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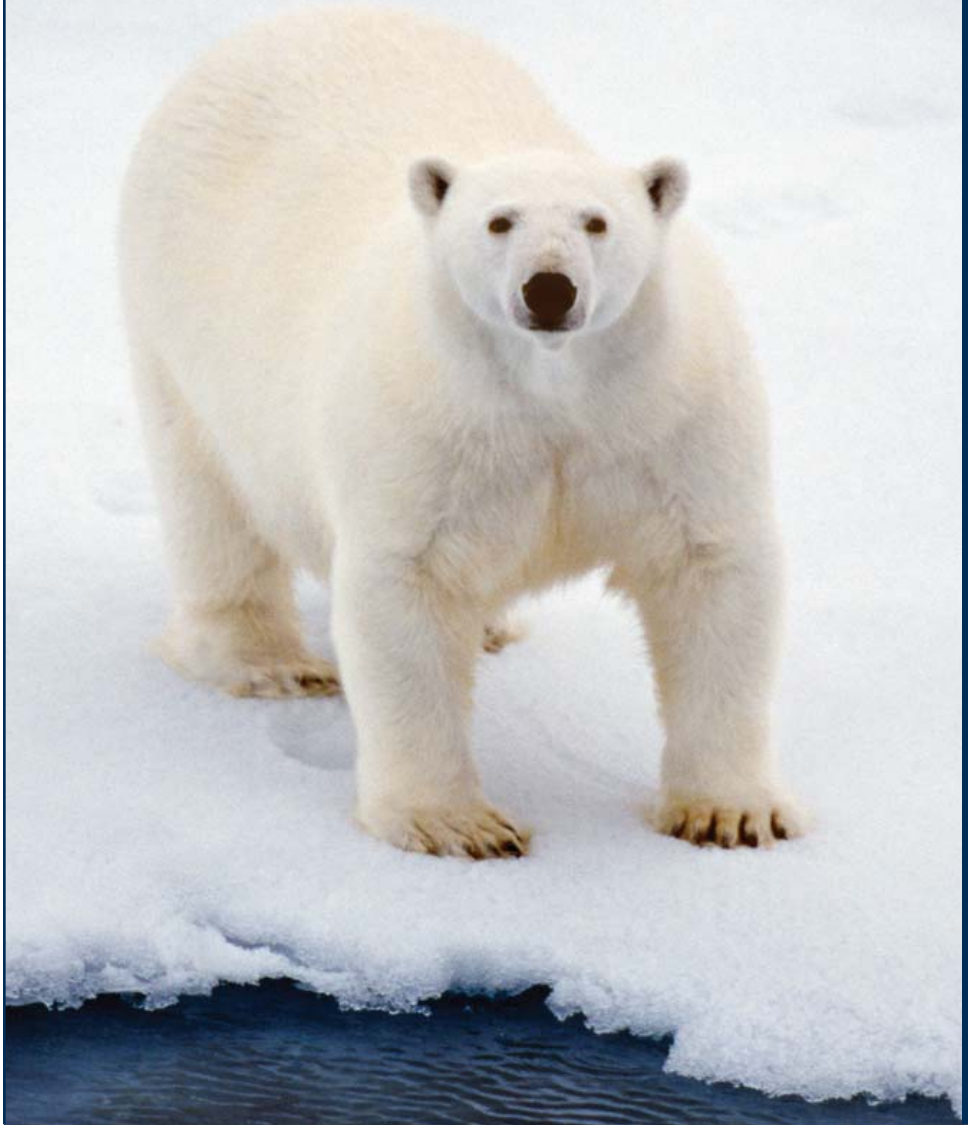
Government, Law and Policy Journal

A Publication of the New York State Bar Association
Committee on Attorneys in Public Service, produced in cooperation with the
Government Law Center at Albany Law School

Climate Change



- Energy Efficiency
- Land Use Law as a Solution
- Carbon Capture and Geologic Storage
- Regional and State-Based Initiatives
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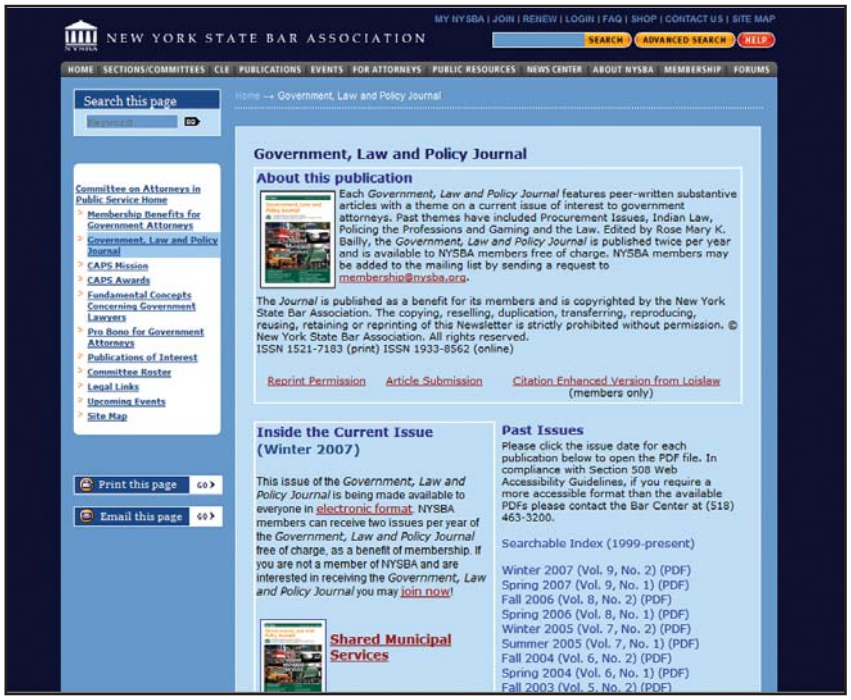

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NYSBA
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Message from the New York State Bar President

By Bernice K. Leber

I applaud the *Government, Law and Policy Journal* for devoting this issue to Climate Change, an issue that is no longer on the horizon, but one that affects all of us and the generations to come. Climate Change impacts on how we operate our businesses, run our households and manage federal, state and local government as well as our natural resources. In short, the time has come for us, as a profession, to consider how we can address these issues and make a difference not only in New York but also nationally and beyond.

"Climate Change impacts on how we operate our businesses, run our households and manage federal, state and local government as well as our natural resources."

The theme of my term is "Helping Lawyers, Helping Clients." At first blush, one may wonder how Climate Change relates to that theme. One need only consider the breadth and substance of articles in this issue to see how the two are related. Whether our clients are municipalities, industries or corporations, lawyers must be prepared to counsel them on how they can meet goals to reduce greenhouse emissions and comply with environmental regulations and legislation, such as the National Environmental Policy Act (NEPA) and the New York State Environmental Quality Review Act (SEQRA). Lawyers also have an obligation to keep abreast of regulatory and legislative changes or needed reforms that affect us as a profession and our clients. Finally, as lawyers, we are dedicated to public service and the betterment of our communities and laws. The ethical constraint of our calling requires each of us to consider how we can reduce carbon emissions and conserve energy resources.

The articles contained in this issue of the *Journal* are timely, informative and important. Once again, our Committee on Attorneys in Public Service (CAPS), ably chaired by Patricia Salkin, has contributed significantly to the scholarship surrounding a vital legal and policy issue. I join CAPS in extending appreciation to guest editor Kevin Healy and the Environmental Law Section for collaborating with CAPS on this issue and, as Climate Change is an issue high on my agenda this year, I expect to hear more from the talented attorneys in our Environmental Law Section. In this election year, it is especially important for lawyers to raise the consciousness and the level of debate on this pressing problem for us and for generations to come.

Message from the Chair

By Patricia E. Salkin

As I am concluding my second year as Chair of the Committee on Attorneys in Public Service (CAPS), I have been fortunate to have had the opportunity to meet and network with a large number of government lawyers for purposes of introducing more public sector attorneys to the wonderful benefits and opportunities of membership in the New York State Bar Association. This Standing Committee was created principally as a mechanism to demonstrate that government lawyers are in fact welcome and wanted for active participation in the activities and leadership of this Association. The Committee has also been able to inform the Bar about interests, issues and concerns of government lawyers. Recently, the Committee has assumed a leadership role in facilitating critically important dialogue about the potential impact of the new state ethics laws on the meaningful involvement of government lawyers in the Association.

Last year, the Legislature passed and the Governor enacted the Public Employee Ethics Reform Act of 2007. This broad, sweeping new ethics law made significant amendments to, among other statutes, the Public Officers Law and the Legislative Law, dealing with issues including conflicts of interest, gifts and lobbying. In March 2008, the Commission on Public Integrity issued a lengthy opinion (Advisory Opinion 08-01) addressing the issue of "gifts," following a change in statutory language which changed the gift prohibition from something of value of under $75 to now anything that is of "nominal value."

When the Committee was initially formed, one important early activity was the development by the Committee, and the adoption by the House of Delegates, of the "Fundamental Concepts Concerning Government Lawyers and Governmental Interests." These Concepts were designed to dispel beliefs that it was somehow unethical for government lawyers to participate in bar association activities. The five concepts, reviewed at the time by the New York State Ethics Commission, provide: **Concept One—**It is in the interest of the government that its lawyers participate in activities sponsored by bar associations. **Concept Two—**Government lawyers may serve in leadership positions within professional organizations. **Concept Three—**Government lawyers may use indirect support services for professional association activities that have been deemed to be in the government's interest. **Concept Four—**Government lawyers may encourage colleagues to join professional associations and to participate in professional association activities. **Concept Five—**Government lawyers may accept discounts on dues, meeting and member benefits, and CLE course fee waivers or discounts.

Questions have now arisen on the part of members as to exactly what, if anything, constitutes a "gift" when government lawyer members engage in Association activities. Furthermore, questions have arisen regarding the ability of non-member lawyers and government officials to participate in Association activities where food is served, where CLE credits are awarded, and where travel reimbursement or fee waivers are typically available and/or needed. Under the leadership of former CAPS Chair, Barbara Smith, CAPS is once again engaged in a study of the impact of public sector ethics laws and regulations on the Association. This critically important initiative is being coordinated Association-wide, with many Sections having appointed liaisons to CAPS for purposes of this study. In addition, each Section and Committee Chair has recently received a written survey from CAPS, requesting input about how each entity believes it may be impacted by the new ethics law. Working with the Association's Government Relations staff, CAPS members will be focusing on this issue throughout the spring and summer.

If you have questions or issues that you believe should be included in our review, please contact me at psalk@albanylaw.edu or Barbara Smith at bfsmith@courts.state.ny.us.

Other CAPS current initiatives include the development of a series of CLE programs on disaster preparedness, mitigation and response. In addition to the live programming, a resource for government lawyers on these topics is planned. Shortly, CAPS will be publically announcing the establishment of a new recognition program for government lawyers. Members Anthony Cartusciello and Robert Freeman have spearheaded this effort. Members James McClymonds and Catherine Bennett continue to demonstrate outstanding leadership in the refinement of a model code of ethics for state administrative law judges. This effort has benefited tremendously from the input of dozens of state agencies and administrative law judges.

Special thanks to our guest editor for this issue of the *Government, Law and Policy Journal*, Kevin Healy, Esq., who answered the call when CAPS approached the Environmental Law Section with the idea of collaborating on this volume focusing on climate change. This is another example of the types of collaboration CAPS seeks to foster within the Association. I am confident that the articles in this issue will help to inform policy and law in this challenging area. Thank you also to editor-in-chief Rose Mary Bailly, and to our student editorial team for producing another first-class publication. Plans are already under way for a special issue of the *Journal* in the Fall focusing on the legacy of Chief Judge Judith Kaye on the courts and communities of this State.

Editor's Foreword

By Rose Mary Bailly

This issue on Climate Change comes at a propitious moment. The words "climate change" and "global warming" are on virtually everyone's lips today. From federal, state and local governments, to industries and businesses, to individuals at home, at work or on the road, everyone is hearing, reading, and talking about the challenges we face from global warming and climate change and how we should address them. In February 2008, the American Bar Association added its voice to the discussion when it adopted a Recommendation urging the United States Government to "to take a leadership role in addressing the issue of climate change through legal, policy, financial, and educational mechanisms." The Recommendation and its accompanying Report are included in this issue.

J. Kevin Healy, Esq., of Bryan Cave LLP, the guest editor of this issue, is an outstanding guide for our examination of climate change. Mr. Healy has practiced environmental and land use law for over 30 years. He co-chairs the Global Climate Change Committee of the Environmental Law Section of the New York State Bar Association. He served on Governor Pataki's Climate Change Task Force and chaired the emissions trading subcommittee of that group, and has also lectured and written extensively on the subject of climate change over the last several years. The authors who have contributed to this issue also reflect outstanding expertise on this difficult yet compelling topic. I am extremely grateful to Kevin and his colleague at Bryan Cave, L. Margaret Barry, Esq., and to the contributing authors for their extraordinary efforts in assembling this issue.

I also want to extend my thanks to everyone else whose hard work and diligence have made this a successful issue. Our Board of Editors always provides support and encouragement. Our student editorial staff, once again, has risen admirably to the occasion. Executive Editor Martha Kronhholm and her colleagues, Kevin Hines, Rita Pasarell, Kaitlin Rogan, Brian Sharma and Thomas Wilder, did outstanding work. Without the talent and expertise of the staff of the New York State Bar Association, Pat Wood, Lyn Curtis and Wendy Harbour, I would be lost. And last, but most certainly not least, my thanks to Patty Salkin for her unstinting support.

"From federal, state and local governments, to industries and businesses, to individuals at home, at work or on the road, everyone is hearing, reading, and talking about the challenges we face from global warming and climate change and how we should address them."

Finally, any flaws, mistakes, oversights or shortcomings in these pages fall on my shoulders. Your comments and suggestions are always welcome at rbail@albanylaw.edu or at Government Law Center, 80 New Scotland Avenue, Albany, New York 12208.

The Challenge of Climate Change

By J. Kevin Healy

At the Annual Meeting of the New York State Bar Association last winter, Professor Nicholas Robinson of the Pace University School of Law briefed the members of the Environmental Law Section on the progress of international negotiations in Bali, Indonesia, toward developing a post-Kyoto framework for addressing climate change. During his presentation, Professor Robinson likened the challenges faced by the "Greatest Generation" in fighting World War II to those we now confront in mitigating and adapting to our rapidly changing climate.

This analogy is both a compelling and imperfect one. It is compelling because drawing a comparison between the current efforts needed to combat climate change to the life-or-death struggle of a global war highlights the sense of urgency we all should feel with respect to this problem. If the majority of the world's credible scientists are not off the mark, society is staring down a gun barrel: we will either move now toward sustainability or matters will deteriorate dramatically over the course of the next few decades. The analogy is also compelling because it highlights the enormity of the task before us. If we are to "lick" the climate change problem (as a member of the World War II generation would say), we will need to make enormous changes in the way we power our global economy. To achieve this will require a concerted worldwide effort of unprecedented proportions.

Professor Robinson's analogy, however, does not convey the long-term nature of the effort before us. Climate change is here to stay—it is not a problem to be resolved in six years, or even over the next decade or two. Keeping the inevitable rise in temperatures to manageable proportions and adapting to the increases that inevitably will occur will be the work of several generations. Our generation has much to contribute to that effort—we can continue to refine the work performed to date by the world's scientific community to achieve a better understanding of the nature and extent of the climate change problem. We can also begin to map out solutions, and put into place the mix of legal requirements and economic incentives needed to set the forces in motion to first reduce the emission of greenhouse gases, and ultimately bring stability to the climate.

This issue of the *Journal* is a step in the right direction. A significant collective achievement of the authors contributing articles to this issue is that they have broken down the potentially overwhelming problem we face into specific, bite-sized issues, and examined each of those issues in detail. Professor Robert Socolow sets the stage for the others in an article based on a presentation given last year to the New York State Public Service Commission. In that article, he summarizes the analytical framework of "stabilization wedges," which he and his colleague Stephen Pacala developed to illustrate how the reductions needed to stabilize carbon levels can be accomplished by pursuing a number of specific mitigating activities simultaneously (a "wedge" being a "unit of mitigation" representing an activity that could be implemented to achieve one gigaton reduction in carbon emissions per year in fifty years). Professor John Nolon picks up this theme, and explains how a "land use wedge" could be identified with the potential to achieve substantial carbon reductions through rational, fuel-efficient development.

"If the majority of the world's credible scientists are not off the mark, society is staring down a gun barrel: we will either move now toward sustainability or matters will deteriorate dramatically over the course of the next few decades."

Richard Tisch digs into another important wedge, carbon capture and sequestration. His detailed and thoughtful article examines the progress that is being made in developing this promising technology-based strategy, and the obstacles that impede its full implementation.

Several of the authors focus their attention on the legal framework required to organize most effectively the national effort to control greenhouse gas emissions.

Catherine Hill and Margreta Margulas first summarize the important work that has gone forward over the last decade or so on the state and regional level to create cap-and-trade programs, and otherwise regulate carbon emissions from stationary sources and motor vehicles. They then discuss how federal legislation could address the complications that might arise from the multiplicity of potentially inconsistent state requirements, while at the same time preserving the benefits of state and regional participation in the national effort to reduce carbon emis-

sions. Jared Snyder's thought-provoking article makes some specific suggestions as to how federal cap-and-trade legislation aimed at achieving a 66% reduction in carbon emissions from major sources by 2050 could be supplemented by state and local actions. Citing the "State Implementation Plan" model established by the Clean Air Act, he recommends a joint effort between each state and the federal government to achieve the additional reductions needed to attain the 80% reduction in carbon emissions required, according to many in the scientific community, by the year targeted by the Warner-Lieberman bill.

"While the task before us is daunting, we may take comfort in the fact that experts of the caliber of the contributing authors have turned their attention to the development of legal, political and scientific solutions."

The article written by Margaret Barry describes the wide variety of climate-change-related initiatives undertaken in recent years by municipalities, both collectively and individually. This article provides an idea of how much localities have to offer in the effort to reduce greenhouse gas emissions, given the jurisdiction they exercise over the design and construction of buildings, land use and other activities affecting the consumption of fossil fuel.

John Dernbach takes the "partnership" concept articulated by Mr. Snyder an important step further, and discusses how individual citizens could be brought into the effort. Recognizing that the monumental task of achieving massive carbon reductions cannot succeed without the support of individual citizens, he suggests several provisions that could be incorporated into the upcoming federal legislation to inform the public and induce individuals to participate in seeking out opportunities to curtail emissions. Hopefully, the message conveyed by this timely collection of articles will be heard by Congress, and the forthcoming federal legislation will allow ample room for participation by other levels of government and individual citizens.

Michael Gerrard focuses his attention on how the powerful environmental review laws enacted in the 1960s and 1970s are now being brought to bear on the issue of climate change. He provides a survey of climate-change-related litigation under the National Environmental Policy Act (NEPA), and describes how states such as New York, Massachusetts and California are addressing climate change in the environmental impact statements (EISs) their state analogues to NEPA require. He also discusses in detail the sorts of issues that an EIS might study with respect to climate change. Both Mr. Gerrard and another contributing author, Peter Iwanowicz, agree that the New York State Environmental Quality Review Act (SEQRA) provides the New York State Department of Environmental Conservation (DEC) with authority to require the examination of climate-change-related issues. Mr. Iwanowicz, who heads DEC's climate change office, also details DEC's progress in addressing climate change, with particular emphasis on the state's groundbreaking contribution to the Regional Greenhouse Gas Initiative (RGGI), the country's first multi-state cap-and-trade program aimed at reducing the emission of carbon dioxide.

