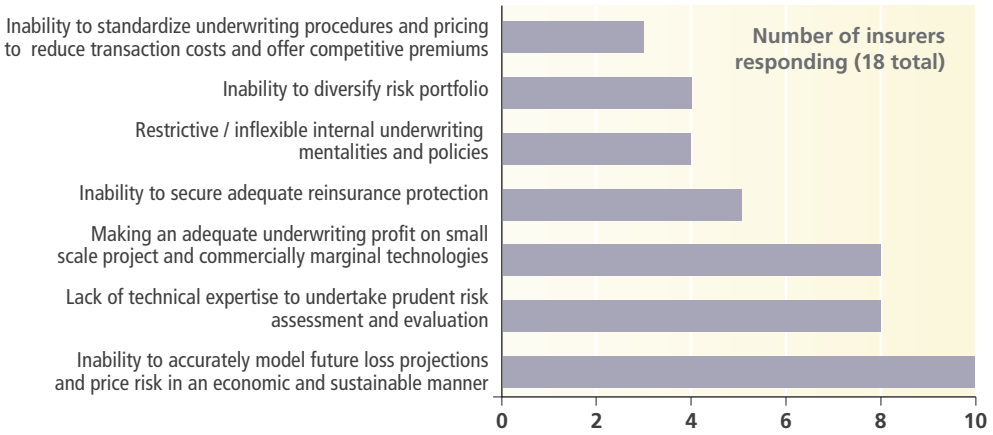


Figure 12. Challenges reported by insurers of renewable energy projects

Source: Marsh. 2006. "Survey of Insurance Availability for Renewable Energy Projects." March, 15pp.

V. The Essential Role of Regulators

Recognizing the material threat of climate change, in 2006 the U.S. National Association of Insurance Commissioners (NAIC) created an executive-level Task Force to study the issue in detail.

Insurers have two overarching and inter-related goals: to maintain the availability and affordability of insurance for customers, and to guard against insurer insolvency. We have previously noted the appropriate roles for regulator in climate change vulnerability assessment,[218] and turn here to their role in enabling the types of traditional and innovative responses described in this report.

Regulators have a responsibility to see that rates are adequate and provide for the solvency of insurers, and that state-operated insurance pools have adequate capacity to pay losses. In a changing climate, this will, among other things, require consideration of the ability of catastrophe models to account for climate change.

Where insurers desire to provide differentiated premiums or financial incentives to encourage risk-reducing behavior, it is often necessary to show regulators that there will be an offsetting reduction in losses. This is done to ensure rate adequacy. Reviews vary from state to state, and are negligible in some cases while quite thorough in others. Insurers interviewed by the Iowa Department of Natural Resources cited difficulties in gaining regulatory approval for premium credits as a key barrier.[219] Insurers are essentially free to develop new fee-based services outside of the insurance core business, such as the risk assessment and management services for carbon offset projects mentioned above.

For insurers to engage in research and development, or equity/venture-capital investments in "climate friendly" companies, they must first demonstrate that their reserves are adequately backed up with bonds. Once this is done, insurers are essentially free to invest elsewhere with the surplus.

It is thus important that concerned insurance regulators review existing rules and policies, identifying potential barriers and providing more flexibility for "doing the right thing".

Requests or requirements to undertake the sorts of innovative strategies outlined in this report could originate from the insurance regulators. For example, regulators could call for separate rating of hybrid vehicles, keep track of loss experience, and ultimately utilize the results to propose differential treatment of customers owning these cars.

Regulators can also call for more complete disclosure of climate risks, both in the core business of insurance underwriting as well as in the selection of potentially weather-sensitive investments that could affect their solvency.

VI. Toward Best Practices

The insurance sector has a key role to play in helping to mitigate the effects of climate change by providing financial indemnification, compensation and relief against climate change events and by developing new products and solutions that can support emerging GHG [greenhouse gas] and Renewable Energy markets.

Marsh (2004)[220]

Discussions of climate change often convey a "gloom-and-doom" outlook for the future. Yet, as the preceding pages testify, there are a host of actionable opportunities for insurers. They have in common the potential for improving the business position of insurers while addressing the risks posed by climate change. While the tightening of terms and conditions and upward adjustments of prices will be appropriate in some contexts, these measures should be regarded as only one class of the options available to insurers.

Giving priority to increasing the resilience of insurance customers to the risks posed by climate change, and simultaneously taking steps to reduce climate change itself, will go farthest towards minimizing damage to insurance markets and revenues, and insurer reputations, while creating a competitive advantage and new sources of economic value for those insurers advancing proactive solutions.

A remarkable number of examples are identified in this report. It should be noted that these forward-looking activities are largely modest initiatives and are collectively far from what would constitute a best-practice offering within the insurance industry. No single insurer has embraced what we would consider a comprehensive strategy, but many are well on the road in that direction.

An insurer that has integrated best practices into its business will implement the following ten-point strategy:

1. Make concerted efforts to restore and maintain the insurability of extreme weather events. This may require partnerships with governments, e.g., in the cases of improved land-use planning and enforced building codes.

2. Improve the modeling and other methods of analyzing risks associated with climate change.

3. Utilize terms and conditions to foster the right decisions by customers. This could range from rewarding risk-minimizing behavior to excluding climate change liabilities for those who make imprudent decisions either as emitters of greenhouse gases or managers of risks associated with climate change.

4. Develop new products and services to facilitate maximum customer utilization of climate-friendly technologies and practices, especially in cases where they yield loss-prevention co-benefits.

5. Invest in strategic R&D and rebalance investment portfolios to (a) recognize climate-related risks to investments and (b) capitalize on opportunities for emerging industries that will participate in climate change solutions.

6. Actively participate in carbon markets, both as investor and risk manager.

7. Lead by example in minimizing the insurer's own "carbon footprint". This includes minimizing the climate impacts of real estate owned by the insurer, as well as the "carbon footprint" of business operations, and by analyzing and disclosing exposures to climate change.