Finally, the report of a study conducted by Kathie Dello, a scientist with DEC, brings home the point that climate change is not some problem for the far-distant future in some far-off lands, but a phenomenon with symptoms that are already starting to show close to home. Ms. Dello examines the temperature and precipitation changes she has discerned in the Adirondack Region over the last several decades. By identifying the parameters of the problem as it has presented itself thus far, her study contributes to the scientific basis needed for development of adaptation strategies for the most precious of our state's natural resources.

The variety of topics covered in this issue of the journal reflects the multi-faceted nature of the challenge the world faces in mitigating and adapting to climate change. While the task before us is daunting, we may take comfort in the fact that experts of the caliber of the contributing authors have turned their attention to the development of legal, political and scientific solutions.

I would like to thank all those whose hard work made this issue of the *Journal* possible, including the contributing authors; the students of Albany Law School: Martha Kronholm, Student Editor-in-Chief, and her colleagues, Kevin Hines, Rita Pasarell, Kaitlin Rogan, Brian Sharma and Thomas Wilder; Rose Mary Bailly, Editor of the *Government, Law and Policy Journal*; Patricia Salkin, Raymond & Ella Smith Distinguished Professor of Law, Associate Dean and Director of the Government Law Center of Albany Law School; and my colleague at Bryan Cave LLP, Margaret Barry.

Introduction to Dr. Socolow

By Eleanor Stein

On June 23, 2008, the New York State Public Service Commission established a statewide Energy Efficiency Portfolio Standard, and approved and funded the immediate expansion or creation of specified energy efficiency programs. In the weeks since the Commission's decision, the state's investor-owned utilities, the New York State Energy Research and Development Authority (NYSERDA) and others have filed plans to realize additional energy efficiency savings. These are the first steps toward decreasing New Yorkers' electric energy consumption by 15% from expected levels by the year 2015, with a similar goal for natural gas consumption.

The generation of electricity and consumer use of fuel by homes and businesses constitutes roughly one-third of greenhouse gas emissions, and energy usage in New York has been rising and is predicted to continue to rise in the future if no action is taken. The region, the state, and municipalities are already taking action to reduce New York's carbon footprint—including the Regional Greenhouse Gas Initiative, the Renewable Portfolio Standard, and the New York City Sustainability Plan (PlaNYC). The Commission added to these what New York and other states call an Energy Efficiency Portfolio Standard, or EEPS: for example, adding to New York's portfolio of energy resources a greatly expanded menu of programs such as modernizing lighting, upgrading the efficiency of household appliances, weatherizing houses and other buildings, and improving the energy efficiency of new construction. Governor Paterson's April 9, 2008, Executive Order No. 2 stresses the importance of these measures in state energy planning.

The New York EEPS will be designed, along with further development of renewable resources such as wind power, solar power, and hydropower, to decrease the state's dependence on fossil fuels for the generation of electricity, create opportunities for New Yorkers to reduce their utility bills by making their homes and businesses more efficient, forestall the need to build new power plants, stimulate clean energy economic development and create jobs in that sector for New Yorkers. The Environmental Impact Statement adopted by the Commission estimates that it will reduce New York's emissions of CO_2 by 16 million metric tons.

More than 100 parties are participating in this proceeding. They include utilities, environmental groups, consumer advocates, large customers, big-box stores, energy efficiency technology providers, towns, New York City, and other state agencies. The proceeding is intended to be a low-carbon regulatory enterprise: filings are electronic; Web-based meeting and communication are encouraged; only the absolute minimum amount of paper is exchanged. All filings and proceedings—including the Webcast of Dr. Socolow's presentation—can be visited at http://www.dps.state.ny.us/Case_07-M-0548.htm.

The proceeding began with a two-day Overview Forum on July 19-20, 2007, at Albany Law School, where parties were invited to offer experts from around the nation in each of the complex areas touched on in this effort. Wanting to frame the case with a sense of the urgency of reducing greenhouse gas emissions, we invited Dr. Socolow to open the proceedings with an overview on the current science and policy on climate change, and his perspective on the role of energy efficiency as a critical part of the solution to the rising concentration of CO_2 in earth's atmosphere. As he explains, he joined us in this effort because of his 30-year commitment to reducing the amount of energy we use as the cheapest, cleanest, safest and most immediately available alternative to expensive, imported, polluting fossil fuels.

Dr. Socolow is co-author, with Steven Pacala, of the ground-breaking study "Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies" (*Science*, August 13, 2004). Their work not only diagrams the climate impacts of greenhouse gases, but develops new tools and gives us a new vocabulary to define and quantify the possible solutions. In very real ways, Dr. Socolow has given us a common language for the climate change discourse. He is co-director of the Carbon Mitigation Initiative and professor at Princeton University, and publishes and lectures widely on climate change mitigation, among other things. We greatly appreciate his contribution to the proceeding, and his consent to publish his remarks on that occasion here.

Eleanor Stein is Administrative Law Judge, New York State Public Service Commission, and Adjunct Professor at Albany Law School, where she teaches The Law of Climate Change: Domestic & Transnational.

The Critical Role of Energy Efficiency in Mitigating Global Warming

By Robert Socolow

Public Service Commission, State of New York Proceeding on Motion of the Commission Regarding an Energy Efficiency Portfolio Standard

Albany Law School, Albany, New York, July 19, 2007

The following is a written version of the lecture presented by Professor Socolow at a meeting of the New York Public Service Commission on July 19, 2007.[1]

Thank you. I'm really thrilled to be here. This is the first talk in the first event of what may turn out to be a truly globally significant initiative on the part of New York State. I hope you can really make a difference by getting energy efficiency to the top of the list of ways in which we attack what's wrong with our current energy system.

It's been a passion of mine, the energy efficiency game. It became, and was, very exciting in the 1970s and 80s. There aren't many veterans of that early effort in this room, but fortunately, a few of us are still kicking who were part of all that. Dick Ottinger, congressman from New York State, from Westchester, was a national leader in the field and taught me a lot. Maybe people want to hear again what we think we figured out and then do it better.

So it's because you're attacking energy efficiency in this meeting that I said I'm going to just be here; if I'm invited, I'm going to come.

Past, Present, and Potential Future Levels of Carbon in the Atmosphere

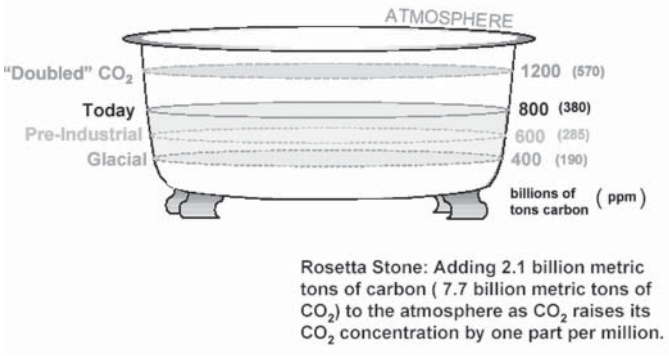


Figure 1

I'm going to start, though, with the biggest picture.

Past, Present, and Potential Future Levels of Carbon in the Atmosphere

The atmosphere can be thought of as a bathtub (Figure 1), and it's not that complicated a place. There's a certain amount of carbon in the atmosphere today. One of the wonderful things about this new way of casting the problem is we are considering the whole earth. It's our earth; it has certain properties. Its atmosphere has, in fact, 800 billion tons of carbon in it right now. Two hundred years ago, it had 600 billion tons of carbon in it. In the depths of the ice age, approximately 20,000 years ago, it had about 400 billion tons of carbon in it.

If you look through the ice-core records, it goes back and forth between 400 and 600 billion tons of carbon in about 100,000 year cycles, which is the ice-age cycle. We can learn about these cycles from ice cores drilled into the Antarctic ice sheet.

Six hundred is the reference number people use when they refer to future carbon. It's called the pre-industrial concentration or the pre-industrial quantity, and people talk about doubling or tripling it. When they just say doubling, that's what they mean. That's 1,200 billion tons of carbon in the atmosphere. From those numbers, you can see that at the present time we are both as far above the pre-industrial level as the depths of the ice ages were below, and one-third of the way to doubling. That is where we are, in this generation, as of the date of this meeting.

There happens to be another unit that people use to talk about carbon in the atmosphere. It is exactly proportional to the unit I've just explained, and it certainly confuses the conversation that we have two such units. This other unit is the fraction of the molecules in the atmosphere at this moment that are carbon dioxide molecules. It is 380 out of every million. When we're breathing right now, 380 molecules of carbon dioxide come in with each million molecules of air entering into our lungs. That number was about 285 in the pre-industrial period. The connection between the two units is 2.1 billion tons of carbon in the atmosphere equates to a part per million.

There's still a third unit: tons of carbon dioxide. Most of the prices that we talk about in the discussions of the

economics of carbon are dollars per ton of carbon dioxide, not dollars per ton of carbon.

So there are three units. They're all proportional, just like miles, feet, and meters. When you have a carbon atom, you have two oxygen atoms attached; if it's carbon dioxide then that's a ratio of 44 to 12, because a carbon atom weighs in at 12 and an oxygen atom at 16. These relationships are part of the lingo of this subject. It takes a while to become comfortable, but there's nothing very difficult going on here.

The ice core records are a marvelous piece of science. When we drill an ice core in the Antarctic, it's just like drilling into a tree to examine the tree rings; the deeper you go, the further back in the past you are. Bubbles are trapped in there. That's allowed us to reconstruct about a half-million years of history in considerable detail and discover what the atmosphere was like in the past, and what's going into that bathtub and what's going out. (Figure 2)

About Half of the Carbon We Burn Stays in the Atmosphere for Centuries

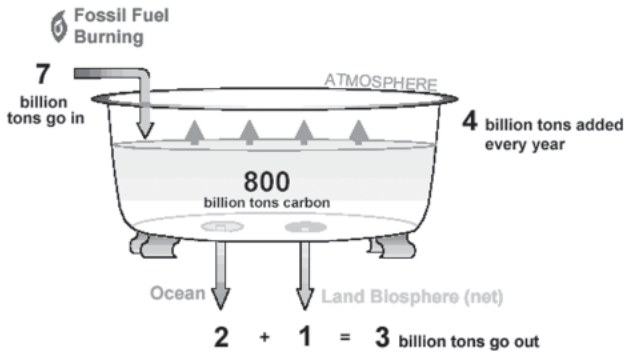


Figure 2

Out of the three units I'm going to pick the "tons of carbon" measurement. Seven billion tons of carbon every year are coming out of the ground. Approximately the same amount of carbon is going into the atmosphere, because not long after it's taken out of the ground, typically months, it will get burned. It'll be carbon dioxide. Not every bit of it is burned, but most of it is.

Carbon Removal Mechanisms

The atmosphere does not grow by seven billion tons of carbon each year, but by something less. That's because there are two removal mechanisms: drains in the bathtub. One is at the surface of the ocean. If there's extra carbon dioxide in the atmosphere, some of it dissolves in the ocean. About 2 billion tons out of the seven get removed that way. There are impacts on the ocean when this happens.

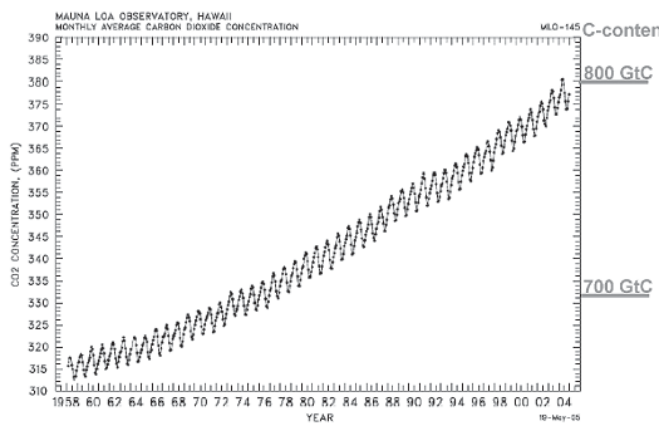
The size of the other removal mechanism is found, in fact, by subtraction. It's hard to measure, no one can model it terribly well. On average there's a net movement of carbon dioxide into plants, and into forests. In spite of deforestation, which affects the "land" arrow and by itself would point *up*, bringing roughly 1 or 2 billion tons of carbon into the atmosphere each year, the net exchange between the biosphere and the atmosphere in these units is one unit going *out* of the atmosphere, a land arrow that goes down. So that's the world we live in.

Climate Change History

The politics of all this starts in 1992 with the Rio Convention on Climate Change, which the United States signed. At that time, you hardly ever heard the word "ocean" in the discussion of the climate change problem. People were thinking about the atmosphere. Today we understand that the surface ocean is being changed by acidification: carbon dioxide goes into the water and makes it acid, which affects coral, for example. We now have a wider understanding of impacts.

We're about to celebrate the 50th anniversary of the measurement program high on the mountain of Mauna Loa, Hawaii, which is one of the two big mountains on the state's "Big Island." When the measurement started, there were fewer than 700 billion tons of carbon in the air, and in the 50 years that this has been going on, it's climbed to 800. It is, of course, still heading up. Figure 3 is the poster child figure for this subject as far as science is concerned.

Mauna Loa CO_2 Data, 1958-2004



Source: Oak Ridge National Laboratory, Carbon Dioxide Information Analysis Center http://cdiac.ornl.gov/trends/co2/graphics/mlo145e_thrudc04.pdf

Figure 3

How many of you are seeing this figure for the first time? More than half, so I'll take a minute with it. It's doing two things: the curve is oscillating and it's climbing.

The oscillation presumably was there 500 and 1,000 years ago, but no one measured it. It's the result of an exchange of carbon dioxide between the forests and the atmosphere on an annual basis. When the forests grow, carbon dioxide comes out of the atmosphere into the

leaves. When the leaves decay on the forest floor, the carbon dioxide goes back where it came from. At that time, this would have been the whole story. The oscillation would have been centered around 280 parts per million or 600 million tons, and it wouldn't have been rising.

The climb is because we're burning fossil fuels and to a lesser extent deforesting. The climb would be twice as steep but for those two sinks, which are making it climb at the rate that is seen here.

This concludes Carbon Cycle Science 101.

Climate Change Impacts

Then we have the question of impacts. I'm going to use this one figure (Figure 4) to discuss impacts, because I want to move along enough not to take four hours with this presentation.

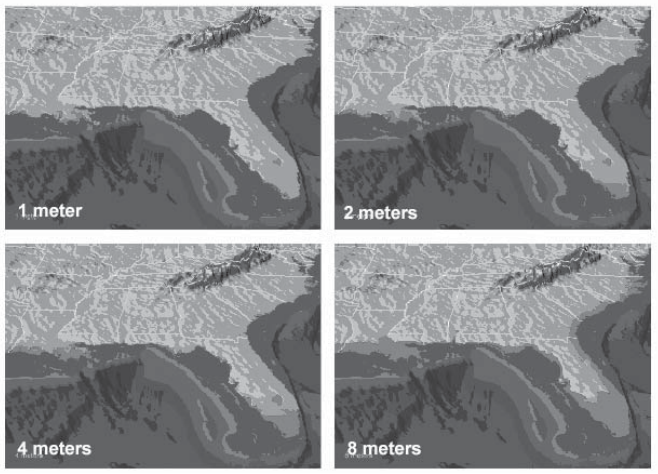


Figure 4

You have here the consequences of sea level rise for the Gulf of Mexico and Florida. The figure reminds you that Florida is very flat. Half of it disappears if sea level is only eight meters higher than it is right now. Will it get eight meters higher? The answer used to be, "We don't have to worry about that for a long time." In the last couple of years, it's, "Well, maybe we do have to worry about that, even now."

There are two ice masses on the planet that are secure for the moment. One is the glaciers of Greenland and the other is what's called the West Antarctic Ice Sheet (it's a piece of Antarctica that points up to Latin America, jutting out toward Argentina and Chile). Each of those, if it were to melt, would be worth about six to eight meters of sea level. You just take the mass of ice, spread it over the surface of the ocean, which is two-thirds of the surface of the planet, and that's how much climb you get.

A question that intrigues me is: "Which of the impacts of Climate Change are the ones that are going to be politically salient?" Is it going to be sea level rise—with a lot of uncertainty about whether it's something we have to be concerned about? Suppose we were told that there is a 10% chance that sea level will rise by 10 meters over the next 1,000 years if we do not address climate change, and that only in 100 years will we know whether this is the track we're on? Would that be enough to engender political action?

Or, considering hurricanes instead of sea level rise (both affecting the same territory, southern Louisiana), will salience adhere to the impacts of rare events becoming more frequent? If a bell curve describes the occurrence of intense storms, droughts, very hot days, and other unwanted environmental phenomena, and climate change simply shifts these bell curves to the right, enriching the upper tail, then there's a bigger chance for extreme events than a focus on average values would suggest. Is that what's going to drive people to action?

In both cases, we can think of our response to climate change as buying insurance. My colleague, [Stephen] Pacala, calls these "the monsters behind the door." There are a bunch of monsters. As we learn more, we find out about more monsters.

Every once in a while, we discover that a monster is not as fearful as we thought it was. There was a lot of concern about the shutting down of the Gulf Stream five years ago, and that was a monster. This outcome may not be as likely as people thought it was. Not everything is getting scarier. But a lot of new knowledge reveals more ways by which our adding carbon dioxide to a complex climate system brings problems for us. Yes, for other species too, but clearly, primarily, for us.

The head of NASA said something very provocative a few weeks ago. He asked why we are privileging the climate of the present time. Why are we going to put all this effort into limiting how much it changes? Someone who spends much of his time thinking about life on Mars might indeed need help with this question. But most of the rest of us can answer: We privilege today's climate because it's the one we've adapted to.

Coming out of the last ice age, suppose sea level had risen above where it is today. Because more glacier melting had occurred, we would have set up our cities in different places; we would have set up our agriculture in different places. We've gotten very locked into this particular way of using the planet. We can move our cities and agriculture, but it's very costly to do so. So, in some sense, in deciding how to deal with climate change we're trading one dislocation against another: the dislocation of adapting to impacts like rising sea level against the dislocation of changing our energy system.

When I talk so anthropocentrically, I am diminishing the impact of irreversible changes on other species, like polar bears. Somehow, we need to make these impacts part of our thinking too.

I'll tell you one last thing about sea level, which I find intriguing: The difference in sea level between its minimum during an ice age and its maximum during an inter-glacial is about 100 meters. The planet's land shape during the last ice age was quite different from today's, with not only the Bering Strait exposed, but also many other land masses.

The last time the Earth came out of an ice age before this time was 120,000 years ago. In fact, the Earth came further out of an ice age that time than this time. More ice melted, and sea level was higher than today by about six meters. So, is our global warming bringing us closer to the world of the last inter-glacial? This is a world where the southeastern U.S. resembles the bottom right panel of the picture (Figure 4).

It's very intriguing; we're learning all this as we go. Discoveries of what the last ice age was like and what coming out of the previous ice age was like (the last relatively warm period) are going to keep coming over the next few years, because many scientists are working on this. We're getting more and more messages that explain the human condition.

Emissions

Steve Pacala and I tried to make sense of what all this had to do with energy and policy. We focused on that 7 billion tons of carbon pulled out of the ground each year today and said, "Let's learn a little more about it." The first thing you can do is look back in the past (Figure 5). We see that 50 years ago the global emissions rate was less than one-third of what it is today.

Earlier today Judge Stein and I were looking at a black-and-white photograph of a scene 50 years ago on the very street in Albany where the hotel is located where I stayed last night, State Street. There were trolleys and some bicycles and lots of cars and older buildings. Albany didn't look in such a bad shape. At that time, the world was using one-third as much carbon (about half as much in the U.S.) compared to today.

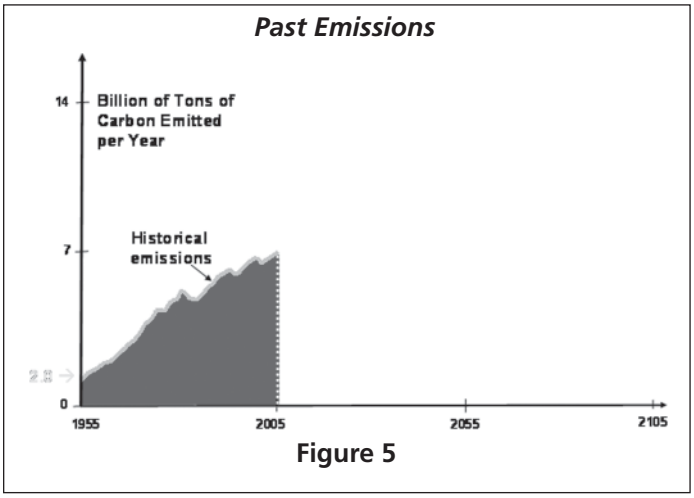


Figure 5

Look at Figure 5. All that blank space at the right side of this picture is intended to provoke two questions. The first question is, "If we don't care about carbon for the next 50 years, what will emissions be?" If we buy Senator Inhofe's view that climate change is a hoax being perpetrated on the American people, it's time to come to our senses: what will be the emissions? There are thousands of papers answering that question, done by a group of people who generally go under the name of econometricians. They use the past as a guide to the future, try to develop what the Gross National Product rate of increase will be, how much technology will come in, and they come up with lots and lots of answers, with a big band of answers.

The other question is, "If we really care about the climate problem and work very hard, what should our goal be for 50 years from now?" Another thousand papers exist with the discussion of that topic.

Because so many papers produced so much noise and so little signal for those of us who are onlookers, Pacala and I asked, "Can't we cut through this?" And we drew this picture (Figure 6). This picture says that about double the carbon extraction rate, 14 billion tons of carbon a year, 50 years from now, is where we're heading if we ignore climate change. Of course, you can make cases for higher or lower numbers, but we needed to make a single choice. We tried to be in the middle of what is out there. The picture also says that if we could keep global carbon emissions to today's level for 50 years, we should be real pleased. We should be proud of ourselves.

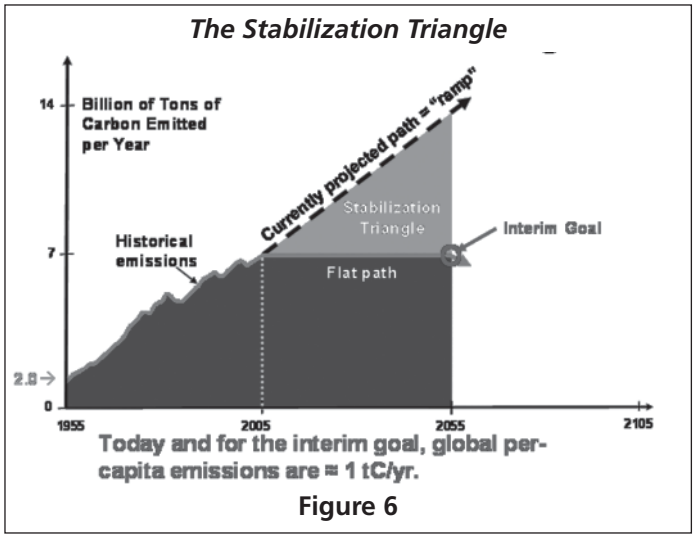


Figure 6

I circled one point on Figure 6, calling it our "interim goal": 50 years from now, the same global carbon dioxide emissions as today. Many of you in this room are going to be around in 2055. Please have a party, and remember us, if the rate really is as little as seven billion tons of carbon per year.

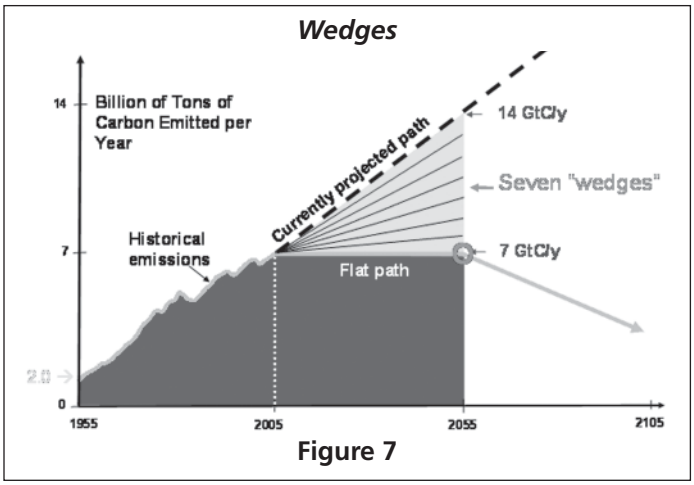


Figure 7

To illuminate that rate in an interesting way, there are about seven billion people on the planet. So our share as individuals is a ton of carbon a year, taking it out of the ground, putting it in the atmosphere. I'm going to repeat that number a few more times and show you how big it is in terms of other things.

I am optimistic that we can meet this interim goal for three reasons. One is that we have a terribly energy-inefficient energy system. At this point in talks, I usually look up at the ceiling in the room I'm in, and, as I do right now, I usually find an incandescent bulb up there. This room is not the most overlit room I've talked in, by a long shot.

The second reason for my optimism is that so much of what will be the world's capital stock in 50 years is not yet built. Sure, some of what we now have, as that photograph in the hotel hallway suggests, will be around in fifty years. But globally, quite a lot is still to be built.

And the third reason for optimism is we haven't yet had a price on carbon. More accurately, we're just beginning to have a price on carbon in a few markets, like the European Trading System. These are the three reasons why I find it possible to imagine achieving all of the savings in the stabilization triangle in Figure 6.

Most of the criticism of Figure 6 in the last three years (a figure that has become something of an iconic figure) asserts that it underestimates the job ahead. The rising arrow isn't rising steeply enough to capture what "Business as Usual" will bring, and the flat line is too timid a course of action to avoid climate change. Keep those criticisms in mind, because to the extent that these criticisms are valid, addressing climate change adequately means doing even more of what we'll be talking about.

Some of you know the language of two degrees and three degrees as another way of talking about goals. These are proposed values for targets expressed in terms of the maximum rise in the average surface temperature of the planet, compared to the pre-industrial time (in Celsius degrees). We're one degree Fahrenheit (0.6ºC) above the pre-industrial temperature already. Figure 6 can be restated in this language. We're on track for a 3ºC (5.4ºF) temperature rise if we follow the flat path, and for perhaps a 5ºC (9ºF) rise if we follow the rising path. Many Europeans argue today that 3ºC is too much, and that we should aim for 2ºC (3.6ºF). To do so requires roughly cutting the global emissions rate by half in 50 years, a much tougher job than keeping it constant.

The Wedge Model

We did one other thing, Pacala and I. We divided the stabilization triangle into seven equal pieces and named these pieces "wedges," creating a unit of discussion for the subject (Figure 7). A wedge is a campaign or a strategy that leads to one billion tons of carbon per year not being emitted on the planet 50 years from now. It could be a campaign of various kinds, and so you can compare campaigns.

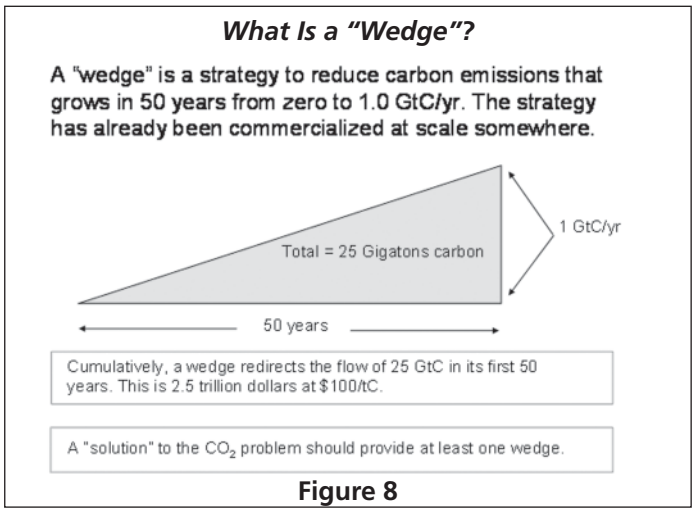


Figure 8

Our wedge is a triangle (Figure 8). You can verify that it results in 25 billion tons of carbon not added to the atmosphere because of some campaign. I want to call your attention to the price of carbon on this figure, $100 a ton of carbon (about $30/ton CO_2). This is, in my view, the approximate price one ought to have in mind for dealing with climate change. It's not cheap; I'll say more a little later about how expensive it is. This price makes a wedge a $2.5 trillion enterprise. That's a lot of jobs around the world.

So, now we go on a hunt for wedges. First, let's find out where the seven billion tons of carbon are coming from right now. Take Figure 9 as a starting point. The three-by-three set of skyscrapers shows how emissions are split between gas, oil and coal. These are the three forms of carbon that come out of the earth. The figure also shows the split between power, mobile applications, and stationary applications that are not in the form of electricity but use fuels directly.

The two tallest skyscrapers are about equally high, and between them they add up to half of the total, which

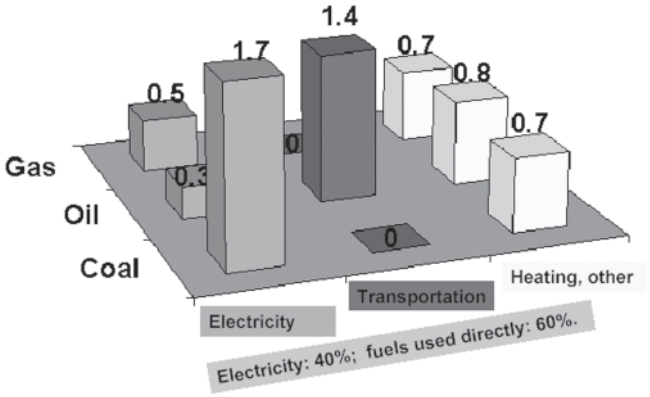


Figure 9

was six billion tons of carbon in 2000. It was seven when Pacala and I wrote the paper. It's around eight right now. When we move past this figure, we'll stick to seven. We're going to change seven to eight with appropriate fanfare sometime soon.

The two tallest ones are coal-to-power and oil-to-transport, no surprise. At the right, you find natural gas going to buildings, which is part of the discussion you're embarking upon today; also oil heat going to buildings, which, I suppose, could escape your process. Since these two compete fiercely, however, you will not really be able to forget oil heat.

If you just take the electricity column, it's 40% of the emissions globally. It's also 40% of the emissions in the U.S.

If you just take the carbon emissions from power, and compare them to the carbon emissions in New York State from everything, does anyone in this room know the percent? It is about 25%.[2] That's because you have a more decarbonized power system than the country as a whole.

We seek broad categories for sorting out the wedge strategies (Figure 10). Energy efficiency is at twelve

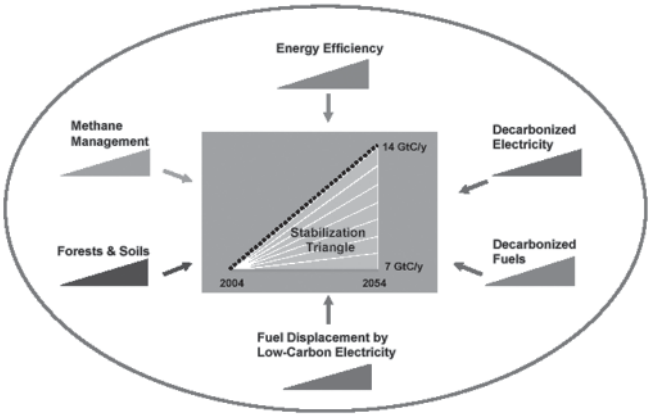


Figure 10

o'clock, because that's where I think it belongs, right at the top. We can decarbonize the electricity system; we can decarbonize the direct use of fuels. At two o'clock and four o'clock, we recognize that both power use and fuel use can be decarbonized, and because of the 40% figure above, neither can be ignored. At six o'clock, we acknowledge that it's harder to decarbonize the use of fuels than to decarbonize electricity. At least that's our current wisdom. So if there's a price on carbon and a tilt in the economy away from emitting carbon, there'll be a shift toward electricity and away from direct fossil applications. An example is the plug-in hybrid car, where much of the energy for driving is coming by way of a battery that is charged from a grid. Another example is the electric heat pump for space heating, which is a very important energy application.

Forests and soils, where we deliberately add to the planet's biomass (and therefore to the carbon in the biomass), e.g., by planting trees, are at eight o'clock. And methane management is at ten o'clock, reminding us that carbon dioxide is not the whole story, that there are other important greenhouse gases. They are less well-understood. They're harder to address. For example, if we want to save methane emissions in New York, I'm not sure I know exactly where to start. Consider the methane issue evidence of the slow pace of science—frankly, an underattended problem.

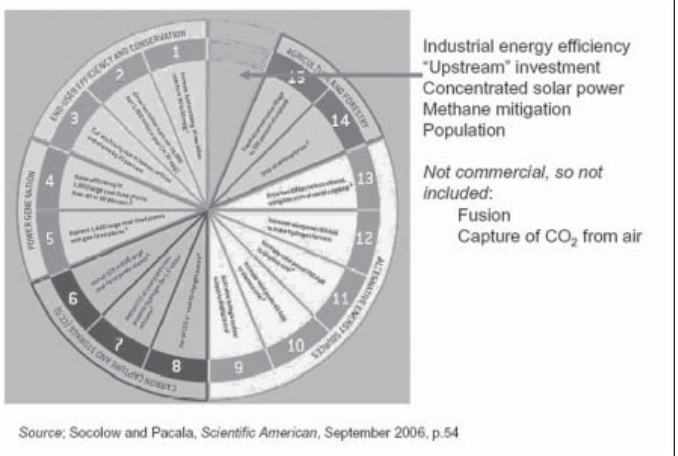
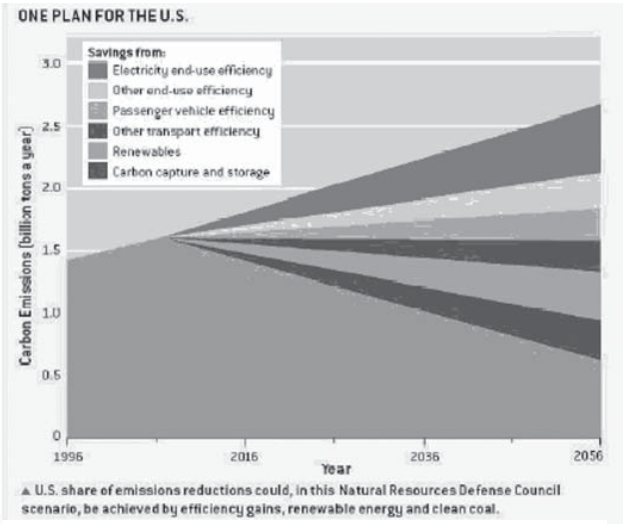


Figure 11

Pacala and I wrote two papers, in *Science* in 2004[3] and in *Scientific American* in 2006.[4] Both have the same list of wedges (Figure 11). I want to identify here a few things that weren't on the list. People say, "Well, here's one not on your list, it must not be important." Read our papers. We said that there are wedges not on our list that are important.

Industrial energy efficiency didn't happen to be on our list. We put in buildings efficiency and vehicle efficiency, but not industrial efficiency, which of course is important. But as all of you know, industrial efficiency

U.S. Wedges



Source: Lashof and Hawkins, NRDC, *in* Socolow and Pacala, *Scientific American*, September 2006, p. 57

Figure 12

is more easily internalized by the decision makers, who will pay more attention to any carbon price that comes in. Carbon efficiency emerges naturally for many of the businesses, especially for those for which carbon or energy is a significant fraction of the total cost. When it isn't, the industry becomes more like a building.

"Upstream" investments are the oil and gas and coal industries' own emissions of carbon as they develop the product for you. We left out concentrated solar power ("CSP") while listing wind and photovoltaics. CSP is a very interesting application where you have troughs in the desert producing high temperature heat to run engines. Also missing are methane (mentioned a moment ago) and population.

It has become unfashionable to link population with environment. This happened in the same period when this whole agenda that we're here to talk about became unfashionable. My shorthand, I hope this is allowed in a room like this, is that Reagan shot the messenger, in 1980 or so. And from then on, environmental problems became less important. The de-linking of population is a part of this story.

I gave a "Millennium Lecture" at Princeton at Alumni Week, only a month ago, to the members of the class of 2000 who returned for reunions. So, they are 28, 29 years old, and there are a couple hundred of them in the room. I said to them, "The most important consumption decision you are going to make is how many children you're going to have." Whoops. Okay.

They said, "Really?"

"Yes."

Fortunately, the past few decades have displayed a very important negative feedback: if we get richer, we want fewer children. Is that feedback robust, or could it get undone? And does this question have anything to do with the task you've set yourselves? I'm not sure.

"The Wedge Model is the iPod of climate change. You fill it with your favorite things." That's a quote from David Hawkins, who works at the Natural Resources Defense Council, and who, with his colleague, Dan Lashof, also made Figure 12. Figure 12 shows U.S. wedges in a world consistent with the Princeton global wedges. Figure 12, which is in Al Gore's movie, shows the U.S. part of that global story and tells us how Hawkins and Lashof would fill their iPod. There is no nuclear power, because NRDC doesn't like nuclear power; but there are four efficiency wedges, one renewables wedge, and one carbon capture and storage wedge in their particular analytical product.

The view of the U.S. in Figure 12 is meant to match a world in which the global emissions are held constant. In such a world, U.S. emissions have to come down and New York emissions have to come down. New York's emissions are about 4% of U.S. emissions.

To complete this general introduction to wedges, I wish to emphasize that every wedge strategy can be implemented well or poorly. These are not miracles. In fact, they're dangerous. For example, nuclear power can be done well, but we're nowhere near doing it well. We certainly don't want to trade climate change for nuclear war.

Conservation can lead to too much regimentation. That, I know, will be on your minds. How much can you intrude on the way people use energy indirectly and directly? I don't know where the right place is to insert it, but I can't resist: You made a major decision in this city two days ago, which is dreadful. It had to do with regimentation and had to do with efficiency and had to do with the way in which we're going to put carbon into the atmosphere and how many years it's going to take to start reducing our national emissions. I'm referring to what happened to the proposal to have congestion charges in New York City. Walking away from this proposal had something to do with avoiding regimentation. Consider the outcome a small taste of what might be coming forward.

Another example of doing wedges badly is not paying attention to the competing uses of land affecting renewables. Still another is "clean" coal. The phrase "clean coal" is widely used by the energy crowd, of which I am part, typically, to mean that you're burning it well, with minimal emissions, including emissions of carbon dioxide. We often forget to insist that the word "clean" should only be used if coal is handled cleanly upstream, too: mining, land reclamation, worker safety all count.

You must assume that whatever you'd like to do as a solution to climate change could be done badly. How will it get screwed up? Ask that question at the front end. You will, of course.

Turning to specific wedges, I'm going to discuss two classes of wedges. I'll go through the first class slowly, because it's about efficiency, the topic of this exercise. I'll go through the second one more quickly; it's about clean coal. These two are, I think, the most urgent ones for the next decade or so.