8. Take an active role in the education of customers about climate-related risks and opportunities for minimizing them.

9. Actively engage in public policy discussions about appropriate responses to climate change.

10. Tighten terms and conditions, withdraw from markets, or increase insurance prices only when the aforementioned best practices have first been exercised to their fullest cost-effective potential.

Corollary best practices for rating agencies will involve assessing insurers' handling of climate risks. Other trade allies—such as brokers, agents, and risk managers—can reinforce the aforementioned best practices on behalf of insurance customers.

Grasping these opportunities is fully consistent with the industry's history as founders of fire departments, early promoters of Underwriters Laboratory, and key players in physical risk management. Insurers have also historically played a role in public policy, whether it is the ongoing debate about terrorism or advocacy for improved building codes.

The opportunities described above can enable individual insurers to differentiate their products from the competition, while enhancing their reputations in the eyes of a public increasingly looking towards all quarters of industry to come forward with constructive responses to the climate change threat. Indeed, insurance customers will come to demand the types of innovative responses documented in this report.

Sustainable energy technologies will be deemed particularly relevant if they help address other acute strategic issues faced by insurers. A good example is the rapid growth in mold and indoor air quality claims and construction defects litigation haunting many insurers;[221] many of these claims trace back to poor design and application of energy-related systems. The growing insurance risks associated with electricity reliability[222] are another example, which can be addressed, in part, through efficiency and distributed renewable energy supply solutions. There are even synergisms between making buildings energy-efficient and less vulnerable to chemical and biological attack, e.g., improved ventilation controls used to minimize energy use in normal operation and to protect occupants during a crisis.[223] Lastly, the crisis of corporate governance is also among the broader strategic issues already troubling insurers, which will only be made more difficult by climate change.

Given that insurance is the world's largest economic sector, and that insurers reach virtually every consumer and business in developed countries, the prospect for their involvement in the development and promotion of climate change mitigation strategies stands as an immense but as yet largely untapped opportunity.

Appendix A. Directory of Insurer Activities to Address Climate Change

Sources: Table summarizes examples enumerated in the text, based on interviews, company publications, or third-party reports.For additional sources and descriptive information, see: Mills, E. 2003. "The Insurance and Risk Management Industries: New Players in the Delivery of Energy-Efficient Products and Services." Energy Policy 31:1257-1272.

	Country	Information, Education, Demonstration	Financial Incentives	Specialized Policies, Products	Direct Investment	Customer Services and Inspections	Codes, Standards, Policies	Energy Research and Development	Climate Modeling and Research	In-House Energy Management	Carbon Risk Disclosure	Carbon Offsets, Trading, or Risk Management
INSURANCE & REINSURANCE COMPANIES												
AAA Chicago Motor Club	US		●									
ACE	US										●	
Aetna	US									●	●	
AGF	FR										●	
Aioi Insurance	JP		●	●								
Allstate	US							●			●	
Allianz	DE	●			●				●		●	●
Firemans Fund Insurance Company (subsidiary of Allianz)	US	●	●	●								
American International Group (AIG)	US	●	●	●	●					●	●	●
Hartford Steam Boiler (subsidiary of AIG)	US			●		●				●		●
American Modern Insurance Group	US	●										
American National Property and Casualty Company	US		●									
Aon Risk Services	US			●								●
Aryeh	IS		●	●								
Aspen Insurance	US										●	
Aviva	UK										●	
AXA	UK	●	●	●							●	
Bankers Insurance Group	US									●		
Berkshire Hathaway Life Insurance Company	US	●										
Blue Cross & Blue Shield Mutual of Ohio	US									●		
Boiler Inspection & Insurance Company	CA			●								
CGNU (formerly General Accident)	UK								●	●		
Chubb	US			●		●		●			●	
Cincinnati Financial Corporation	US										●	
Connecticut Mutual Life Insurance Home Office	US									●		
Continental Insurance	US									●		
Delta Lloyd Verzekeringsgroup NV	NL									●		
Developers Professional Insurance Company (DPIC)	US		●									
Employers Re (now part of Swiss RE)	US			●					●			
First Treasury	CA			●								

	Country	Information, Education, Demonstration	Financial Incentives	Specialized Policies, Products	Direct Investment	Customer Services and Inspections	Codes, Standards, Policies	Energy Research and Development	Climate Modeling and Research	In-House Energy Management	Carbon Risk Disclosure	Carbon Offsets, Trading, or Risk Management
FM Global (formerly Arkwright Mutual)	US	●							●	●		
GMAC	US		●	●								
Garant Insurance	AU											●
GEICO	US	●										
Gerling	UK		●		●							●
Groupma Insurances	UK		●	●								
Hanover	US		●									
Harleysville Mutual Insurance Company	US									●		
Independent Insurance	UK									●		
Insurance Australia Group	AU	●					●	●	●			●
ITT Hartford Group, Incorporated	US									●		
Johnson & Higgins	US									●		
KBC Bankassurance	BE										●	
Legal & General Group	UK										●	
Lloyds of London	UK	●			●	●						
Millea	US										●	
Milwaukee Insurance	US									●		
Minnesota Mutual Life Insurance Company	US									●		
Mitsui Sumitomo	JP										●	
Munich Re	DE	●		●					●		●	
Nationwide Mutual Insurance Company, Inc.	US									●		
New York Life Insurance & Annuity Corp.	US									●		
North American Capacity Insurance Co. (owned by Swiss Re)	US			●								
Norwich Union	UK		●	●								
NRMA Insurance	AU	●	●	●								
PAY PER K	SA		●	●								●
Pennsylvania Blue Shield	US									●		
Phoenix Home Life Mutual Insurance Co.	US									●		
Plymouth Rock Insurance Co.	US		●	●								
Polis Direct	NL		●	●								
Premier Underwriting	UK		●	●								
Progressive Auto Insurance	US		●					●				
Provident Life & Accident Insurance Co.	US									●		