Efficiency Wedges

We are talking about the consumption of the people on the planet who already have some means, the consumers, the members of post-industrial society. They have appliances in the homes and the vehicles by which they move around dominate the scene. The importance of their consumption in global terms is relatively new, as you saw in earlier figures.

Globally, 60% of oil is used in vehicles and 60% of electricity is used in buildings. In the U.S., 70% of electricity is used in buildings. In New York State in 2006, the fraction was 85%! 150 billion kilowatt hours of electricity were consumed, 52% in commercial buildings and 33% in residences.

The carbon dioxide mitigation challenge is a challenge to both energy supply systems and energy use systems, but for now we'll talk about the use systems.

Here's a carbon number: If your car gets 30 miles a gallon and goes 10,000 miles a year, you're going to put a ton of carbon into the atmosphere. That was your quota as a global citizen, if you remember, for all of your carbon. That one part of your footprint is the global average. Some of you are driving 60 miles a gallon cars 10,000 miles a year, and some of you are driving a 30 mpg car 5,000 miles a year. If you're doing one of those, you're putting half a ton of carbon in the atmosphere.

The first wedge calculation I'm going to show you concerns auto carbon dioxide emissions (Figure 13). The auto industry believes there will be 2 billion vehicles on the planet in 2057, about three times what we have right now. If they are the reference vehicles that I just referred to, 2 billion tons of carbon will go into the atmosphere. If instead, by deliberate policy driven by climate concerns, they are 60 miles per gallon vehicles on average, we'll have a wedge from energy efficiency in vehicles. If we have restructured our cities and commute less and if we are using video-conferencing and drive less on the job, we might actually have a wedge in a different way, 30 miles per gallon cars with 5,000 miles of driving each. Or we could have done both, and we would have a wedge and a half.

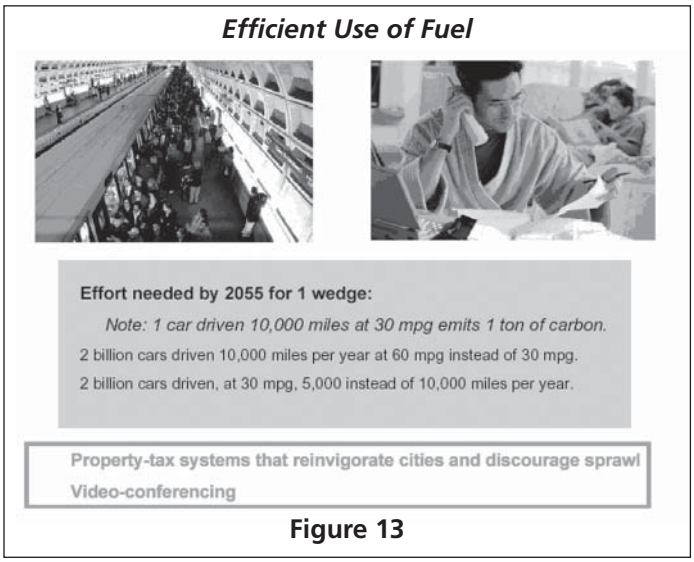


Figure 13

This is not a meeting about transportation. Some of you ought to be (and I'm sure you are) asking yourselves, "How are we going to deal with that other part of the carbon problem in New York State, the carbon coming out of the tailpipes of vehicles?" I hope some groups of people are putting that onto Governor Spitzer's agenda. We are driving more and more in the U.S. We're also not improving the vehicle efficiency.

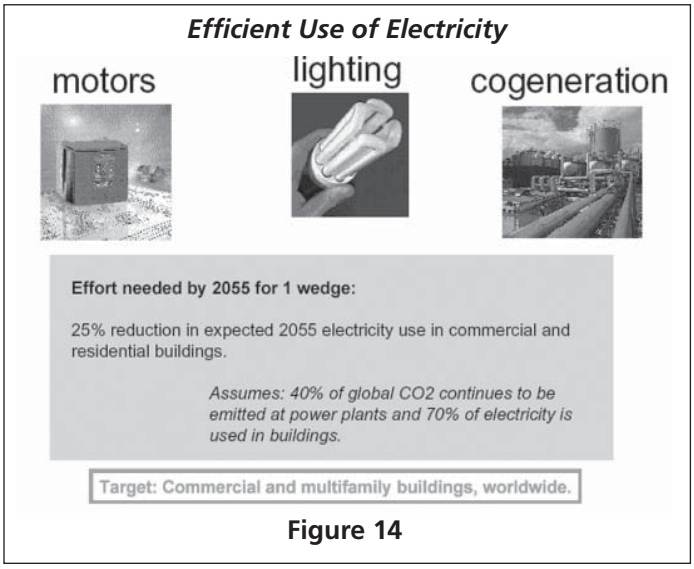


Figure 14

More to the point of your exercise is efficiency in electricity use (Figure 14). If 40% of carbon dioxide will continue coming from power plants, and 70% of that power will be used in buildings, and 14 billion tons of carbon is our baseline, then cutting a quarter out of electricity use in buildings will be a wedge. Cutting a half out would be two wedges. Wedges are hard to find. These are promising and exciting wedges. Obviously if we're decarbonizing the power system at the same time, we're doing better still. And if we're recarbonizing, moving to coal, these are even more important wedges.

I've got three images in Figure 14. One is the variable speed drive motor. An awful lot of electricity is consumed in motors, and motors can be made a lot more efficient. Another is the compact fluorescent bulb that isn't in the

ceiling straight over my head. The third is a cogeneration plant, which is using both electricity and the heat generated in producing it. The Public Utility Regulatory Policies Act of 1978 (PURPA) enabled cogeneration. It was a conceptual breakthrough. It forced utilities to allow non-utility generators to put their electricity on the grid. It and CAFE were perhaps the most important carbon related initiatives.

Which new conceptual breakthroughs will you produce, your generation's equivalent of PURPA and CAFE, that the energy policy community will talk about with admiration twenty years from now?

Five Ways to Cut 1 Ton C/yr. by Half

	1 ton carbon/yr	Cut in half	How?
a) Drive	10,000 mi, 30 mpg	60 mpg	Lighter, less power(?)
b) Drive	10,000 mi, 30 mpg	5,000 miles	Live closer to work
c) Fly	10,000 miles	5,000 miles	Video-conference
d) Heat home	Nat. gas, av. house, av. climate	Insulate, double-pane windows, fewer leaks, condensing furnace,	
e) Lights	300 kWh/month when all-coal power (600 kWh/month, NJ)	All-coal power: add CCS* at 60% of the plants, or permanently replace twenty 60W incandescent bulbs, lit 6 hrs/day, with compact fluorescents.	

*CCS = CO_2 capture and sequestration

Figure 15

To be concrete about energy efficiency, consider Figure 15. I list activities that emit a ton of carbon per year and how to cut them in half. The first two are from our already discussed reference car, which we can drive less or exchange for a car with better fuel efficiency.

The third is about air travel. A mile flying in a commercial aircraft has about the same associated carbon dioxide emissions as a mile of driving alone in our reference car. Many of us in this room have to face the fact that our footprint is dominated by plane travel. Only a small fraction of the people on this planet have carbon footprints dominated by air travel, but it's an awfully common situation among analysts who work on energy efficiency.

As for the fourth item, residential heating, I've worked out the CO_2 emissions that accompany the heating of my own home in Princeton, which is not a McMansion. I heat with natural gas, and the carbon emissions from that heating are just about a ton of carbon a year. I split that with my wife, so that's a half a ton of carbon for me. It could be a lot easier to make this calculation, and your group could address this. My gas bill is in therms. Few people have a clue how to go from therms to tons of carbon. (Answer: Burn about 700 therms of natural gas and a ton of carbon will go into the atmosphere.) The gas bill could do this for us.

We energy analysts were talking in the 70s endlessly with the utilities about what goes on the bill statement. I feel like I'm Rip Van Winkle, you know? Those histograms on your bills today with bars on them showing gas consumption are the result of the 70s work. They don't have anything directly to do with carbon, because carbon wasn't what we were specifically interested in, but the arguments and outcomes are all transferable from energy to carbon. Carbon histograms could be constructed by changing a couple of keystrokes. You could tell customers what the carbon footprint was in their home: giving them annual numbers, comparing these numbers with past values, comparing them to a reference group, and doing whatever else you wanted to do. All these ideas were discussed a great deal in the 70s literature.

For electricity consumption, the final item in Figure 15, the story is slightly more complicated than with gas. We need extra information from the electric utilities. With gas, you can go from therms to carbon without further information, and so you can work out your emissions yourself if you want to. Your local newspaper might tell you how to do it. But for electricity calculations, you need another number: the carbon intensity of your particular utility for some particular time period. What exactly were the energy sources that produced the electricity you happened to buy that month? That's known, but it's not known past the utility level today.

If I used 300 kilowatt hours a month (which is about a third of my own actual electric bill) my carbon footprint would be a ton of carbon a year—provided I used coal-based electricity exclusively. But New Jersey is about half as carbon intensive as that, so 300 kilowatt hours would be associated with half a ton of carbon. In New York State, you're going to get quite different answers in different parts of the state. The carbon footprint for electric power, which is key to what your meeting is about, is geographically dependent within the state because the key conversion factor depends on how much of your power comes as hydropower from Canada, or nuclear power from your own plants, or coal power produced in Pennsylvania.

You have a job ahead of you to translate this to the public. But when you do, you'll create a lot of understanding you'll be able to build upon. At least I think so. You just might impact China when you're all done. Don't forget that. The world is going to watch what you do. You're actually early movers.

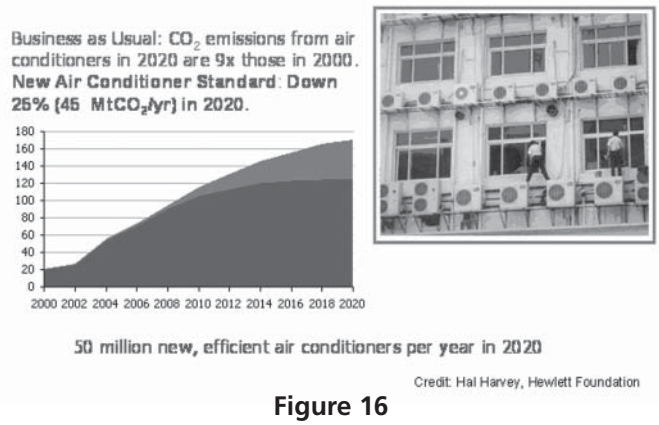


Figure 16

Here is a marvelous picture. I think these guys are cleaning windows and they're not even wearing safety belts (Figure 16). But they're standing on the room-by-room air conditioners that are sprouting like mushrooms all over China. The figure also shows two projections of the carbon dioxide emissions from China's air conditioners, with and without an advanced efficiency standard in place. With the standard, China will install 50 million new efficient air conditioners a year in 2020. The figure says that the efficiency policy, if enforced, will produce that upper wedge of savings, which has grown to 45 million tons of carbon dioxide per year (12 million tons of carbon a year) in 2020. Is it conceivable that U.S. labor could make these air conditioners, or parts of them?

How does New York's air conditioner standard compare with the Chinese standard? Does New York State have a tougher one than the U.S. federal standard? Is it allowed to have a tougher standard? I look forward to having your group broadcast this information. The work begun in the 1970s on appliance efficiency standards surely did improve the air conditioner, but if I'm not mistaken, progress stopped at some point, and now you're going to help make progress resume.

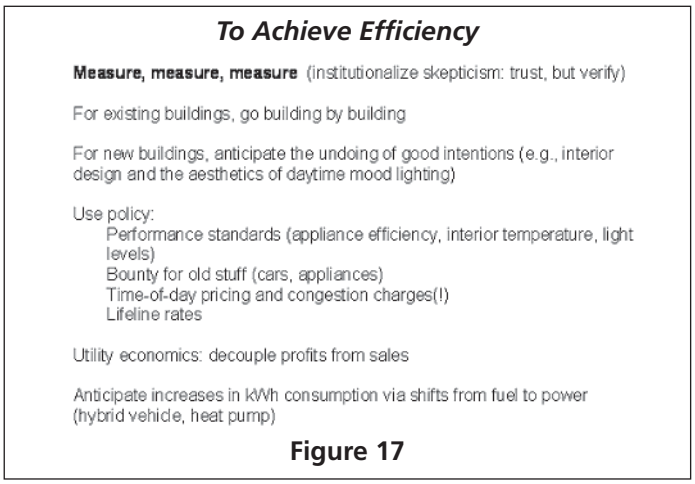


Figure 17

I put this figure together for you (Figure 17). What did we collectively learn in the 70s and 80s about efficiency?

Measure, measure, measure. Maybe you wouldn't expect that as number one. What does it mean? Don't give prizes for designs of buildings before they're built, for example. There is such a large shortfall unless you're watching and can see the outcomes. President Reagan said, "Trust, but verify." That principle, which couldn't have better credentials, sums up the most important lesson we learned about efficiency the first time around.

For existing buildings, go building by building. They're all different. In the 1970s and 80s, trained workers were going building by building, sometimes working for the gas and electric utilities, which had put these costs in their rate base. My own research group at Princeton developed diagnostic tools using an infrared camera and equipment to pressurize a building, so that trained personnel could understand energy efficiency opportunities, which were numerous and were usually related to deficiencies in building design and construction.

For new buildings, anticipate the undoing of good intentions. My own group monitored nominally low-energy buildings that were designed so that daylight would penetrate deep into the interior. The designer imagined that the perimeter office would be occupied by an executive who would be perfectly happy to have a glass interior wall. But, alas, he wasn't, or she wasn't. The executive valued privacy and used a curtain. As a result, daylight did not go to the interior.

Nominally low-energy buildings generally assume low demands on energy for discretionary activities inside. But the interior decorator in one building we studied thought that there should be oil paintings on the walls and that they should be lit by task lighting. All of this happens; all of this happens. So to save energy in buildings, we must get the interior decorators into the electricity efficiency business. So far, they've not been told that saving energy is what their client wants them to do. The same can be said of the lighting specialist, who could find lighting solutions using less energy if asked to do so.

Performance standards. These clearly have great impact. They determine appliance efficiency, interior temperature and light levels. Light levels in schools, for example. I'm telling you 70s stories. We discovered that the lighting standards were captives of the lighting industry, which found ways to justify the need for great amounts of interior light in order to do various tasks. And we, meaning a group of intruders into the worlds of lighting and heating and ventilating, and there were hundreds of us (I just played a minor role) started challenging these arguments. We asked about the evidence that you need the extra light in order to do a particular task. We asked whether there might be a concept called over-lit. Well there *is* a concept called over-lit.

Bounties. Are there any bounty policies in New York? Decades ago, the California authorities were paying people to give up their old, inefficient refrigerators, and

would come to your house to pick them up. Some of these inefficient units had been put in the basement when a person bought a new refrigerator; they were often running while hardly being used. California was doing the same thing for old cars.

Time of day pricing and congestion charges. I put that exclamation mark on the night before last, when I read about the impasse regarding congestion charges for New York City.

Lifeline rates. This entry connects the environmental and the environmental justice communities. One of the arguments against efficiency improvements that shouldn't have any weight at all is that these improvements will hurt the poor. This never needs to happen, because one can always implement lifeline rates, where the first block of consumption is less expensive than the next block of consumption. It's a progressive policy idea. Any governing body can do as much of it as it wishes, with a political fight. If the overall result of some policy is that retail electricity or retail gas gets more expensive on the average, there's nothing conceptually difficult about protecting the first block of kilowatt hours or therms from a price increase. The richer consumers then carry a bit more of the total burden. I don't know the extent to which lifeline rates are a feature of present rate structures in New York.

Decouple profits from sales. This is a goal Amory Lovins, in particular, has been articulating for as long as I have been in this game. The regulatory body sets utility revenue rules that create incentives to sell not raw kilowatt hours but the services that power produces. With such an arrangement, an investment in energy efficiency that reduces kilowatt hours sold is still rewarded.

Anticipate increases in kWh consumption via shifts from fuel to power. Strong carbon policy is likely to add kilowatt hours to sales. Say that our country has a goal of reducing carbon dioxide emissions by 15% below levels projected for 2015. As carbon policy starts to kick in, you should anticipate shifts to heat pumps and to hybrid vehicles. You don't want to set electricity production goals that result in fighting these shifts. How are you going to do that? A goal of simply reducing kilowatt hours may not be sufficiently subtle.

Wedges of Energy Supply

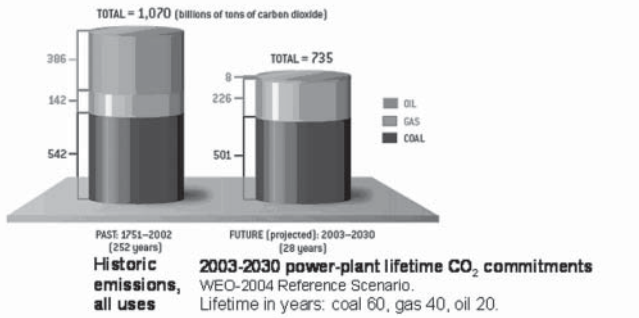
Let's discuss energy supply for a few minutes.

In the United States, the electricity sector is becoming more carbon-intensive, which, from a climate change perspective, is not good news. This development reverses a trend of a very long period, 50 years or more, when the nationally averaged carbon emissions per kilowatt-hour produced fell steadily. I'm pretty sure these trends have been true as well for New York State, but it would be good to see a graph of these data to be sure.

The surprise of the last five years has been that natural gas is not going to be the source of choice for incremental electricity in most of the country, but coal is going to be very, very competitive. It's the worst possible news from a climate perspective. Another carbon number you might consider learning is this one: seven hundred 1,000-megawatt power plants (big ones), running on coal, will put a billion tons of carbon into the atmosphere a year. So not building those plants is a wedge.

The International Energy Agency said in 2005 that we're going to put the equivalent of 1,400 times 1,000 megawatts of new coal power plant capacity into place globally, a lot of that in China, but some of it here, by 2030. So we have a tremendous challenge to build a different plant than the one we're heading for. And because of the length of time that coal plants hang around, we have very little time to procrastinate.

Emission Commitments from Capital Investments



Policy priority: Deter investments in new long-lived high-carbon stock: not only new power plants, but also new buildings.

Needed: "Commitment accounting." *Source*: Concept by David Hawkins, NRDC, *in* Socolow, *Scientific American*, July 2005, p. 52

Figure 18

To understand the carbon dioxide emission commitments embedded in new coal plants, consider Figure 18. Consider the bottom barrels only. The left bottom barrel is all the coal we've ever pulled out of the ground until now, and the right-hand barrel is all the coal that will be pulled out of the ground to fuel those 1,400 coal plants over their lifetimes. The two barrels are about the same size. So that's how much carbon is at stake.