	Country	Information, Education, Demonstration	Financial Incentives	Specialized Policies, Products	Direct Investment	Customer Services and Inspections	Codes, Standards, Policies	Energy Research and Development	Climate Modeling and Research	In-House Energy Management	Carbon Risk Disclosure	Carbon Offsets, Trading, or Risk Management
Prudential Assurance	UK									●	●	
RAS	IE										●	
Reinland Versicherungen	DE		●									
Royal Maccabees Life Insurance Company	US									●		
Safeco	US			●								
Saint Paul Travelers	US		●								●	
St. Paul Fire and Marine Insurance	US									●		
Sorema Re	CA			●					●			
South Carolina Farm Bureau Mutual Insurance Company	US			●								
State Compensation Insurance Fund	US									●		
State Farm	US							●				
State Farm Mutual Automobile Ins Co	US									●		
Storebrand	N				●	●			●			●
Swiss Re	CH	●			●		●		●	●	●	●
Tokio Marine & Nichido Life	J	●							●		●	
Travelers	US		●									
Trygg-Hansa	S				●							●
USAA	US	●								●		
USF&G was (merged w/by St.Paul's Co.)	US				●					●		
Victoria/Ergo	D				●							●
Westbend Mutual	US							●				
Zurich American Insurance Group / Steadfast	US			●								
Zurich Financial	CH										●	
INSURANCE BROKERS												
AON	UK			●		●			●			●
Clair Odell Group	US			●		●						
Guy Carpenter and Company (subsidiary of Marsh)	US									●		
Marsh	US	●							●			
Morris & Mackenzie	CA			●								
NRG Savings Assurance	US			●								
Willis Corroon/Willis Canada	US/CA			●		●						
INSURANCE ORGANIZATIONS												
Advocates for Highway and Auto Safety	US	●					●					
American Insurance Association (AIA)	US	●										
Association of British Insurers	UK	●					●		●			
Institute for Business and Home Safety (IBHS)	US	●					●	●				

	Country	Information, Education, Demonstration	Financial Incentives	Specialized Policies, Products	Direct Investment	Customer Services and Inspections	Codes, Standards, Policies	Energy Research and Development	Climate Modeling and Research	In-House Energy Management	Carbon Risk Disclosure	Carbon Offsets, Trading, or Risk Management
Institute for Catastrophic Loss Reduction	CA	●					●		●			
Insurance Information Institute	US	●										
Insurance Institute for Highway Safety (IIHS)	US	●					●					
Lockton Risk Services	US			●								
National Association of Independent Insurers	US	●										
National Associationof Insurance Commissioners (NAIC)	US	●										
United Nations Environment Programme Insurance Initiative	Int'l	●							●			
OTHERS												
Boston Edison Company	US	●										
Building Air Quality Alliance (BAQA)	US					●						
Building Code Assistance Project (BCAP)	US						●					
Ceres	US	●									●	
Climate Group	UK	●										
Environmental Defense	US			●								
Federal Highway Administration (FHA)	US							●				
Institute for Business and Home Safety	US	●					●					
International Energy Agency	Int'l	●					●			●		
Iowa Department of Natural Resources	US	●					●					
Natural Resources Defense Council	US	●										
Pacific Gas & Electric Company	US						●					
RESNET	US			●								
Rockefeller Family Fund	US	●										
Roofing Industry Committee on Wind Issues (RICOWI),	US						●	●				
U.S. Department of Energy	US	●						●				
U.S. Department of Transportation	US						●					
U.S. Environmental Protection Agency	US	●								●		
Waterhealth International	US	●						●				
World Wildlife Fund	US	●										

Appendix B.

Characterization of climate-change adaptation-mitigation co-benefits, and insurance lines of business effected

SECTOR > Strategy	MITIGATION BENEFIT	ADAPTATION BENEFIT	TYPES OF INSURANCE BENEFITS
Energy Sector – Demand Side			
Energy efficiency generally	reduced energy use	grid reliability	business interruption, contingent business interruption, service interruption, boiler and machinery, perisha
Natural ventilation; daylighting	reduced energy use	allows continued facility occupancy during power outage	business interruption
Insulated ceilings in cold climates	reduced heating energy	structural integrity and extended habitability of structures during natural disaster	property, business interruption
Concrete-polystyrene wall systems	reduced heating and cooling energy use	resistent to wind and water damage	property, life/health, mold liability
Heat island mitigation, e.g. via reduced roof albedo and urban forestry	reduced cooling energy use	extended habitability of structures during heat waves; moderation of precipitation (urban trees) and reduced flash flooding, reduced smog formation due to lower temperatures	health, life, relocation expenses; business interruption
Efficient grid-independent lighting	reduced electricity use	disaster recovery	business interruption
Efficient windows	reduced space-cooling energy	improved fire-resistance and reduced vulnerability to wind-blown debris	property
Energy Sector – Supply Side			
Renewable energy systems	reduced energy use	grid reliability	business interruption, service interruption, cyber-risk insurance (data loss), worker›s compensation, property loss, liability, perishable goods interruption
Distributed energy systems	reduced electricity transmission losses (and thus energy use)	grid reliability	Business interruption; more reliabie power for earlly-warning systems and post-event operations
Hydroelectric systems	reduced ghg emissions	flood control	property, life/health
Biomass energy plantations	carbon sinks		
Agriculture, Forestry, and Land Use			
Agricultural soil management	increased soil carbon content	enhanced drought-resistence	crop
Land restoration and afforestation	carbon sinks	reduced flood/mudslide risk	property, crop
Mangrove protection/restoration	carbon sinks	enhanced flood and tidal-surge resistence	property, life/health
Health (Human and Other Systems)			
Improved forest management	reduced wildfires (carbon emissions)	reduced habitat for malaria vectors; flood control; reduced vulnerability to forest pests; retention of disease vectors (e.g. bats–Nipah virus) otherwise hazardous to humans	health, life, property
Ultraviolet water disinfection	reduced commercial energy use; reduced deforestation associated with water boiling	ability to respond to water quality crises following extreme weather events	health, life

References

1 Swiss Re. 2006. "Natural Catastrophes and Man-Made Disasters 2005." Swiss Reinsurance Company, Sigma no. 2/2006, Zurich.

2 Waddell, L. 2006. "Rising Insurance Rates Push Florida Homeowners to Brink." *New York Times*, June 29.

3 Associated Press. 2006. "Insurance Prices Skyrocket on Alabama Gulf."

4 McDonald, C. 2005. "Katrina An Industry Shocker, Says PCI's CEO." *National Underwriter News Service*, 27 October.

5 AIG. 2006. *AIG's Policy and Programs on Environment and Climate Change*.

6 Swiss Re. 2006. op. cit.

7 Swiss Re. 2006. op. cit.

8 A.M. Best Co. 2006. "Thinking the Unthinkable: How 'Mega-Cats' May Bruise Insurers." *Bests Review*, p. 81, July.

9 McDonald, C. 2005. op. cit.

10 Berliet, J.P. 2006. "Katrina: Why Risk Management Failed." *Best's Review*, pp. 34–36, June.

11 Parekh, R. 2006. "Quanta Quits Most Lines After Huge Storm Loss." *Business Insurance*, p. 1, May 29.

12 Ruquet, M.E. 2006. "Flood Claim Battle Could Drown Insurers." *National Underwriter*, January 2/9, p. 12.

13 *The Wall Street Journal*. 2006. "As Hurricane Season Begins, Disaster Insurance Runs Short." July 10.

14 Munich Re and American Re. 2006. "Hurricanes: More Intense, More Frequent, More Expensive." Munich Reinsurance Company and American Reinsurance Company, 44pp.

15 National Research Council. 2006. "Surface Temperature Reconstructions for the Last 2,000 Years." National Academy of *Science*s and the National Academy of Engineering, Washington, D.C.

16 Kerr, R.A. 2006. "No Doubt About It, the World is Warming." *Science* (news section) Vol. 312, pp. 825.

17 Emanuel, K. 2005. "Increasing Destructiveness of Tropical Cyclones over The Past 30 years," *Nature*, 436, pp. 686–688.

18 Webster, P.J., G.J. Holland, J.A. Curry, and H.-R. Chang. 2005. "Changes in Tropical Cyclone Number, Duration, and Intensity in a Warming Environment," *Science* 309, pp. 1884–1846.

19 Mann, M.E. and K.A. Emanuel. 2006. "Atlantic Hurricane Trends Linked to Climate Change." *EOS Transactions*, American Geophysical Union, 87(24), p. 233.

20 Rignot, E. and P. Kanagaratnam. 2006. "Changes in the Velocity Structure of the Greenland Ice Sheet." *Science* 311: 986-990.

21 Goss Levi, B. 2006. "Is there a Slowing in the Atlantic Ocean's Overturning Circulation?" *Physics Today*, April, pp. 26–28, summary of Curry and Mauritzen. *Science*, 308:1773, 2005.

22 Westerling, A.L., H.G. Hidalgo, D.R. Cayan, and T.W. Swetnam. 2006. "Warming and Earlier Spring Increases Western U.S. Forest Wildfire Activity." *Science*. DOI: 10.1126/science.1128834 (Science Express)

23 Bryden, H.L, H.R. Longworth, and S. A. Cunningham. 2005. "Slowing of the Atlantic Meridional Overturning Circulation at 25∞N." *Nature*. Vol. 438, pp. 655-658.

24 Mills E. 2005. Response to: "Attribution of Disaster Losses" *Science*, Vol. 310, pp. 1615–1616. 9 December.

25 Schiermeier, Q. 2006. "Insurers' Disaster Files Suggest Climate Is Culprit." *Nature*, 441:674–675, June 8.

26 Oreskes, N. 2004. "Beyond the Ivory Tower: The Scientific Consensus on Climate Change." *Science*. Vol. 306. No. 5702, p. 1686

27 Australia, Belgium, Brazil, Canada, Caribbean, China, France, Germany, India, Indonesia, Ireland, Italy, Malaysia, New Zealand, Sweden, Turkey, and the United Kingdom..

28 Joint Science Academies' Statement: Global Response to Climate Change." http://www.nationalacademies.org/onpi/06072005.pdf

29 Waddell, L. 2006. "Rising Insurance Rates Push Florida Homeowners to Brink." *New York Times*, June 29.

30 Hoffman, D. 2006. "Directors and Officers Liability Insurance (D&O Insurance)." Pacific Risks.

31 Mills, E. 2005. "Insurance in a Climate of Change," *Science* Vol. 308, No. 5737, pp.1040–1044, August 12.

32 Vellinga, P. V., E. Mills, L. Bowers, G. Berz, S. Huq, L. Kozak, J. Paultikof, B. Schanzenbacker, S. Shida, G. Soler, C. Benson, P. Bidan, J. Bruce, P. Huyck, G. Lemcke, A. Peara, R. Radevsky, C. van Schoubroeck, A. Dlugolecki. 2001. Insurance and Other Financial Services. Chapter 8 in *Climate Change 2001: Impacts, Vulnerability, and Adaptation*. Intergovernmental Panel on Climate Change, United Nations and World Meteorological Organization, Geneva.

33 Mills, E., R.J. Roth, E. Lecomte. 2005. "Availability and Affordability of Insurance Under Climate Change: A Growing Challenge for the U.S." Prepared for The National Association of Insurance Commissioners.

34 Fuquay, J. 2006. "State Farm Increase Rejected." *Star-Telegram*.

35 Hyman, A.S. 2006. "Sarbanes-Oxley will Force Corporations to Confront Climate Change." Fiske Walter Capital Management, Ltd.

36 Cornejo, R. 2006. "Katrina's Next Wave." *Best's Review*, p. 22, June.

37 *Investment News*. 2006. "Financial Services Industry Addresses Climate Change Issue." June 19.

38 Ruquet, M. 2006. "Exposures Overly Concentrated Along Storm-Prone Gulf Coast." *National Underwriter Property & Casualty*, p. 7, 2006.