Maybe this is a place where those involved in the new New York State initiative could innovate. Today, carbon dioxide analysts do only one-column bookkeeping, and we could be doing two-column bookkeeping. By one-column bookkeeping, I mean that analysts work out (and in some instances are required to report) only the carbon being emitted in a given year—for example, in New York State, in some municipality, or in some home. No one has the task of measuring and reporting the amount of future carbon emissions committed by the investments made by the same geographical entity in the same year—different and complementary data. Private industry does such double bookkeeping all the time. Firms routinely estimate

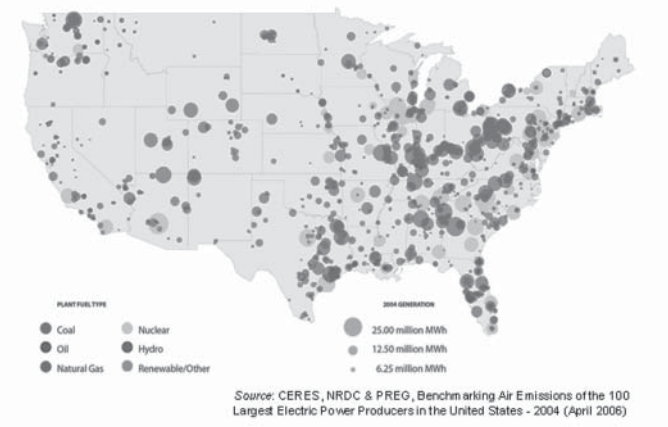
future obligations when they build something. We don't do that in the public sector. But New York State could start.

An additional assumption is required, before one can make estimates of future committed emissions—namely, how long is the thing going to be around? You'd have to justify your answer. A coal plant, I argue in Figure 18, is going to be around 60 years. Somebody might want to say 45 years, or lower the height of the right-hand lower barrel. To institutionalize "commitment accounting," a government would have to debate these additional assumptions and then embed its choices in the reporting methodology.

It could be a perfect role for New York State to report how much future carbon emission is implicit in the construction going on in the State. Items to be included are the lifetime fuel consumption of any new home that is sold and the lifetime power and fuel use in any building under construction. Would it be charged at groundbreaking? At time of occupancy?

The reason that commitment accounting is important takes us back to our view of the atmosphere as a bathtub: from a long-term climate impact, it doesn't matter if carbon dioxide enters the atmosphere next year or five years from now. Carbon is around for so long that we really can sum over future years and find out something meaningful. I recommend that you think about an expansion of how governments do carbon accounting as one of the outcomes of your work.

U.S. Power Plants by Fuel Type



Source: CERES, NRDC & PREG, Benchmarking Air Emissions of the 100 Largest Electric Power Producers in the United States - 2004 (April 2006)

Figure 19

I want to show you this wonderful graph, which I found recently (Figure 19). It shows the conditions right now for electric power plants. One issue is to distinguish between what you produce inside your state, what you import, and what you export. In New Jersey, my home state, there's a complex issue relating carbon accounting and imports: New Jersey gets about half of its electricity from across the border in Pennsylvania and other states to the west.

You're more self-contained in New York State: you imported only 12% of your electricity in 2006. But you are still going to need to be careful about where you draw the system boundary for your bookkeeping. When you talk about carbon emissions in New York, you ought to include the emissions produced in other states that accompany the power you import. Then, your "score" will depend on whether you're importing hydro or nuclear or coal power.

Look at the Appalachian region in Figure 19. It reminds me of the Japanese game of Go. All the darker circles, coal plants, produce an empty region that looks like captured territory. Then the lighter circles, nuclear plants, form a ring around the coal.

U.S. Power Plant Capacity, by Vintage

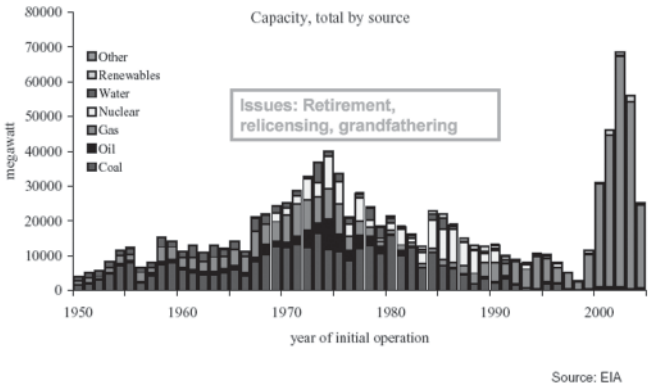


Figure 20

Figure 20 shows when the currently operating U.S. power plants were built. The bottoms of each bar are the coal plants, and the light parts of the bars in the 1970s and 80s are the nuclear plants. We have lots of power plants that are 30 to 40 years old. As a result, industry and government are confronting relicensing, grandfathering, retirement, and "scrap and build." Scrap and build means tear down the current plant, stay at the same site, and build something new and spiffy, a process with considerable virtue from an environmental perspective.

Note the remarkable lemming-like behavior at the far right, which some of you know much more about than I do. We built an extraordinary amount of natural gas power when many investors persuaded themselves that this was a brilliant thing to do, when it may have been for each of them acting alone but was not when many others did the same thing. The price of natural gas went way up, with all this new demand (and for other reasons), with the result that many of the plants on the right are either mothballed or running many fewer hours a year than they were expected to. Several firms went bankrupt. It is sobering how a very few years ago, a large number of investors made a collectively wrong decision.

I just spent very little time on the many alternatives to building coal plants, because I want to have a little time

for discussion. Wind power, for example, can replace coal. But you need a huge amount of wind: to replace 700,000 megawatts of coal would require about 2 million megawatts of wind. (The reason the two numbers don't match is because the watt that we're talking about in both cases is a peak watt, and the intermittency of wind is worth about a factor of three when you compare wind to coal.) Wind is growing 30% per year globally. It's growing substantially in the U.S. I don't know whether there are major wind issues in New York State.

Decentralized electricity production is another option. Every roof is a potential energy collector. In your exercise, you're going to have to ask how you're going to count decentralized kilowatt-hours versus centralized kilowatt-hours, confronting "net metering," for example.

Nuclear energy will be on your plate as well. I imagine that your key issues over the next ten years will involve relicensing.

The Future Fossil Fuel Power Plant

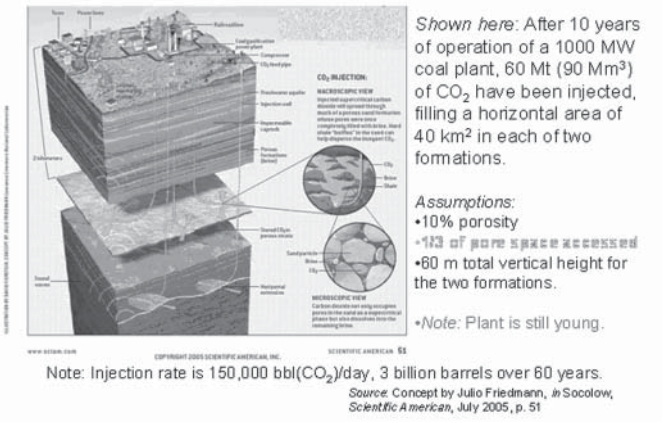


Figure 21

Last of the alternatives to coal-as-we-know-it is a favorite of mine, because I spend a lot of time on it, where we modify coal plants so that they're capturing their own carbon dioxide emissions and putting them underground. This half-a-loaf strategy assumes that we are going to continue to build fossil fuel plants and tries to transform their impact on the environment. Figure 21 is from an article I wrote in the August 2005 *Scientific American*, called *Can We Bury Global Warming?* I tried to imagine a coal plant that was capturing carbon dioxide and putting it below ground and forced myself to get quantitative about the amount of carbon dioxide you would collect and how big a space it would occupy below ground. Probably all of you in this audience have heard of this concept by now, but it is still largely unknown by the general public.

We can't simply shut down the coal system. But we can build a different kind of coal power plant, at some extra costs. One such plant, at Huntley, is being discussed for western New York, where the captured carbon dioxide will be sequestered deep below ground to the south and west of Buffalo. As I understand it, state money will be required to make this path-breaking project happen.

$100/tC=2¢/kWH Induces CCS. Three Views.

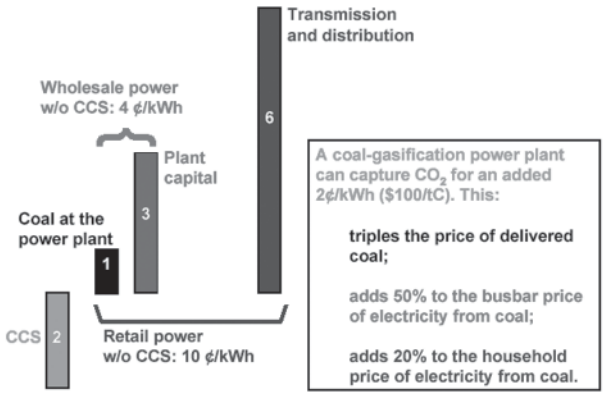


Figure 22

Carbon management is going to increase the price of electricity, and Figure 22 presents three ways of thinking about this increase. Think of the extra cost of carbon capture and storage (CCS) at a power plant as two cents per kilowatt-hour. That extra cost is about the same as the extra cost for the same coal plant if its normal carbon dioxide emissions are charged $30 a ton of carbon dioxide or $100 a ton of carbon. ($30/ton CO_2 is the breakeven price.) The question then, is, compared to what? Compared to the cost of coal, to the wholesale cost of power, or to the retail customer's cost of power?

We'll use ballpark numbers, all in cents per kilowatt-hour. It's about one cent for the coal burned, three cents more for paying off the capital costs for building the plant, and another six cents for the transmission, distribution, and retail handling costs between the power plant and the residential consumer. Those numbers aren't exactly right for any specific situation, but they're conceptually right. So if you're in the coal industry, you're looking at a tripling of the cost of your product, and you could be losing out in your competition with natural gas. If there is a $30/ton CO_2 carbon tax, it'll triple the cost of your coal delivered to the utility. The utility is looking at a 50% increase in its plant-gate ("busbar") costs. The residential customer is looking at a 20% increase in the costs on the bill. How hard people will fight your carbon policy that leads to a $30/ton CO_2 emissions price (whether they will tie you up in court, for example) is implicit in the numbers in Figure 22.

To be sure, Figure 22 assumes that the extra carbon dioxide cost gets passed from one transaction to the next without overheads being charged or costs being partially

absorbed, something that legislation could assure. Similar legislation governs the pass-through of fuel escalation costs in electricity markets.

Without such legislation, all along the value chain, percent overheads could be charged on top of the wholesale carbon dioxide emissions price, and two cents per kilowatt-hour on the coal could turn it into seven at your home. You don't want that to happen.

The utilities argue the other way. They want to make sure they can recover the full two cents. The consumer advocate should have the job of making sure the cost of carbon dioxide mitigation is moving through all the transactions right in the middle of the fairway.

Avoid Mitigation Lite

Carbon emission charges in the neighborhood of $30/tCO$_2$ can enable scale-up of most of the wedges, if supplemented with sectoral policy to facilitate transition.

Form of Energy	Equivalent to $100/tC or $30/tCO$_2$
Natural gas	$1.50/1000 scf
Crude oil	$12/barrel
Coal	$65/U.S. ton
Gasoline	25¢/gallon (ethanol subsidy: 50¢/gallon)
Electricity from coal	2.2¢/kWh (wind and nuclear subsidies: 1.8 ¢/kWh)
Electricity from natural gas	1.0¢/kWh

$100/tC was the approximate EU trading price for a year ending April 2006, when it fell sharply.

Figure 23

How can we think about $30 a ton of carbon dioxide and the carbon policy that might get us there? (Figure 23) First, it's far more than the emissions costs usually being talked about in Washington today. It is far more than being talked about as a cost in the Regional Greenhouse Gas Initiative (RGGI)—the interstate initiative being designed by northeastern U.S. states today, including yours and mine. And, I think it's the kind of cost we need to expect, and to put into place.

How much is $30/ton CO_2 in other energy units? It would help if more people could know the answers. Because there's a specific amount of carbon in any ton of fuel or gallon of fuel, these answers are well defined. I've prepared Figure 23 for you to keep and refer to.

Natural gas is measured in the U.S. either in therms or in standard cubic feet. $30/ton CO_2 is about fifteen cents a therm, or $1.50 a thousand standard cubic feet. Wholesale natural gas prices, at the point where the gas enters our interstate pipeline system, are about four times higher than that today, and at the customer level, maybe ten times higher.

The corresponding price in units familiar to those who work with crude oil is $12 a barrel, about a sixth of the current reference price that we read about in the papers.

Coal prices are usually in tons, and $30/ton CO_2 is about $65 per ton of coal, approximately twice what a New York State coal burning utility pays for coal. A $30/ton CO_2 price on carbon dioxide emissions to the atmosphere has a truly big impact on the competitions between coal and natural gas for electric power and the competition between fuel oil and natural gas for home heating fuel.

Coal, oil, and gas are affected unequally by a price on CO_2 emissions, because the three feedstocks produce different amounts of CO_2 when they deliver the same amount of energy. Natural gas emits only a little more than half as much CO_2 as coal and about two-thirds as much as oil. The underlying reason is a difference in the amount of hydrogen in each fuel, compared to the amount of carbon. Hydrogen burns to water and produces no CO_2. As a result, when more hydrogen is present for the same amount of carbon, more energy is produced for the same amount of CO_2. Natural gas has the highest hydrogen-to-carbon ratio of the three fuels.

By the time the price of $30/ton CO_2 reaches the consumer, if it's a straight pass through, it's twenty-five cents a gallon of gasoline, a price that isn't likely to have a big effect on driving. It's two cents per kilowatt-hour for a customer whose electricity comes exclusively from coal power plants. It's one cent per kilowatt-hour for a customer whose power comes from natural gas. It's also about one cent per kilowatt-hour for an average New Jersey resident, given the mix of the nuclear, coal, and gas power plants that produce our electricity.

Given the way these numbers work, I think you will agree that it is important to levy the carbon dioxide emissions charge far "upstream," ideally, where the fossil carbon comes out of the ground or across our borders. The further upstream, the higher the percent impact on the price of the product for the same charge. If one places the charge far downstream where gasoline is purchased and electricity bills are paid, the result of the same carbon dioxide emissions charge is likely to be much less carbon dioxide emissions reduction. If there is a carbon dioxide tax, impose it on the fossil fuel producer and importer; if there is a carbon dioxide cap-and-trade system, cap the carbon flows of the same players. I think discussions of carbon dioxide policy design haven't focused enough on this question of who the players are who will be targeted initially by the policy. I can believe that in an ideal market it doesn't matter, but in sticky markets it does.

Do I have this right? If I do, and yet for societal buy-in you want involvement of the downstream consumer

(the retail consumer of gasoline and electricity) in carbon policy, you're going to need to supplement price with policy to get carbon dioxide savings. Price is not going to motivate a whole lot on its own. An example of policy is CAFE, the Corporate Average Fuel Economy standard that governs the new-car market.

We will need a ramp to get to \$30/ton of CO_2. It seems to be an academic's role to make options vivid, so to be specific, what about a ramp that climbs to \$30 per ton of CO_2 in ten years—an increase of \$3 per ton of CO_2 every year for ten years. Five years into the policy, the price is \$15 per ton of CO_2. The start date might be 2010.

If, instead, we lock in much lower carbon dioxide prices, we set up what I call "Mitigation Lite," and I say avoid "Mitigation Lite." Mitigation Lite has the right words and the wrong numbers. Advocates of Mitigation Lite argue that we can fix the numbers after we've gotten used to the right words. The trouble with this line of reasoning is that the industry negotiators are saying, "We'll take anything you want to throw at us as long as you promise not to change it." Mitigation Lite is a poor option, if regulatory certainty for a decade or more is attached to it.

Can We Do It?

Finally, can we do it? People, *we*, are becoming increasingly determined to lower the risk that we and our children will experience major social dislocation and environmental havoc as a result of rising carbon dioxide in the atmosphere, and we are learning that there are many ways of changing how we live, what we buy, and how we spend our time, that will make a difference.

We are in the midst of a discontinuity. What once seemed too hard has become what simply must be done. Precedents include abolishing child labor, addressing the needs of the disabled, and mitigating air pollution.

What once seemed too hard has become what simply must be done. Thank you.

Endnotes

1. For further reading, see two papers by Steve Pacala and Rob Socolow: 1) *Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies*, 305 SCIENCE 968, 968-972 (2004) (and its Supporting Online Material); 2) *A Plan to Keep Carbon in Check*, SCI. AM., September 2006, at 50-57.
2. *See* NEW YORK STATE ENERGY RESEARCH AND DEVELOPMENT AUTHORITY, PATTERNS & TRENDS: NEW YORK STATE ENERGY PROFILES: 1992-2006 (Jan. 2008), *available at* http://www.nyserda.org/publications/Patterns%20&%20Trends%20Final%20-%20web.pdf.
3. S. Pacala & R. Socolow, *Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies*, 305 SCIENCE 968, 968-972 (2004).
4. S. Pacala & R. Socolow, *A Plan to Keep Carbon in Check*, SCI. AM., September 2006, at 50-57.

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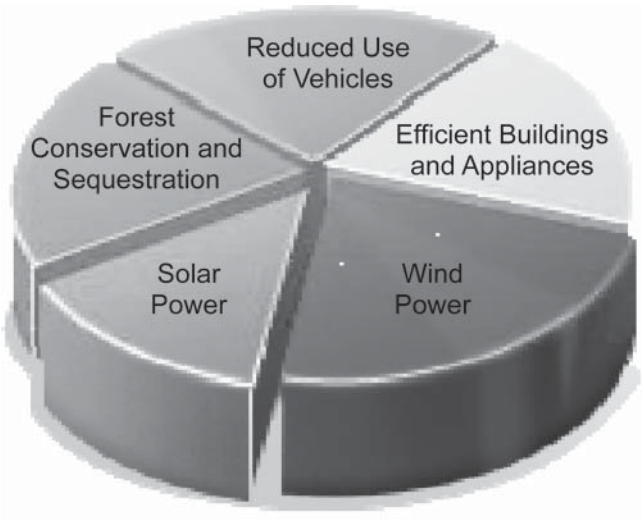
Shifting Ground to Address Climate Change: The Land Use Law Solution

By John R. Nolon

Strategies for Mitigating Climate Change

Robert Socolow, a professor of engineering at Princeton, set an action agenda for mitigating climate change by identifying 15 strategic "stabilization wedges," each one capable of preventing the emission of at least a billion metric tons of carbon annually using existing technologies.[1] The genius of Socolow's strategy is that it divides the daunting and discouraging task of climate change mitigation into categories that enable us to order our response efficiently. It makes a formidable challenge seem more doable and allows us to identify the actors who are capable of effective adaptation within each wedge and to formulate strategies that enable and empower those actors to succeed. One of Socolow's wedges focuses on reduced use of vehicles (vehicle miles traveled), which lowers the use of fossil fuels consumed by vehicles. A second aims at creating energy efficient buildings and appliances. A third fosters wind energy and a fourth energy produced through solar power. A fifth aims at preserving forests and vegetated soils to capture and sequester carbon.[2]

Chart 1



The Land Use Stabilization Wedge
Climate Change Mitigation

This article conceives and describes a Land Use Stabilization Wedge: a strategy that aggregates these five wedges and further organizes strategic energies. (See Chart 1). This builds on Socolow's optimistic assertion that "an excuse for inaction based on the world's lack of technological readiness does not exist."[3] I assert that the existing legal authority of state and local governments to regulate and guide land use and building is a powerful "technology already deployed somewhere in the world."[4] The Land Use Stabilization Wedge aggregates several of Socolow's initiatives and employs multiple mitigation techniques available to citizens in every locality in the country. (See Chart 1).

"The genius of Socolow's strategy is that it divides the daunting and discouraging task of climate change mitigation into categories that enable us to order our response efficiently."

The Land Use Stabilization Wedge comprises all the ways the device of land use control can reduce CO_2 and other greenhouse gas emissions. These include:

1. shifting development patterns so that less driving occurs,
2. reducing the size of housing units,
3. creating more compact and thermally efficient buildings,
4. reducing the materials consumed in building construction,
5. creating more energy efficient buildings,
6. utilizing more efficient equipment and appliances,
7. permitting and encouraging the use of wind energy generation facilities,
8. permitting and encouraging the use of solar energy generation facilities,
9. preserving undisturbed vegetated areas that sequester carbon, and
10. retaining agricultural lands and the production of farm products close to urban centers, further reducing transportation costs.

This article touches on corollary benefits that result from the implementation of the Land Use Stabilization Wedge. These include reduced use of drinking water, reduced impervious coverage and flooding, prevention of water pollution, and others. (See Chart 2).

These objectives can be achieved by local governments in most states through the legal authority already delegated to them to regulate land use and building construction.[5] The Land Use Stabilization Wedge targets local governments as key actors in climate change mitigation, understanding that considerable support and assistance from state and federal agencies and the cooperation and guidance of the private sector are essential to their success.

Potential Effects of Mitigation Through Land Use and Building Control—Shifting Ground[6]

The U.S. Census Bureau projects that the nation's population will grow by 100 million by the year 2043.[7] With a projected household size of 2.6 persons, this yields 40 million new households. This new population and the need to replace aging homes and buildings will cause the private sector to build 70 million new homes and 100 billion square feet of nonresidential space.[8] About two-thirds of the development on the ground by 2050 will be built between now and then. How that growth is placed on the landscape in human settlement patterns is critically important.

In the past decade approximately 60% of households have chosen to live in single-family homes on individual lots. For a variety of reasons, the projected 40 million new households will be more urban oriented and willing to live in dynamic, walkable neighborhoods in cities and urban suburbs. Market projections indicate that urban housing located in compact developments will increase in price more rapidly than single-family, suburban homes.[9] It is quite possible that the market demand will support "shifting ground," so that the historical numbers are reversed. If 60% of these new households (24 million) choose to live in more compact, mixed-use environments and 40% (16 million) choose the single-family pattern, this will shift fully 8 million households (over 20 million people) from one human settlement pattern to the other.

Chart 2

The Land Use Stabilization Wedge
Corollary Benefits

The new paradigm for development, one consistent with the Land Use Stabilization Wedge strategic approach, is a more compact, dense and mixed-use human settlement pattern, one capable of being implemented through coordinated local land use law. This envisions a shift in the dominant pattern of development from single-family, single-use neighborhoods to neighborhoods characterized by smaller homes, clustered and stacked, mixed with service and retail uses reachable by foot or on bicycle, with nearby schools and recreation, served by transit stops, now or in the future.

The movement of vehicles is responsible for about one-third of U.S. CO_2 emissions and that number is growing. "Single family homes use more energy per person than multifamily homes. Large homes use more energy than smaller homes. The farther new homes are from existing population centers, from work and shopping, the greater the additional energy use in transportation per home and per person."[10] A little over one-third of the increase in driving is associated with demographic change; the rest is attributed to "land use patterns that have led to increases in average trip distances (38%) and in the number of trips made (25%)."[11]

Portland, Oregon, is one city likely to achieve significant greenhouse gas emission goals, owing to the urban growth boundaries adopted in 1974 that were designed to protect farmland and contain sprawl. Climate change mitigation, in this case, is an unintended benefit that is due to the increased density, reduced vehicle trips and vehicle miles traveled, and increased transit ridership that land use law reform achieved.[12]

According to the Urban Land Institute's *Growing Cooler* report, "much of the rise in vehicle emissions can be curbed simply by growing in a way that will make it easier for Americans to drive less. In fact, the weight of the evidence shows that, with more compact development, people drive 20 to 40% less, at minimum or reduced cost, while reaping other fiscal and health benefits."

Compact development, as defined in the *Growing Cooler* report "does not imply high-rise or even uniformly high density development . . . that will result in the 'Manhattanization' of America."[13] It refers to development at about 12–14 dwelling units per acre, which is 75% above the 2003 national average density for all housing development. The report concludes that "shifting 60% of new growth to compact patterns would save 85 million metric

tons of CO_2 annually by 2030." This is aimed at abating the alarming increase in driving caused by the dominant single-family growth pattern, which will increase driving by 59% by 2030 while the population increases by 23%, according to the U.S. Department of Energy's forecasts.

If it were possible to shift half of these 8 million households from single-family settlements to higher density urban development—the type associated with transit-oriented development—the positive effect on the environment and climate change would be dramatic.[14]

1. In higher density urban developments, the amount of CO_2 emitted per capita can be 15 metric tons less annually, when compared with single-family living.[15] Multiplied by 10 million people shifted into higher density urban developments, the potential CO_2 reduction equals 150 million metric tons annually.
2. Residences in higher density urban and compact developments are smaller than the national average for single-family homes. Using an estimate of 1,500 square feet for these developments, compared with the single-family average of 2,600, yields a savings of 1,100 square feet. This space does not need to be heated and cooled. Less space to construct reduces the fossil fuel consumed in manufacturing and assembling building materials.
3. Additional CO_2 stabilization occurs when local governments zone to encourage wind and solar generation, preserve undisturbed landscapes, and preserve farm land close to urban market demand.

The corollary benefits of the compact development pattern are equally dramatic. The Hudson Park project in Yonkers, New York, discussed in the next section, is a representative example of a higher density, transit-oriented development in an urban neighborhood. Its first phase contains 118 dwelling units per acre, four or five times denser than the average compact development project. If half of the 8 million new households were shifted from single-family settlements to this type of development, the results would include:

1. 74 billion fewer cubic feet of stormwater annually.[16]
2. 33 billion square feet less impervious coverage.[17]
3. 100 billion gallons of potable water saved per year.[18]

Reducing Use of Vehicles

How can the Land Use Stabilization Wedge reduce the number of trips taken and the vehicle miles traveled in the U.S.? Comprehensive plans and zoning laws adopted by local governments, when aggregated, create the blueprint for the development of land and buildings for their region. Through changes in plans and zoning laws, communities can create transit-oriented development and transportation efficient development that shift development patterns from a single-family dominant pattern to one that fosters compact, mixed-use development. This new pattern greatly reduces automobile dependency, vehicle trips, and vehicle miles traveled: a method of implementing Socolow's Vehicle Travel Reduction Wedge.

Central cities and their older and developing suburbs constitute the relevant region for transportation planning purposes. In these regions, Metropolitan Planning Organizations (MPOs) prepare capital plans for all types of transportation infrastructure, including transit services. Developing mechanisms to coordinate state and MPO transportation planning with local land use planning is key to the success of connecting higher density urban developments and compact developments to transit services now or in the future and is arguably required under federal law.[19]

Whether legally mandated or not, for practical reasons, land use planning among localities in a transportation region must be coordinated with transportation infrastructure planning and development. Local land use plans and zoning determine how much population can increase over time, and this, in turn, determines demand for various types of transportation services. Transit lines for rail and Bus Rapid Transit (BRT) services cannot be planned in isolation, station by station. The economics of transit station development and rail and bus lines are dependent upon land use densities; there must be a sufficient number of commuters in a relevant group of adjacent communities to provide a minimal level of ridership throughout the area served by the transit system. Where transit service is not feasible because of insufficient land uses and densities, other modes of transportation must be planned.

Transportation Efficient Development (Compact Development)

Compact developments may not be intense enough to support ridership at various locations in a transportation region. In the near term, they may have to be developed as "transportation efficient" communities that are ready to receive transit services in the future as the region grows. Compact developments not near existing transit services can incorporate a variety of land use and transportation features that reduce vehicle miles and trips. Land use plans can allow for mixed uses, a variety of housing types and sizes, parking and bicycle facilities, and transportation related improvements. These can be coordinated with planned capital improvements such as interconnected sidewalks and trails, bike paths, and jitney service from moderate density hamlets to regional transit stations. Together these initiatives can reduce congestion and car dependency, and provide for transit stops in the future.

The Town of Malta, just outside Albany, New York, used an innovative land use technique that can be employed by communities to manage and define future

growth in a way that creates more livable places that are transportation efficient and transit ready. It adopted a central business district overlay zone that is transit ready. The Malta zoning law provides densities at the compact development level and contains a number of standards that will create a typical mixed-use and walkable neighborhood. Currently, the town is not served by transit, but the Capital District Transportation Plan calls for BRT service in the future. In anticipation, the overlay zone provides for mass transit. It states that "to promote pedestrian activity and multimodal transportation, developments should be located within 1,320 feet of an existing or future transit stop as approved by the Planning Board."[20]

The Town of LaGrange, in Dutchess County, New York, adopted a mixed-use Priority Growth District, or PGD, that directs development to a specific location and contains design and amenity standards that provide an alternative to the large lot single family zoning prevalent in suburban areas that are distant from the metropolitan center and transit services.[21] The PGD concept is particularly well suited for outlying suburban communities, where the rate of growth is significant but where there are still rural characteristics and significant natural resources to be preserved. The pressure to provide new homes in these suburban growth areas can be addressed through the identification of Priority Growth Districts where roadways and other infrastructure either exist or can be accommodated in ways that reduce the length and number of automobile trips and create the possibility for some type of transit service in the future.

LaGrange worked with Dutchess County to create a PGD zone where there was an existing suburban transportation corridor and intersection. The zone in effect creates a new hamlet, serving new and existing residential development and providing some retail services. It combines mixed-use development, a variety of housing types including affordable units, and trails and sidewalks. The zone encompasses 616 acres, and provides for up to 220,000 square feet of commercial space, including up to 160,000 square feet of retail, a supermarket and restaurants, a 50,000 square foot government center with a library, and between 560 to 680 housing units of several types: senior housing and assisted living units, apartments, townhouses, and single-family residences. It will be served by central water and sewer with potential to serve additional adjacent growth, and is located along a state highway.

Transit-Oriented Development (Higher Density Urban Development)

In many urban areas served by transit stations, densities of housing at 15–40 dwelling units per acre can be achieved. Around transit stops, particularly, higher urban density development can be planned for and supported by zoning and infrastructure planning. These types of developments, as demonstrated above, significantly reduce per-capita carbon emissions and yield numerous other climate change and environmental benefits.

The Bloomington, Minnesota, City Code provides for an "HX-R" zoning district (high intensity mixed use with residential) that is aimed at getting people out of their cars.[22] It attempts to reduce vehicle trips and vehicle miles traveled by maximizing high-intensity development in close proximity to transit. The ordinance prohibits drive-through uses that obstruct sidewalks and discourage walking. It provides a minimum density of 30 dwelling units per acre for residential development. It also provides a minimum floor area ratio of 1.5 and a maximum of 2. This maximum may be increased through density bonuses to encourage retail and service businesses, below grade parking, development of plazas or parks, affordable housing, public art, and sustainable design. Parking is restricted in the ordinance in order to promote walking, biking, and transit use. Parking must be located below grade, within structured ramps, or in individual on-street spaces parallel with and adjacent to low-volume streets. Bicycle parking must be provided near building entrances. Development directly adjacent to transit stations must provide sidewalk and bikeway connections to the transit station as well as to adjacent sites. The Bloomington zoning strategy evinces a commitment to development that is truly transit oriented. It restricts parking, connects to nearby transit, locates retail and service uses within short walks of residences, and thereby reduces vehicle trips and vehicle miles traveled.

The City of Yonkers, New York, struggled for years to jump-start its downtown and adjacent industrial waterfront on the Hudson River, an area that is served by three commuter train stations, less than a half-hour trip from New York City's Grand Central Terminal. During the past two decades, the city amended its waterfront urban renewal plan over a dozen times before the private market began to respond. Governmental commitments to provide urban recreational and design amenities, build an impressive central library, renovate historic buildings, clear deteriorated buildings, remediate brownfields—all within walking distance of the renovated central rail station on the river—began a process that has led to considerable success.

The zoning and land use techniques that the City of Yonkers used were numerous and are instructive. It adopted a highly detailed master plan for the waterfront area that contained certain specifications regarding the types of development the city wanted on available vacant land in the area. An innovative zoning technique—called the Master Plan Zone—was adopted that provided as-of-right status for developments that conform to the design standards contained in the master plan. Compliance with New York State's extensive environmental review requirements was waived for such projects, since the impacts of development contemplated by the master plan had already been studied in detail and mitigation provided.

Early in this process, a developer was selected through a request-for-proposals process to plan the redevelopment of two centrally located sites, immediately adjacent to the train station. As the city developed its plan and conducted its environmental impact review, the private developer began site planning and provided economic and market input. Information provided by citizens, environmental consultants, other professionals, and the developer were integrated as the process progressed and the master plan and designs for the two sites were adjusted.

The result is the development of Hudson Park, a two-phase project that contains nearly 500 middle-income rental residential units, public pedestrian access to a renovated waterfront, restaurants, office and retail space, and immediate access to the train station through carefully designed walkways and entrances that provide security to riders. Hudson Park is a dramatic transit-oriented development where parking provided is approximately 50% less than the amount required by traditional urban zoning. This is possible because the buildings and area appeal to commuters who travel to work by train and the developer's marketing was designed to attract them. The developer saved $25,000 in development costs for each parking space not constructed, and residents save $6,000 annually for owning one car instead of two. Three high quality restaurants and a number of retail stores catering to the middle income population of these buildings have appeared since the first 250 residents moved into phase one of the Hudson Park development. This project and the public amenities provided by the government are credited with sparking considerable additional private sector interest in the area.

Efficient Building Location, Construction, and Operation

Suburban and urban communities can mitigate carbon emissions and promote energy efficiency by adopting building design and location standards, such as those promoted by the Leadership in Energy and Environmental Design (LEED) criteria promulgated by the U.S. Green Building Council.[23] They can do this in at least three ways: by committing themselves to meeting LEED and other energy standards in newly built or renovated municipal buildings, or in those funded by the municipality; by requiring new privately built or renovated buildings to meet such standards; and by adopting zoning standards for appropriate districts similar to those contained in the Council's evolving Neighborhood Development Rating System.

There are four levels of LEED certification for individual buildings which can be attained by accumulating points for implementing design standards in the categories of sustainable site development, water savings, energy efficiency, materials selected, and indoor environmental quality. The LEED standards can serve as a model for incorporating energy efficient design standards into local building codes and requirements. LEED standards also contain design features normally associated with land use planning and zoning. For example in a LEED for Homes Certification, a new home receives 10 points, one-third of the required number of points for certification, just for being smaller than the national average.[24] A project can also earn points toward certification by developing at higher densities, by being located near public transportation, or by using energy efficient appliances.

Building Code Adaptation

New York is one of 22 states that have adopted a set of building codes that must be enforced at the local level but that allow local legislatures to add more restrictive standards.[25] These codes create the standards that local building inspectors must enforce when asked for a building permit by a private contractor or developer prior to undertaking a building project. Under section 379 of the New York Executive Law, the legislative body of a local government may adopt local ordinances imposing more restrictive standards for construction to ensure energy efficiency and minimize carbon loading.

The Town of Greenburgh, New York, amended its code to add new energy conservation requirements more restrictive than the adopted statewide mandatory energy code.[26] Greenburgh's local law requires that all new homes constructed in the town comply with Energy Star guidelines introduced by the EPA in 1992.[27] The program provides several methods of making a home at least 15% more energy efficient through such mechanisms as effective insulation, high performance windows, efficient heating and cooling equipment, and various energy efficiency products. The law applies to one- and two-family dwellings and multi-family buildings of three stories or less. In 2006, the Town of Babylon, New York, adopted a law requiring all newly constructed commercial buildings, office buildings, industrial buildings, multiple residences, and some senior citizen residences to comply with LEED standards.[28]

Zoning Law Reform

The Boston Zoning Code Green Building Amendments were adopted in 2007 to "ensure that major building projects—buildings over 50,000 square feet—are planned, designed, constructed, and managed to minimize adverse environmental impacts; to conserve natural resources; to promote sustainable development; and to enhance the quality of life in Boston."[29] The Boston legislation incorporates by reference the U.S. Green Building Council's LEED rating system.[30] The LEED building certification standards do not impose requirements but rather allow developers to choose among a variety of criteria to obtain sufficient points for the project to become a certified LEED building. Compliance with the local law is required but developers are allowed to choose voluntarily which LEED standards to meet.

The U.S. Green Building Council is providing additional guidance to municipalities interested in promoting energy efficiency at the neighborhood development level. Under its LEED for Neighborhood Development Rating System, it integrates smart growth, new urbanism, and green building standards into a system for designing and rating neighborhood development.[31] Under this system, both the location and the design of buildings can be certified as meeting the Council's standards for environmentally responsible and sustainable development.

The U.S. Green Building Council adopted the LEED-ND program as a pilot. At the end of 2008, the early results will be evaluated and a revised rating system will be instituted. Among the standards contained at the pilot stage are reduced automobile dependence, creation of a bicycle network, compact development, diversity of uses and housing types, affordability of housing, the proximity of housing and job sites, reduction of parking footprints, proximity to transit facilities, and transportation demand management. These are matters that go to the heart of traditional local land use regulation and are at the forefront of integrating transportation and land use planning.

Communities can incorporate the lessons of the LEED-ND program in their land use plans, regulatory standards, and development approval processes.

Regulation and Use of Public Buildings and Property

The City Council of Scottsdale, Arizona, adopted a formal Green Building Policy for municipal buildings in March 2005. The mandatory policy for municipal buildings requires that "all . . . city buildings of any size will be designed, contracted and built to LEED Gold Certification levels or higher."[32] The Township of Cranford, New Jersey, passed a local ordinance in 2005 adopting a policy that township owned and funded projects will meet LEED Silver ratings.[33]

There are 40,000 localities in the U.S. Many of them are recycling solid waste, planting trees, greening public buildings, using biodiesel fuel in vehicles and machinery, developing methane recovery systems in landfills, using solar energy to power municipal buildings, installing geothermal pump systems to heat and cool public facilities, replacing incandescent traffic signals with light-emitting diode signals, mounting police on bicycles, adopting anti-idling protocols for municipal vehicles, and exhibiting extraordinary creativity along the way.

Wind Power

Although wind-generated power constitutes a small fraction of the nation's power needs (around 1%), it is growing quickly and could eventually meet over 20% of the nation's demand for energy.[34] General Electric, whose Renewable Energy Global Headquarters are in Schenectady, NY, is in the process of building nearly 900 1.5 megawatt wind turbines, many in upstate New York. A 1.5 megawatt turbine can supply the power needs of over 400 single-family homes. This trend is encouraged by New York State's adoption of a state policy establishing a goal that 25% of energy consumed by 2013 will be produced by renewable sources such as wind, solar, biofuels, tidal energy, and other mechanisms.

One way that municipalities may encourage wind power use is to purchase electricity from wind farms to run locally owned utilities or to heat and cool town buildings. Lisle, a village in Illinois, purchases 4,500 megawatt-hours a year of electricity from a nearby wind farm to provide power to its water utility, saving nearly five million pounds of carbon dioxide emissions annually.[35]

Localities may also amend zoning to permit and encourage homeowners to install individual wind generation systems. Individuals are beginning to install backyard wind turbines on towers 50–70 feet high that generate enough power for their household use. In some cases, excess power is created that can be directed back to the local power company grid, sometimes for credit or cash. Some claim that a single wind turbine of this size can produce enough electricity for two average sized homes in an area with moderate wind speeds, raising a host of regulatory and real estate law issues. These types of "distributed generation systems" are supported by the American Planning Association's Energy Policy Guide.[36] Under the New York State Real Property Tax Law, local tax assessors are permitted to offer property owners who construct small wind energy systems an exemption or partial exemption from local real property taxes for the increased value of the property due to the addition of the facility to the land.[37]

Local governments are adopting comprehensive plan components that contain local energy goals and policies, moratoriums that prevent the construction of wind-generation facilities until they can be properly regulated, and a number of zoning, subdivision, site plan, special use, and environmental review mechanisms to balance the benefits of wind-generated power and the detrimental effects such facilities can have on the community. While these laws can be used to limit and discourage wind generation facilities, they can also become part of the Land Use Stabilization Wedge by encouraging the construction and use of wind-generation projects both large and small through zoning and site plan provisions, tax abatement, and other initiatives.