39 O'Connor, R. 2006. "Hurricanes Drive Lloyd's To 130 Million Pounds Loss." *Best's Review*, p. 99, May.

40 Swiss Re. 2006. "The Effects of Climate Change: Storm Damage in Europe on the Rise." Swiss Reinsurance Company, Report 1503160_06_en.

41 Ceniceros, R. 2006. "Catastrophe Model Changes Tighten Market for Storm Risks." *Business Insurance*, p. 24, June 12.

42 Huang, P. 2006. "Climate Boiling Point." *Forbes*, p. 42, January 9.

43 AIG. 2006. op. cit.

44 Marsh. 2006a. "Risk Alert – Climate Change: Business Risks and Solutions." 36pp, April.

45 Epstein, P. and E. Mills (eds.). 2005. "Climate Change Futures: Health, Ecological and Economic Dimensions." Published by Harvard Medical School, sponsored by Swiss Re and the U.N. Development Programme. Contributing Authors: Pamela Anderson, John Brownstein, Ulisses Confalonieri, Douglas Causey, Nathan Chan, Kristie L. Ebi, Jonathan H. Epstein, J. Scott Greene, Ray Hayes, Eileen Hofmann, Laurence S. Kalkstein, Tord Kjellstrom, Rebecca Lincoln, Anthony J. McMichael, Charles McNeill, David Mills, Avaleigh Milne, Alan D. Perrin, Geetha Ranmuthugala, Christine Rogers, Cynthia Rosenzweig, Colin L. Soskolne, Gary Tabor, Marta Vicarelli, X.B. Yang.

46 Munich Re. 2005. *Weather Catastrophes and Climate Change*. Munchener Ruckversicherungs-Gesellschaft, Munich.

47 The Australian Climate Group. 2006. "Climate Change: Solutions for Australia." World Wildlife Fund and the Insurance Australia Group. See also http://www.iag.com.au/pub/iag/sustainability/index.shtml

48 Association of British Insurers. 2005. "The Financial Risks of Climate Change."

49 Dlugolecki, A. and S. Lafeld. 2005. "Climate Change and the Financial Sector: An Agenda for Action." Allianz and the World Wildlife Fund, 59 pp.

50 Lloyds of London. 2006. "Climate Change, Adapt or Bust." See also: http://www.lloyds.com/News_Centre/360_risk_project/

51 Malaysian Insurance Institute. 2006. "The Gathering Storm." *MII News*, 1/06, p. 1, January.

52 Slater, G. "How Dry Can it Get?" *The Oklahoman* July 2.

53 Valverde, L.J. Jr. and M.W. Andrews. 2006. "Global Climate Change and Extreme Weather: An Exploration of Scientific Uncertainty and the Economics of Insurance." Insurance Information Institute.

54 Tuckey, S. 2006. "Hurricanes Boost Reinsurers' Combined Ratio by 23 Points." *National Underwriter Property & Casualty*, p. 6, March 27.

55 *Financial Times*. 2006. 8 February.

56 Insurance Information Institute. 2006. Hot Topics & Issue Updates. "Hurricane and Windstorm Deductibles." July. http://www.iii.org/media/hottopics/insurance/hurricanwindstorm/

57 Hartwig, R.P., Wilkinson, C. 2003. "Mold and Insurance." *Insurance Issue Series* Vol. 1 No. 4. Insurance Information Institute, New York, NY. (August 2003).

58 Cavanaugh, B.B. 2006. "High Water Mark." *Best's Review*, pp. 49-54, July.

59 Insurance Information Institute. 2006. Hot Topics & Issue Updates. "Reinsurance." July. http://www.iii.org/media/hottopics/insurance/reinsurance/

60 Sclafane, S. 2006. "Cat Re Capacity Shrinks for Key Regions." *National Underwriter*, July 17, pp. 12–17.

61 Ruquet, M.E. 2006. "Watch out for Speed Bumps… As Softening Market Gains Momentum." *National Underwriter*, May 22, page 12.

62 Lynch, D. 2006. op. cit.

63 Sclafane. 2006. op. cit.

64 Horvath, S. 2006. "Some Businesses Operate Without Insurance." *Palm Beach Post*, July 9.

65 Ceniceros, R. 2006. "Catastrophe Cover Capacity Shrinking." *Business Insurance*, May 15, p. 1.

66 Pilla, D. 2006. "More Storms on the Horizon." *Best's Review*, pp 81–85, May.

67 Sclafane, S. 2006. "Gaping Captial Hole Troubles Cat Modeler." *National Underwriter Property & Casualty*, p. 8, June 12.

68 Ruquet, M. 2006. "MGAs See No Quick Fix on Cat Coverage." *National Underwriter Property & Casualty*, p. 7, May 15.

69 Wharton Risk Center. 2005. "TRIA and Beyond." Philadelphia, PA.

70 Calder, C. and T. Griggs. 2006. "Insurance An Obstacle in N.O." The Advocate (July 15).

71 Bushouse, K. 2006. "Legislature Seeks Freeze on Rate Hikes for Home Insurance." *South Florida Sun-Sentinel*, July 13.

72 Mowbray, R. 2006. "Law Bans Dropping Coverage: Battle with Allstate May Go to Court." *New Orleans Times Picayune*.

73 Annualized numbers for all property policies as of 31 March 2006, provided by Jonathan Kees, Dir. Communications at the Florida Office of Insurance Regulation during 28 June 2006 phone conversation.

74 *Allstate Floridian*. 2006. Press Release: "Allstate Floridian Welcomes New Insurer to Florida Market." 12 May 2006.

75 Adams, M. 2006. "A Storm of Trouble." *USA Today*, June 8.

76 Waddell, L. 2006. op. cit.

77 Waddell, L. 2006. op. cit.

78 Adams, M. June 2006. op. cit.

79 Kuykendall, L. 2005. "Allstate Cuts Gulf Coast Exposure After Hurricane Insurer Reports Loss of $1.55 Billion: 'Virtually No New' Policies." *The Wall Street Journal*, October 21.

80 Kuykendall, L. 2005. op. cit.

81 Gagnet, K. 2006. "Homeowners Struggle to Find, Afford Post-Storm Insurance." The Advertiser, July 6.

82 Hipp, L. 2006. "Dale OKs Hikes for Twelve Insurance Companies." Miss. State Repr quoted in *Clarion Ledger*, June 23.

83 Mowbray, R. 2006. op. cit.

84 Bernstein, J. 2006. "Allstate: No New LI Home Policies." *Newsday*, January 12.

85 Adams, M. June 2006.op. cit.

86 Adams, M. 2006. "Strapped Insurers Flee Coastal Areas. *USA Today*, April 26.

87 InsuranceJournal.com. June 4.

88 Lord, P. 2006. "Homeowners Near Coast Get Surprise on Insurance." *The Providence Journal*, June 11.

89 Lord, P. 2006. op. cit.

90 Lord, P. 2006. op. cit.

91 Burns, J. 2006. "Insurers Team Up to Fight Policy Downturn." *The Sun News*, May 23.

92 Burns, J. 2006. op. cit.

93 Burns, J. 2006. op. cit.

94 Hull, P. 2006. "Money Alone Can't Buy Insurance." *The Post and Courier*, June 4.

95 Insurance Journal. 2006. Fla. Property Owners to Pay 1% Insurance Charge for Hurricanes." June 2.

96 *The Economist* 2006. "The Price of Sunshine." June 10.

97 Waddell, L. 2006. op. cit.

98 6/30/06 – *Louisiana Hurricane Season No Insurance for Industry*

99 Cornejo, R. 2006. "Large Florida Homeowners Insurer Goes into Receivership Following Hurricanes." *Best's Review*, p. 6, June.

100 *The Economist* 2006. op. cit.

101 Total number of policies as of 31 March 2006, provided by Jonathan Kees, Dir. Communications at the Florida Office of Insurance Regulation during 28 June 2006 phone conversation; Hsu, S. 2006. "Insurers Retreat From Coasts: Katrina Losses May Force More Costs on Taxpayers." *Washington Post*, April 30.

102 Waddell, L. 2006. op. cit.

103 *The Economist* 2006. op. cit.

104 Rawls, L. "State Realtors Head Calls for Affordable Catastrophe Insurance." *Palm Beach Post*. 2006, June 22.

105 Waddell, L. 2006. op. cit.

106 Sclafane, S. 2005. "Florida Homeowners Rates Could Triple, Citizens Warns." *National Underwriter Property & Casualty*, p. 21, 5 December.

107 Insurance Information Institute. 2006. Hot Topics & Issue Updates. "Reinsurance." July. http://www.iii.org/media/hottopics/insurance/reinsurance/

108 Juneau, D. 2006. "Louisiana Hurricane Season No Insurance for Industry." *Bayou Buzz*, June 29.

109 Hipp, L. 2006. op. cit.

110 6/30/06 – *Louisiana Hurricane Season No Insurance for Industry*

111 Hipp, L. 2006. op. cit.

112 Juneau, D. 2006. op. cit.

113 Hsu, S. 2006. op. cit.

114 Dlugolecki, A. 2004. "A Changing Climate for Insurance." Association of British Insurers, 24pp.

115 Marsh. 2006b. "Survey of Insurance Availability for Renewable Energy Projects." 15pp, March.

116 Mills, E. 2004. "Insurance as an Adaptation Strategy for Extreme Weather Events in Developing Countries and Economies in Transition: New Opportunities for Public-Private Partnerships." Lawrence Berkeley National Laboratory Report No. 52220.

117 The Munich Climate Insurance Initiative. No date. "Insurance-Related Options for Adaptation to Climate Change." 10pp.

118 AIA. 2000. "Potential Areas of Focus for the OECD with Regard to Global Catastrophe Mitigation." American Insurance Association, Washington, D.C.

119 Kovacs, P. 2006. "Hope for the Best and Prepare for the Worst: How Canada's Insurers Stay a Step Ahead of Climate Change." *Policy Options*, p. 53–56, December/January.

120 Dankwa, D. 2006. "FM Global Touts Underwriting by Engineering as Superior." *Best's Review*, p. 93, June.

121 Green, M. 2006. "Preparing For the Worst." *Best's Review*, pp. 40–44, April.

122 Multihazard Mitigation Council. 2006 "Natural Hazard Mitigation Saves: An Independent Study to Assess the Future Savings from Mitigation Activities." National Institute of Building *Science*s. Prepared for FEMA.

123 Burby, R.J. 2006. "Hurricane Katrina and the Paradoxes of Government Disaster Policy," Annals of the American Academy of Political and Social *Science*, March.

124 Dlugolecki and Lafeld. 2005. op. cit.

125 Stagnitta, L. and K. Forster. 2005. "Is Climate Change for Real and if so What is the Cause, Likely Impact, and Remedy?" *Proceedings of the Australian Building Codes Board National Conference*, Insurance Australia Group.

126 Association of British Insurers. 2005. "East London Sub-Regional Development Framework: Consultation." July.

127 Mills, E. 2003. "The Insurance and Risk Management Industries: New Players in the Delivery of Energy-Efficient Products and Services." *Energy Policy* 31:1257–1272.

128 Vine, E., E. Mills, and A. Chen. 1999. "Tapping Into Energy: New Technologies and Procedures that Use Energy More Efficiently or Supply Renewable Energy Offer a Largely Untapped Path to Achieving Risk Management Objectives." *Best's Review-Property/Casualty Edition* May, pp. 83–85. Oldwick, NJ: A.M. Best Company.

129 Mills, E. 2006. "Synergisms between Climate Change Mitigation and Adaptation: An Insurance Perspective," *Mitigation and Adaptation Strategies for Global Change*, Special Issue on Challenges in Integration Mitigation and Adaptation Responses to Climate Change. (in press)

130 Wendt, R. and H. Aglan. 2004. "After The Flood—There's Hope: Homes that are damaged by flooding can be repaired and made more durable." *Home Energy*, September/October, pp. 18–23.