Solar Power

Local governments can mitigate climate change in at least two ways that employ solar energy generation: equip public buildings with solar facilities and adopt land use regulations that encourage their use by homeowners and businesses.

The New York State Comptroller reports that Albany County, the Ulster County towns of Woodstock and Rosendale, the Ulster County village of New Paltz, the Nassau County town of Hempstead, and the Tompkins County town of Lansing received financial and technical assistance from the New York State Energy and Research Development Authority (NYSERDA) for their public building initiatives. The audit, conducted for the period January 2003 to July 2007, determined that by installing solar panel electrical systems, each of these municipalities could save roughly a million dollars and reduce the release of the greenhouse gases carbon dioxide, nitrous oxide, and sulfur dioxide by over 6.6 million pounds during the life of the panels, which should exceed 40 years. With state assistance these municipalities paid roughly a quarter of the total project costs.[38] An impressive number of state and federal initiatives are available to local governments as well as private property owners that lower the capital costs of solar installations.

In 1979, the state legislature granted express power to local governments to add provisions to their zoning regulations to permit and encourage solar energy systems and equipment, including access to sunlight.[39] The legislature declared that access to solar energy is a valid public purpose and left it to each local government to adopt regulations suitable to its local environment and circumstances. This authority, which probably existed as an implied power prior to the act, makes the power of local governments to permit solar power facilities explicit. Local governments may amend their zoning to permit solar energy systems in all zoning districts, to provide waivers of any height, area, or bulk requirements that obstruct solar facilities, or to create zoning overlay districts within which solar access is particularly appropriate.

Carbon Capture Through Sequestration

In developing suburban areas, there are often significant land areas that have been undeveloped for some time that contain undisturbed vegetated areas. As noted earlier, suburban communities can mitigate climate change by zoning to accommodate the bulk of population growth in compact developments as the towns of Malta and LaGrange are doing. By so doing, they may find it easier politically to adopt strong environmental protection ordinances applicable to the land outside these higher density zones. Density bonuses can be provided to developers of compact developments and cash contributions can be received in exchange for such bonuses, which can be used to purchase the development rights of valuable open space areas that contain critical natural resources.[40]

The preservation of such resources will provide valuable environmental benefits such as carbon sequestration, food production, wetlands and habitat preservation, stormwater management and flood prevention, watershed protection, and the prevention of erosion and sedimentation. Soil organic carbon accumulates in undisturbed naturally vegetated areas.[41] Further carbon stabilization occurs when developing communities preserve existing farmland where food products can be produced closer to population centers, thereby reducing transportation costs. Wetlands preservation, seen though the lens of climate change mitigation, offers the additional benefit of carbon sequestration since most wetlands have been undisturbed by previous development.[42]

In local zoning and subdivision regulations, standards that prevent the disturbance of soils and vegetation on development sites have similar effects. The emerging field of "low impact development" experiments with pervious alleys and green roofs in urban projects and, in compact developments, vegetated swales that replace curbs and gutters for storm water control, cluster development, tree retention, and retaining permeable topsoil on site during and after construction.[43]

Conclusion

Climate change has altered the federal and state agenda and will reshape funding programs and priorities for programs and projects that promise to reduce fossil fuel consumption, dependency on foreign oil, and greenhouse gas emissions. There are relatively few local initiatives in the nation that utilize the Land Use Stabilization Wedge techniques described in this article. Localities that do move in this direction should enjoy considerable success in soliciting state and federal funding for land use and transportation planning, environmental studies, workforce housing, transportation and urban amenity capital projects, and other support needed to create successful transportation and land use demonstration projects.[44]

Local governments, with their power to plan and regulate land use, are a critical ally of state and federal governments in the race to mitigate climate change. They have always been laboratories for experimentation—crucibles of change—from the time that New York City invented the comprehensive zoning ordinance through a host of celebrated land use movements: post-Euclidean zoning, growth management, the advent of local environmental law, and smart growth. Now we have the Land Use Stabilization Wedge: the climate change mitigation movement. While models exist for greening public and private buildings, reducing vehicular travel, preserving undisturbed lands, and fostering wind and solar power, much needs to be done.

Not all states empower their localities as thoroughly as does New York. Relatively few localities have the capacity to grow cooler with all the staff and technical attention that this task requires.[45] They need resources, technical assistance, and funding as incentives to continue this exciting trend toward green growth. Local initiatives cropping up around the nation must be harvested by state and federal programs designed to shift ground: to ensure that new population growth occurs in compact and higher density urban developments.

Endnotes

1. S. Pacala & R. Socolow, *Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies*, 305 SCIENCE 968, 968–972 (2004) [hereinafter Pacala & Sokolow]. "A wedge is 1 GtC/y of emissions savings in 2054, achieved by a single strategy that will not occur without deliberate attention to global carbon." *Id*. *See also* ELIZABETH KOLBERT, FIELD NOTES FROM A CATASTROPHE: MAN, NATURE, AND CLIMATE CHANGE 137 (Bloomsbury 2006) .
2. Pacala & Socolow, *supra* note 1, at table 1.
3. Pacala & Socolow, *supra* note 1, at 3.
4. *Id.*
5. *See* John R. Nolon, *Historical Overview of the American Land Use System: A Diagnostic Approach to Evaluating Governmental Land Use Control*, 23 PACE ENVTL. L. REV. 821, 821–22 (2006).
6. Data and supporting material for this section are taken from REID EWING ET AL., GROWING COOLER: THE EVIDENCE ON URBAN DEVELOPMENT AND CLIMATE CHANGE (Urban Land Institute 2007) and from the recent assessment reports of the Intergovernmental Panel on Climate Change. WORKING GROUP III REPORT, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, MITIGATION OF CLIMATE CHANGE (2007), *available at* http://www.ipcc.ch.
7. U.S. CENSUS BUREAU, U.S. INTERIM PROJECTIONS BY AGE, SEX, RACE, AND HISPANIC ORIGIN (2004), *available at* http://www.census.gov/ipc/www/usinterimproj/.
8. The new development forecast by 2043 includes homes and non-residential buildings needed to replace obsolete buildings that exceed their useful lives. *See* Arthur C. Nelson & Robert E. Lang, *The Next 100 Million*, 73 PLANNING 4, 4-6 (2007).
9. *See generally* CHRISTOPHER B. LEINBERGER, THE OPTION OF URBANISM: INVESTING IN A NEW AMERICAN DREAM (Island Press 2008), describing the re-emergence of walkable urban development as the "next American dream."
10. Consortium for Atlantic Regional Assessment, Land Use Primer: How Does Land Use/Land Cover Affect Global Climate?, http://www.cara.psu.edu/land/lu-primer/luprimer14.asp.
11. DEVELOPMENT, COMMUNITY, & ENV'T DIV., U.S. ENVTL. PROT. AGENCY, OUR BUILT AND NATURAL ENVIRONMENTS: A TECHNICAL REVIEW OF THE INTERACTIONS BETWEEN LAND USE, TRANSPORTATION, AND ENVIRONMENTAL QUALITY 21 (2001), *available at* http://www.epa.gov/smartgrowth/pdf/built.pdf.
12. Patrick Condon, *Planning for Climate Change*, LAND LINES, Jan. 2008, 5, 5–6 (citing a report of the Institute for Local Self Reliance). *See also* LEINBERGER, *supra* note 12 ("Because of the strong links between energy use, greenhouse gas emissions and climate change, rates of new construction are strongly related to rates of climate change, especially when this new construction is relatively distant from existing population centers.").
13. EWING, *supra* note 9, at § 1.2.
14. Calculations in this section are the author's, based on per-capita or per-household consumption figures estimated by the EPA, the U.S. Public Health Service, and the Department of Energy.
15. Alex Williams, *Don't Let the Green Grass Fool You*, N.Y. TIMES, Feb. 10, 2008, at 1. The article quotes statistics from the PlaNYC report of the Bloomberg administration in New York City indicating that the average citizen of New York City produces 7.1 metric tons annually, compared with a national average of 24.5. Statistics in that article indicate that suburban Atlanta residents generate up to 31.1 tons/year. The author has adjusted the New York City number upward to approximate the greater emissions in cities generally and has used the 24.5 metric ton nation-wide number in these calculations.
16. The EPA estimates that single-family homes generate 18,700 cubit feet/year/unit of runoff. Hudson Park contains 266 units on 2.26 acres and generates 229 cubic feet of runoff per household annually, a difference of 18,471 cubic feet. Multiplied by four million shifted households, this yields a savings of nearly 74 million cubic feet per year.
17. Under typical suburban single-family zoning standards, 8,713 square feet of space can be covered with impervious surfaces. Hudson Park units create 370 square feet per unit, a difference of 8,343 square feet. Multiplied by four million households this yields a saving of 33.5 billion square feet of impervious cover. The fossil fuel saved by not producing and installing that impervious material generates additional savings in CO_2 emissions.
18. According to U.S. Public Health Service estimates, single-family homes use, on average, 28 gallons per day per capita for outdoor water use; since Hudson Park uses a negligible amount of exterior water, it consumes that much less potable water; multiplied by 10 million people times 365 days, this would save over 100 billion gallons of potable water per year at a time when 36 states are projecting drinking water shortages.
19. Federal law requires MPOs to conduct planning processes that "provide for consideration of projects and strategies that will . . . protect and enhance the environment, promote energy conservation, improve the quality of life, and promote consistency between transportation improvements and State and *local planned growth and economic development patterns*." 49 U.S.C.A. § 5303(h)(1)(E) (2005) (emphasis added). This same language is made applicable to statewide transportation planning and programming in 23 U.S.C.A. § 135 (2005), which requires each state to carry out a statewide transportation planning process that achieves these same objectives.
20. MALTA, N.Y., CODE ch. 167, art. XIV, §§ 167-60 and 167-61(2005).
21. LAGRANGE, N.Y., CODE ch. 240 art. II; art. III, § 240-35 (2006).
22. BLOOMINGTON, MINN., CODE ch. 19, § 19.29 (2008).
23. U.S. GREEN BUILDING COUNCIL, LEED RATING SYSTEMS (2008), *available at* http://www.usgbc.org/DisplayPage.aspx?CMSPageID=222.
24. *See* U.S. GREEN BUILDING COUNCIL, RATING SYSTEM FOR PILOT DEMONSTRATION OF LEED FOR HOMES PROGRAM 22 (2005), *available at* http://www.usgbc.org/FileHandling/show_general_file.asp?DocumentID=855.
25. David Listokin & David B. Hattis, *Building Codes and Housing*, 5 CITYSCAPE 1, 11 (2005). Note that there are six states that do not allow their localities to adopt more stringent code provisions.
26. GREENBURGH, N.Y. CODE, §§ 100-15–100-17 (2002).
27. *See* History: Energy Star, http://www.energystar.gov/index.cfm?c=about.ab_history (2007).
28. BABYLON, N.Y., CODE ch. 89, art. VIII (2006).
29. BOSTON, MASS., Zoning Code, § 37.1 (2007).
30. U.S. Green Building Council: About USGBC, http://www.usgbc.org/DisplayPage.aspx?CMSPageID=124.
31. U.S. GREEN BUILDING COUNCIL, LEED FOR NEIGHBORHOOD DEVELOPMENT RATING SYSTEM (2007), *available at* http://www.usgbc.org/ShareFile.aspx?DocumentID=2845.
32. SCOTTSDALE, ARIZ., RESOLUTION NO. 6644, (2005). Scottsdale's Green Building Program is described at http://www.scottsdaleaz.gov/greenbuilding/.
33. CRANFORD, N.J., ORDINANCE NO. 2005-46, § 106-2(c) (2005). The ordinance also encourages private redevelopers to adopt LEED standards by offering a Green Building Density Incentive Program. *Id.* § 106-3. The incentive includes a slightly larger building than permitted by the underlying zoning in the applicable district.
34. According to the American Wind Energy Association, wind energy generation capacity increased by over 27% in 2006 and by a dramatic 45% in 2007. AMERICAN WIND ENERGY ASSOCIATION 2007 MARKET REPORT 1 (Feb. 6, 2008) *available at* http://www.awea.org/projects/. Over 6,500 wind turbines are in operation globally and by the end of this year that number should exceed 10,000 units.

35. *See* Williams, *supra* note 18, Correction Mar. 2, 2008, *available at* http://www.nytimes.com/2008/02/10/fashion/10suburbs.html?_r=1&scp=1&sq=&st=nyt&oref=slogin.

36. Am. Planning Ass'n, Energy Policy Guide, Initiative 9 (2004), *available at* http://www.planning.org/policyguides/pdf/Energy.pdf.

37. N.Y. Real Prop. Tax Law § 487 (2006).

38. Office of the N.Y. State Comptroller, Usage of Solar Panels in Municipalities (2008), *available at* http://www.osc.state.ny.us/localgov/audits/swr/08solarpanel/solarpanels.pdf.

39. N.Y. Gen. City Law, § 20(24) (2001); N.Y. Town Law § 263 (2004); N.Y. Village Law § 7-704 (1979).

40. Permit conditions can be imposed to protect the environment, which can include curbing greenhouse gas emissions. In *Konicelik v. Planning Board of East Hampton*, the court upheld a planning board's conditional approval of subdivision plat that imposed several conditions designed to protect "the extensive area of undisturbed forest, and the presence of numerous important plant species throughout the site." 590 N.Y.S.2d 900, 901–02 (2d Dep't 1992).

41. Wilfred M. Post & K.C. Kwon, *Soil Carbon Sequestration and Land-Use Change: Processes and Potential*, 6 Global Change Biology 317 (2000), *available at* http://cdiac.ornl.gov/programs/CSEQ/terrestrial/postkwon2000/postkwon2000.html.

42. Office of Science, U.S. Department of Energy Carbon Sequestration Focus Areas: Enhancing the Natural Terrestrial Cycle, (2004), *available at* http://cdiac2.esd.ornl.gov/scienceman.html#enchancing.

43. P.M. Condon & K. Isaac, *Green Municipal Engineering for Sustainable Communities*, 156 Mun. Eng'r 3 (March 2003), *available at* http://www.yorku.ca/carmelca/6000P/readings/AddOns0301-Neighborhoods2Streets/b.municipal_engineer_article.pdf.

44. The Transit Village Act of 1995 in California encourages local jurisdictions to zone and plan for intensive, mixed-use development around rail stations, and gives state transportation funds to those who pursue TOD. Robert T. Dunphy et al., Developing Around Transit: Strategies and Solutions that Work 36 (Urban Land Institute 2004). The Federal Transit Administration evaluates specific aspects of a site to determine if it should receive grants for major capital projects. These aspects included the following: 1. *Existing Land Use* (What is the density of the population in the area, and how pedestrian friendly is it?); 2. *Containment of Sprawl* (What kind of growth management is in place?); 3. *Station Area Zoning* (Do the ordinances support increased development near stations?); 4. *Corridor Planning* (Is transit-supportive development encouraged in the transit corridors?); 5. *Policy and Plan Implementation Processes* (What public and private processes facilitate station area development?); and *Impact of Transit Oriented Planning* (Is there a positive development impact on the area due to transit?). *Id. at* 90.

45. The *New York Times* reports that Arlington County, Virginia, an "urban suburb of Washington [D.C.], seems well-prepared for a leading role in the green revolution embraced by hundreds of the nation's cities, counties, and towns." But "county officials are reckoning with the fact that though green is the dream, the shade of civic achievement is closer to olive drab. Constraints on budgets, legal restrictions by states, and people's unwillingness to change sometimes put the brakes on ambitious plans to cut carbon dioxide emissions." Arlington is not alone in running up against problems. Counties across the nation are having trouble lowering their carbon emissions, as community lifestyles, homeowners associations, and legal limits on county officials stymie environmental initiatives. "We have been doing things like filling potholes and reducing crime since cities began," David N. Cicilline, the mayor of Providence, R.I., said, adding that "energy efficiency requires 'a whole new infrastructure to evaluate and measure.'" Felicity Barringer, *In Many Communities, It's Not Easy Going Green*, N.Y. Times, Feb. 7, 2008, at A18.

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Carbon Capture and Geologic Storage

By Richard G. Tisch

1. Introduction

In response to a collective international anxiety regarding perceived human-induced global warming attributed to our burning fossil fuels, most of the world's countries became parties to the United Nations Framework Convention on Climate Change (FCCC) in 1992.There are now 189 signatories, including the United States. The ultimate purpose of the FCCC is to stabilize greenhouse gas (GHG) concentrations in the atmosphere at a level that will prevent dangerous anthropogenic interference with the climate system and to enable economic development to proceed in a sustainable manner.[1]

"It is best to have more than one solution to a large, enduring, and expensive problem."

Anon.

The Convention spawned the Kyoto Protocol in 1997, in force since 2005, which establishes common but differentiated responsibilities between the so-called developed nations and developing nations, recognizing the elevated accountability of the former arising from their primacy for GHG [2] emissions, their wealth, and their technological capabilities. The Kyoto Protocol imposes no duty to reduce GHG emissions on developing nations and imposes an average of a 5% reduction obligation from their 1990 GHG emissions levels on developed nations, to be achieved during the 2008–2012 period. While many party nations are intending to meet this objective, some may not—compliance is proving challenging. In any event, Kyoto is understood to be merely the first step in a series of increasingly more onerous steps that governments will need to take in order to achieve a stabilization of GHG concentrations. Since world population growth continues unabated and energy needs will rise correspondingly, as each year passes more fossil fuel use will mean more GHG emissions. Because the atmospheric longevity of the GHG is measured in years or decades, the warming potential created by ever increasing emissions will result in a buildup of GHG whose effect will grow over time, even after actual GHG emissions may decline. Notwithstanding Kyoto, the developed nations are finding GHG emissions reductions to be difficult to achieve, and are increasingly willing to continue fossil fuel usage if substantial quantities of the GHG emissions can be captured and sequestered.[3] The cost for such capture and storage, however, may prove quite expensive.[4]

Carbon dioxide, a seemingly innocuous and ubiquitous gas that we exhale and that trees and plants respire, is now the key compound in a global environmental challenge. What a difference a decade makes.

2. What Is Carbon Capture and Storage?

Carbon capture and storage (CCS), as considered here, involves the separation of carbon dioxide from fossil-fuel-fired power plants and large industrial sources, its transport to a secure land-based geologic storage/sequestration location, and its long-term isolation from the atmosphere.

The international body generally recognized to speak with authority on anthropogenic greenhouse gas emissions attributed to global warming is the Intergovernmental Panel on Climate Change (IPCC). Comprised of hundreds of scientists and representatives from scores of nations, including a robust U.S. representation, the IPCC has prepared numerous comprehensive reports addressing a broad series of global climate change topics over a ten-year period. One such publication is the IPCC Special Report on Carbon Dioxide Capture and Storage.[5]

Although sometimes overlooked in commentators' and the media's emphasis on finding alternatives to the three main fossil fuels (coal, natural gas, and oil), capturing and storing[6] carbon dioxide have been identified by the IPCC as a critical component in combating global warming—the IPCC "considers CCS as an option in the portfolio of mitigation actions for stabilizing of atmospheric greenhouse gas concentrations."[7] This option, however, like finding viable substitutes for fossil fuels, is a long-term option. It presents a substantial and urgent need for government-funded demonstration, pilot, and modest commercial-scale CCS projects to advance our understanding of geologic site characterization and selection; CO_2 storage and leakage mechanisms; measurement, monitoring, and verification tools; CO_2 impacts on geologic media; injection well integrity; remediation technologies; the potential for CO_2 releases; liability regimes; and, importantly, CCS costs.