131 Mills, E. and D. Sartor. 2006. "Energy Use and Savings Potential for Laboratory Fume Hoods." *Energy* 30:1859-1864.

132 Shamshoian, G., M. Blazek, P. Naughton, R.S. Seese, E. Mills, and W. Tschudi. 2005. "High-Tech Means High-Efficiency: The Business Case for Energy Management in High-Tech Industries." Lawrence Berkeley National Laboratory Report LBNL-59127.

133 See http://hightech.lbl.gov/dc-powering/

134 See http://www.millea.co.jp/en/social_respon/earth.html

135 Parker, D. 2005. "Post-Hurricane Opportunities." *Home Energy*, March/April, p. 24-27.

136 See http://www.fas.org/main/content.jsp?formAction=297&contentId=64

137 Submission to the Carbon Disclosure Project #3, http://www.cdproject.net/

138 http://www.locktonaffinity.com/resnet/

139 Brovik, C. 2006. "New Insurance Benefit for RESNET Members." *Home Energy Magazine*, p. 5, July/August.

140 Mills, E. 2003. "Risk Transfer via Energy Savings Insurance." Energy Policy, 31:273-281. LBNL-48927.

141 Seifert, B. 2006. "The Emerging Arena of Sustainable Building and The Contract Surety." *Surety Institute Claims Newsletter*, Vol. 18, No. 2, p. 4.

142 Mills, E. 2003. op. cit.

143 Makower, J., Pernick, R., Wilder, C. 2006. "Clean Energy Trends 2006." Clean Edge, Inc. p.3. McGraw Hill.

144 Dlugolecki, A. and Lafeld. 2006. op. cit.

145 Marsh 2006b. op. cit.

146 Marsh. 2006b. op. cit.

147 Kats, G., L. Alevantis, A. Berman, E. Mills, and J. Perlman. 2003. "The Costs and Financial Benefits of Green Buildings: A Report to California's Sustainable Building Task Force." Capital E, Washington D.C.

148 Cheslin, N. 2005. "Insuring a Green Future: A Proposal to Integrate the Interests of the Insurance and Green Buildings Industries." The Green Roundtable, Massachusetts.

149 Deering, A. and J.P. Thornton. 1998. "Solar Technology and the Insurance Industry: Issues and Applications." NREL/MP 520-25866, National Renewable Energy Laboratory, Golden, CO, 14pp.

150 See http://www.naturesave.co.uk/

151 Chen, A. and E. Vine. 1999. "It's in the Air: Poor Indoor Air Quality in Commercial Buildings is Costing Insurers More." *Best's Review*, pp. 79–80. Oldwick, NJ: AM Best Company.

152 Tom Wenzel. 1995. "Analysis of National Pay-as-you-Drive Insurance Systems and Other Variable Driving Charges." Lawrence Berkeley National Laboratory.

153 Victoria Transport Policy Institute. 2005. "Pay-As-You-Drive Vehicle Insurance." http://www.vtpi.org/paydsum.pdf

154 See http://pressroom.progressive.com/releases/Tripsense_04.asp

155 ICF. 2003 "Insights: Pay-As-You-Drive Insurance Offers Potential Benefits to Consumers and the Environment." (Winter) http://www.icfconsulting.com/transportation

156 O'Connor, R. and L. Goch. 2004. "U.S. and U.K. Policyholders Test 'Pay As You Drive'." *Best's Review*, p. 54, October.

157 Zwirner, O. 2000. "Impact of Greenhouse Gas Mitigation on the Insurance Industry." In Bernstein, L, Pan, J. (eds.) Sectoral Economic Costs and Benefits of GHG Mitigation, Proceedings of an IPCC Expert Meeting, Eisenach, Germany, 14–15 February 2000, pp. 260–269.

158 Berz, G. and T. Loster. 2000. Munich Reinsurance Company. Private communication.

159 See http://www.gerling.de/de/internet/content/kfz_oekotarif/jsp/intro.jsp?uid=Mail_unf

160 American Insurance Association. No date (c. 1999). "'Pay-at-the-Pump' Auto Insurance: An Idea Going Nowhere Fast." Washington, D.C.

161 See http://www.solomononline.com/

162 Zeng, L. and P.J. Kelly. 1997. "A Preliminary Investigation of the Trend of Flood Events in the United States." Presented at the National Association of Real Estate Investment Managers Senior Officer Property Insurance Forum, Boston, (March 18–19). Arkwright Mutual Insurance Company.

163 Swiss Re. 2006. Op cit.

164 Association of British Insurers. 2005. op. cit.

165 RNK Capital and Swiss Re. 2006. "RNK Capital and Swiss Re Structure First Insurance Product for CDM Carbon Credit Transactions: Insurance Instrument Mitigates Kyoto-Related Transaction Risk for Global Carbon Credit Trading." News Release, June 13.

166 Goodell, J. 2006. "Capital Pollution Solution." *New York Times*, July 30.

167 Aon. 2005. "Aon Provides Strategic Climate Change Review to BG Group." *In Alternative Views: Aon Captive Services Group Newsletter*, Issue 43, July.

168 Carr, M. 2005. "Swiss Re Offers Products to Limit European Carbon Risks." Bloomberg, March 30.

169 Dlugolecki and Lafeld. 2006. op. cit.

170 RNK Capital and Swiss Re. 2006. op. cit.

171 AIG. 2006. op cit.

172 See http://www.climatehelp.com.au/

173 Osborne, H. 2006. "'Green' Insurance Offsets Carbon Emissions." *The Guardian*

174 See http://www.climatesure.co.uk/

175 Linden, E. 2006. *The Winds of Change: Climate, Weather, and the Destruction of Civilizations*. Simon & Schuster: New York.

176 Marsh. 2006a. op. cit.

177 Credit to Rick Jones of AIG/Solomon for coining this term in the context of energy efficient behavior.

178 Travelers. 2006. "Travelers to Offer Hybrid Owners Across U.S. 10 Percent Discount on Auto Insurance." News Release, January 5. Hartford.

179 Mills, E., H. Friedman, T. Powell, N. Bourassa, D. Claridge, T. Haasl, and M.A. Piette. 2004. "The Cost-Effectiveness of Commercial-Buildings Commissioning: A Meta-Analysis of Energy and Non-Energy Impacts in Existing Buildings and New Construction in the United States." Lawrence Berkeley National Laboratory Report No. 56637

180 Lloyds of London. 2006. op. cit.

181 See http://www.iii.org/media/facts/statsbyissue/industry/

182 Mills, E. and I. Knoepfel. 1997. "Energy Efficiency Options for Insurance Loss Prevention." *Proceedings of the ECEEE Summer Study*, June 9–14, Prague.

183 Mills, E. and I. Knoepfel. 1997. op. cit.

184 Nutter, F.W. 1996. "Insurance and the Natural *Sciences*: Partners in the Public Interest," *Research Review: Journal of the Society of Insurance Research*, pp. 15–19 (Fall), Marietta, GA, USA.

185 See http://www.ricowi.com/

186 AIG. 2006. op. cit.

187 Business Wire. 2000. "Evergreen Solar Inks Financing and Marketing Deals; Prepares for Full-Scale Production." *Business Wire*, February 8.

188 See http://www.gerling.com/navigation/load.asp?ARTICLE=132&V=3

189 See http://www.allianz.com/azcom/dp/cda/0,,838721-44,00.html

190 Swiss Re. 2005. "German Allianz to Invest in Renewable Energies." German News Digest, 29 June.

191 See http://www.gerling.com/navigation/load.asp?ARTICLE=155&V=3

192 See http://www.storebrand.com/Storebrand/nyaapen/stbcomsri2.nsf/sok/9C7622954CF17C1AC1256FF1003BB261?OpenDocument

193 See http://www.swissre.com/internet/pwsfilpr.nsf/vwFilebyIDKEYLu/ DDAR-5S6JBH/$FILE/ TestimonyChrisWalkerUS SenateCommerceCommitteeOct103.pdf

194 Kovacs, P. 2005. "Homeowners and Natural Hazards." Canadian Underwriter, January 2.

195 Steitner, M. 1996. "Virtue Has its Rewards." Worth Magazine, p. 154, November.

196 Kellie Lewis. 2006. Insurance Australia Group. Private communication, May 25.

197 See http://www.afrbiz.com.au

198 See http://www.climatehelp.com.au/

199 Ryland, H. 2006. "IBHS Leads the Way to Safer Living." *Natural Hazards Observer*, pp. 11–12, July. Additional information from Chuck Vance, IBHS.

200 See http://www.unep-fi.net

201 Nutter. 1996. op. cit.

202 See http:// www.businessroundtable.com.au. and http://www.wwf.org.au/articles/australian-climate-group-acg/

203 AIA. 1999. "Property-Casualty Insurance and the Climate Change Debate: A Risk Assessment." American Insurance Association, Washington, DC.

204 AIA. 2000. op. cit.

205 Beattie, J. 2002. "Auto Insurers Back new CAFE Plan." *The Energy Daily*, 30 (17):1.

206 Green, M. 2006. "SUVs No Safer Than Passenger Cars for Kids." *Best's Review*, p 97, February.

207 UNEP-FI E-Bulletin. 2006. Issue 46 December 2005-January 2006 http://www.unepfi.org/ebulletin

208 Kroner, W., J.A. Stark-Martin, and T. Willemain. 1992. "Using Advanced Office Technology to Increase Productivity." Center for Architectural Research and Center for Services Research and Education, Rensselaer University, Troy, NY.

209 Gordes, J. 2000. "The Power to Insure: Reducing Insurance Claims with new Electricity Options." Greenfield, MA: Northeast Sustainable Energy Association.

210 See http://www.cdproject.net/

211 Friends of the Earth. 2005. "Climate Risk Reporting in SEC Filings of Publicly-Traded Property & Casualty Insurers."

212 Lecomte, E. A.W. Pang, J.W. Russell. 1998. "Ice Storm '98." Institute for Catastrophic Loss Reduction and Institute for Business and Home Safety.

213 Avery, D., E. Mills, M. Breighner, and J. Naylis. 1998. "Campus Lighting – Lighting Efficiency Options for Student Residential Living Units: A Study at Northeastern University, Boston, Massachusetts". LBNL/PUB-816. Also published by Arkwright Mutual Insurance Co. and by the University Risk Management and Insurance Association's *URMIA Journal*, 1999, pp. 44–52, Chevy Chase, MD.

214 See Mills, E. and I. Knoepfel. 1997, as well as Mills, E. 2005. op. cit. for more discussion of this point.

215 Ross, M. and T. Wenzel. 2002. "An Analysis of Traffic Deaths by Vehicle Type and Model." LBNL Report No 49675.

216 Wilson, E.J., T.L. Johnson, and D.W. Keith. 2003. "Regulating the Ultimate Sink: Managing the Risks of Geologic CO_2 Storage," *Environmental Science and Technology*, 37:3476-3483.

217 Wilson, E.J. and M.A. de Figueiredo. 2006. "Geologic Carbon Dioxide Sequestration: An Analysis of Subsurface Property Law." *Environmental Law Review*, 36:10114.

218 Mills, E., R. Roth, and E. Lecomte. 2005. op. cit.

219 IDNR. 2000. "Insurance Industry Participation in Promotion of Building Energy Codes." Prepared by the Center for Business and Economic Research, Louisiana State University, for Iowa Department of Natural Resources, August.

220 Marsh. 2004. "Responding to Climate Change Risks and Opportunities." Topics Letter Number XVI.

221 Green, M. 2003. "A Hole in the Wall." *Best's Review*, p. 51, July.

222 Mills, E. 2001. "When the Lights Go Out." *Best's Review*. Oldwick, NJ: A.M. Best Company, pp. 73-77, July.

223 See http://securebuildings.lbl.gov/