3. What Are the Sources of CO_2 That Can Be Sequestered?

Coal-fired power plants are unquestioned kings in the hierarchy of large stationary sources of CO_2 emissions. Almost 60% of the electricity generated in the United States and about 30% of the world's electric power comes

from coal burning.[8] America has over one-quarter of the world's coal reserves, exceeding any other nation's supplies, presenting us with a relatively inexpensive—and independent—source of power for several centuries. Unfortunately, coal is also the most carbon-intensive fossil fuel. Existing coal-burning plants generate almost one-third of CO_2 emissions within the United States.[9] Our continued reliance on cheap, abundant coal-fired electricity seems commonsensical, but if we do not capture the carbon dioxide emissions from these plants, the addition of CO_2 to the atmosphere will be significant. As of last May, the U.S. Department of Energy estimated that about 145 gigawatts of new coal-fired plants will be built in America by 2030, "resulting in CO_2 emissions of 790 million metric tons per year in the absence of emission controls."[10] This represents about 13% of the CO_2 emissions from all sources in the United States in 2005.

After power plants, cement production, oil refineries, the iron and steel industry, and the petrochemical industry are the chief emitters of carbon dioxide from stationary sources which may be suitable for CCS.[11] Sequestering CO_2 from these discrete, significant sources, in addition to the fossil-fuel power plants, would substantially reduce atmospheric emissions, and nations are recognizing the benefits of CCS: preventing GHG emissions and enabling continued use of fossil fuels until alternative fuels can be used on a larger scale.[12] Moreover, the good news seems to be that we may have no insuperable technological barriers to implementation of CCS.

4. How Does CCS Work?

A. The Capture Phase

In a CCS system, carbon dioxide is dehydrated, compressed to a supercritical liquid, conveyed by pipeline to an injection well, and then pumped deep underground within fully characterized formations which enable maintenance of necessary pressures and temperatures to hold the CO_2. The carbon dioxide seeps into the subsurface rocks (often sponge-like structures) and is prevented from escaping to the surface by a caprock or other impermeable formation. Some CO_2 may dissolve in saline ground water and react with the various minerals, forming carbonates with little mobility, and other CO_2 is trapped by capillary forces.

There are three generally recognized methods of capturing carbon dioxide: post-combustion, pre-combustion, and oxyfuel (or oxycoal) combustion, and each presents noteworthy cost burdens.

In a simple post-combustion operation, a carbon dioxide capture system is added to the back end of a power plant and the resulting flue gas is scrubbed to remove the carbon dioxide. Capture of CO_2 is difficult due to low CO_2 concentrations (about 15%) in the flue gas. The large volumes of flue gas are handled by conventional absorption processes; the resulting efficiency penalty is substantial: over 25%. Chemical and physical absorption of CO_2 entail other capture technologies, but are costly.

Some consider amine scrubbing as the best candidate for post-combustion decarbonization of flue gases. With this process, cooled CO_2 encounters an alkanolamine solvent, which binds the CO_2 chemically. The CO_2-rich solvent is then conveyed to a stripping tower where the solvent is heated, releasing highly concentrated CO_2 that proceeds to the next phase: compression. Amine scrubbing, however, is challenged by the low pressure of the flue gas, and the use of alkanolamines—suitable for such low pressures—is problematic for other reasons.[13]

Pre-combustion technology involves removal of the carbon before combustion. An Integrated Gasification Combined Cycle (IGCC) process is often identified as a potentially viable technology to employ CCS. First, coal, or another fossil fuel, is changed into a synthetic gas (syngas—hydrogen and carbon monoxide). Then, the CO in the syngas is converted to hydrogen and carbon dioxide in a so-called water-gas shift reactor. After mercury, sulphur, and CO_2 removal operations, the hydrogen passes through a combustion turbine to generate electricity and the exhaust heat from the turbine spins a steam turbine also to generate electric power—hence the "combined cycle" in the description.

For years syngas from gasification has been used as the initial material for the manufacture of chemicals and liquid fuel; the chemical industry has extensive experience—there are about 120 gasification plants operating worldwide—but most of these do not generate electric power.[14] The carbon capture potential at IGCC plants is in the range of 85%.[15]

Oxyfuel (or oxycoal) combustion provides a third significant method of decarbonization. It is a more sophisticated means than post-combustion technology because pure oxygen is used as the oxidant instead of air (oxygen can also be used in an IGCC process). As a result, nitrogen (79% in air) is absent from the process, avoiding NOx emission concerns. The resulting fuel gas consists primarily of CO_2 and water vapor and the latter can be easily condensed.

Oxyfuel technology is more promising for new installations than post-combustion carbon dioxide capture.[16] While the air separation process (to generate oxygen) uses considerable energy (large volumes of oxygen are separated cryogenically), this overhead is ameliorated by the elimination of the final CO_2 separation operation. The resulting CO_2 is highly concentrated—at about 90% or higher—and storage-ready after dehydration by a simple condensation process. Several companies are engaged in worldwide efforts to lower the cost of producing the oxygen needed for the oxyfuel combustion process, including using membranes at high temperature. Importantly, it appears that oxyfuel combustion systems and post-com-

bustion capture systems may be retrofitted, unlike IGCC, to many coal-fired power plants.[17] In order to prove the technological and costs feasibility of oxyfuel technology, demonstration projects are needed.[18]

B. The Storage Phase

Geologic carbon sequestration involves the injection of pressurized carbon dioxide into the earth's strata. Just as oil and natural gas have been created and stored underground over many millions of years, CO_2 can be sequestered as pore-filling fluid at depths of approximately 3,000 feet or more below the surface. Deep saline formations containing huge unusable quantities of salty water are globally widespread, common in the United States, and offer the possibility of storing injected CO_2 for thousands of years.[19]

In addition, depleted oil and gas wells and deep coal seams present genuine potential for enhanced oil recovery ("EOR") and natural gas recovery—processes which use CO_2 as the injected fluid to drive out the hard-to-get fossil fuels through exit wells to the ground's surface. More than 100 million tons of carbon dioxide have already been injected into quiescent oil reservoirs for EOR as well as into deep saline aquifers.[20] The oil industry in the United States has substantial experience over many decades using EOR with reliable, heartening results: more than 99% of the injected CO_2 stays underground. Similarly, gas and pipeline companies successfully store natural gas in subsurface formations. As the IPCC noted in its CCS Report, multiple storage mechanisms operate at various length and time scales to trap CO_2 in the earth's crust.[21] Over decades, scientists predict that the risks of carbon dioxide migration or surface escape diminish and permanence increases.[22]

The few commercial CCS operations have provided, to date, geologic storage integrity consistent with EOR experiences. Offshore of Norway the Sleipner project is approaching twelve years of CO_2 injection down one well at a rate of one million metric tons/year. The Weyburn, Saskatchewan, Canada (2000) and In Salah, Algeria (2004) projects provide further positive, albeit limited, experience. Weyburn actually involves fifty EOR wells and In Salah entails injection down three wells into a deep saline formation. These projects are of similar scale as Sleipner. All demonstrate that fairly large quantities of CO_2 can be injected deep below the earth's surface, the CO_2 can be handled safely, monitoring of CO_2 movement is feasible and effective, and the techniques used by the petroleum industry for decades work quite well.[23] However, in order to craft a credible, comprehensive framework of CCS applicable to injection of billions of tons of carbon dioxide into hundreds of wells, we need more and larger demonstration projects.[24]

In the U.S., since 2003, the coordinated efforts of the Department of Energy (DOE) and private enterprise have shown promise in providing this CCS experience, with most of the work to date directed at carbon capture rather than storage. The DOE's Regional Carbon Sequestration Partnerships (in which my company, Praxair, Inc., is a participant) have developed know-how and technology regarding storage site characteristics, seeking to identify the most promising regions in America for carbon capture and storage. Over 350 entities, 41 states, 4 Canadian provinces, and 3 Indian nations participate in the Partnerships, which continue their efforts.[25] In the initial, or Characterization Phase, the members have developed the National Carbon Sequestration Database and Geographic Information System (NATCARB) that provides a national perspective of carbon storage in North America. Data from the seven regional partnerships are integrated, and users of NATCARB can estimate the volumes of CO_2 from various large stationary sources that may be securely sequestered over extended periods of time.[26]

Over two dozen geologic field sites have been identified in the Validation Phase of the Partnership, expected to continue through 2009. Geologic capacities; injectivity capabilities; monitoring, mitigation, and verification technologies (reservoir monitoring); permitting conditions; and well construction methodology comprise this Phase of the activities. Deployment—the actual scaling up to commercialization—has a ten-year horizon requiring seven large volume storage tests with injection rates of 225,000 to 900,000 metric tons per year for several years. These tests are needed to provide insight into the technical and operational issues regarding the various formations.[27]

5. Are the Large CO_2 Sources Near Favorable Geologic Sequestration Formations?

Large stationary sources of CO_2 are sited in major industrial and urban areas and often within 150 to 200 miles of potentially viable geologic sequestration formations. As the IPCC has noted, however, available studies linking such large sources to suitable geologic storage sites is limited.[28] Some of this data gap is being remedied in the U.S. through the work of the Regional Carbon Sequestration Partnerships, the NETL, and NATCARB. They have prepared a Methodology for Development of Carbon Sequestration Capacity Estimates document that integrates the results of assessments of oil and gas formations, unmineable coal seams, and saline formations.[29] The approach used included an estimate of the efficiency with which the geological resources can store the carbon dioxide, thus highlighting certain formations throughout North America that may be higher quality candidates for sequestration. Data collected by the seven Partnerships were gathered, assessed, and used in conjunction with widely accepted assumptions about geologic storage mechanisms. Particular CCS projects, however, will require site-specific and detailed geologic models and simulations of CO_2 injection in order to best estimate storage capacity.

Other important work from this collaborative effort includes identification of the key carbon dioxide stationary sources—about 86% are electricity generating plants—throughout the U.S. Carbon dioxide storage capacity estimates for the various formations are also identified for each of the seven Partnerships. What becomes evident is the surfeit of subsurface storage sites for CO_2. In 2004, EPA estimated total U.S. GHG emissions at just under 8 billion tons (about 7 billion metric tons). The 4,365 stationary sources listed by the Partnerships emitted a total of 3.8 billion metric tons, over one-half of all GHG emissions in the U.S. The total CO_2 capacity of the low estimate of the smallest of the seven Partnerships' saline reservoirs, located in the Southwest Regional Partnership on Carbon Sequestration, is 18 billion metric tons. The high estimate is 64 billion metric tons. The low capacity estimate for the Partnership with the largest storage capacity—the Southeast Regional Carbon Sequestration Partnership—is 360 billion metric tons, with the high estimate pegged at 1,587 billion metric tons, which is substantially more than enough storage capacity for all the forecasted CO_2 emissions in the United States this century.[30] California, obligated to mitigate its GHG emissions under its Global Warming Solutions Act of 2006, contains major oil and gas fields for both sequestration and EOR. Its ten most promising saline basins have a total storage capacity of between 75 and 300 billion metric tons.[31] It seems fair to say that finding suitable and enough geologic storage sites will probably not be the limiting factor in any CCS program in America.

Installing CO_2 injection wells near the major sources is desirable, of course. But if such sources are not serendipitously located, we will be able to carry the supercritical CO_2 they would otherwise emit by pipeline to geologic storage sites (subject to the cost, time, and logistics burdens identified above). There are over 3,000 miles of CO_2 pipelines operating in North America today and they annually convey more than 30 million tons of CO_2.[32] The Weyburn project transports carbon dioxide from Beulah, North Dakota to Saskatchewan, a distance of about 200 miles, for enhanced oil recovery. Obviously, the shorter the distance that CO_2 must be piped, the lower the transportation costs, including fewer rights-of-way agreements that would be needed to permit transport over third-party properties. In short, the United States, primarily through private/public/academic collaboration, possesses the technical knowledge and understanding to design, build, and operate pipelines that safely transport carbon dioxide to appropriate geologic sequestration sites.

6. What Are the Risks of CCS?

As noted earlier, the IPCC is very optimistic regarding the issue of safe geologic storage of carbon dioxide.

> With appropriate site selection informed by available subsurface information, a monitoring programme to detect problems, a regulatory system and the appropriate use of remediation methods to stop or control CO_2 releases if they arise, the local health, safety and environmental risks of geological storage would be comparable to the risks of current activities such as natural gas storage, EOR and deep underground disposal of acid gas.[33]

This is a positive statement, and the data from this country's experience support it. Industry has many decades of EOR experience and the EPA has issued tens of thousands of permits covering more than 650,000 underground injection wells for disposal of waste, much of it hazardous, since implementation of the Underground Injection Control (UIC) program under the federal Safe Drinking Water Act. More than 750 billion gallons of fluid are injected each year—an astonishing amount.[34] The history of these wells' performance regarding protection of subsurface drinking water sources—the primary purpose of the UIC program—is excellent, and the EPA solidly directs, in cooperation with a number of state agencies, mature, sophisticated regulatory programs. While it is true that a sudden and significant release of CO_2 to the surface from a subsurface reservoir could pose a hazard to human health (if CO_2 concentrations exceeded about 7% by volume in air), the likelihood of this occurring is very remote and the risk has been effectively managed and should be so managed in the future. The rare cases of human or animal harm arising from CO_2 releases that may appear in the press relate to the rare volcanic eruptions in large quantities (Cameroon, Africa) or from pooled CO_2 in ground level depressions (Mammoth Mountain, CA). Industry has successfully plugged and abandoned large numbers of CO_2 injection wells in accordance with regulatory requirements at no harm to human health or the environment.

Currently, pipeline carriage of CO_2 through populated areas of the country relies on route selection, leak detection, overpressure protection, and other design criteria to minimize health risks. Neither the IPCC nor other knowledgeable commentators foresee any substantial barriers to a pipeline CCS design and usage.[35] Moreover, carbon dioxide is, quite simply, not hazardous as that term is often used in the environmental regulatory context. It is not identified as a hazardous substance under the federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or "Superfund") nor is it a listed or characteristic hazardous waste under the federal Resource Conservation and Recovery Act, the basic federal law regulating hazardous waste from generation to ultimate disposal. While the U.S. Supreme Court has ruled that CO_2 fits within the definition of the term "air pollutant" under the Clean Air Act, this ruling was based on the straightforward observation that the substance is a "physical [or] chemical . . . substance or matter which is emitted into . . . the ambient air."[36] The potential risks

posed by this air pollutant, as discussed by the Court and now being examined by EPA, stem only from its contribution to global warming.

Other potential adverse consequences of CCS involve groundwater quality degradation, resource damage, structural damage to the wells, or releases to the atmosphere. The first of these is the most commonly considered and this risk is specifically regulated through the UIC program administered by the EPA and states.

In order to inject a fluid underground, you need a well. Well design and construction has a full history, although further study is being done and will continue to be done to address the significant volumes and characteristics of CO_2 injected in these wells. A comprehensive wellbore integrity program is in operation within the oil and gas industry that is considering frequency of failure, mechanisms and consequences of well failure, and remediation methods.[37] Researchers are aware, for example, that the cement used in well construction may break down in laboratory studies when it is exposed to CO_2, but field experience does not corroborate this result. Further study of seals and their threshold for leakage is needed; since CO_2 is lighter than oil, it applies more buoyancy pressure. Carbon dioxide also has a lower interfacial tension than natural gas, so it leaks more easily than the gas. These issues, while being studied, still require additional work, and will benefit from continuing attention and funding by the federal government[38] to assist the private sector in identifying and fully understanding the technical complexities of CO_2 storage.

While this may be surprising to many, the U.S. EPA's UIC program currently provides a regulatory framework for the geological storage of carbon dioxide. So-called Class I permits control technically sophisticated deep injection wells with siting, monitoring, and closure requirements. Class II wells cover EOR activities and hydrocarbon storage. In Class V Experimental Technology Well Guidance, published by the EPA in March 2007, the Agency stated that injection of CO_2 for geological sequestration is an experimental application of an existing technology, that is, EOR and enhanced gas recovery.[39] The Guidance refers to the "validation" and "deployment" phases of the research and development on geological storage and salutes the Partnerships supported by the DOE that are pursuing such R&D. But the EPA's Guidance is just that—guidance—and without comprehensive regulations specifically covering the geologic sequestration of CO_2, industry is unable to obtain certainty regarding a regulatory regime for future CO_2 storage. This is likely to change.

On October 11, 2007, the Administrator of the EPA announced that the Agency would develop a proposed rule for commercial scale geologic sequestration by the summer of 2008. The EPA has achieved this deadline, having published proposed regulations in July 2008, although final rules may not be promulgated for several years. The EPA had held several workshops on geologic sequestration with vibrant public/private/non-governmental organization collaboration in December 2007 and February 2008 and had also held technical workshops on well construction and mechanical integrity testing, geologic setting, area of review, and abandoned well issues earlier in 2007. Among other topics, the latest workshop addressed EPA's current thinking regarding subsurface CO_2 monitoring, financial assurance for long-term site care, and closure and post-closure care. To try to ensure that any proposed regulation is consistent with air emission-related activities and energy matters, the EPA's Office of Ground Water and Drinking Water is coordinating its rule-making efforts with the Office of Air and the U. S. Department of Energy.

A proposed rule issued by the EPA will bring into some focus the technical issues that are presented by a substantial CCS underground injection permit program. However, the public should not expect to find in these proposed rules provisions related to two critical components of geologic sequestration: CCS costs and liability.[40]

7. What Are the Costs of CCS?

The anticipated considerable cost burden of CCS has been referenced earlier.[41] Higher capital costs, significantly more fuel use, and lower electricity output (power is cannibalized to support the added capture-related techniques), in addition to the expense associated with CO_2 compression, CO_2 transport to an injection well, well construction, and injection itself combine for a substantial cost premium for CCS.

As noted, there is little commercial experience with CCS and, therefore, only incomplete cost data exist. Literature suggests consistently that the cost of CCS will fall over time in response to technological advances. Economic and energy models, often used to forecast CCS costs, are also consistent in finding that only limited deployment of CCS will occur absent legislatively mandated GHG reduction regimes.[42] With such GHG mitigation requirements, integrated economic assessments indicate that CCS costs will be comparable to other large-scale alternative power sources such as nuclear or renewable fuels technology and that deployment will occur when carbon is priced at \$25–\$30/CO_2 ton.[43] Nevertheless, attempting to predict CCS costs within a narrow cost range strains economic modeling because there are so many unknowns: technology development expenses, the cost of capital, fuel prices, operating and maintenance costs, monitoring costs, regulatory costs, etc., all of which are projected to a future horizon.

The cost of carbon capture, including not only the separation of CO_2 but also the cost of compressing the CO_2 to a pressure appropriate for pipeline transport, is considered to be the highest CCS cost, as much as four times the cost of transport and sequestration.[44] With improvements to current technologies for separating

out the CO_2, costs may be reduced 20%–30% in coming decades. New technologies may permit even greater cost reductions.[45]

Pipeline transport of the captured carbon dioxide presents a cost structure which is well-known and offers some degree of accuracy in cost prediction, although it may promise, correspondingly, less opportunity for future cost reduction. Generally speaking, pipeline construction costs, operation and maintenance, and miscellaneous costs (e.g., rights-of-way, insurance, fees) present familiar problems with expected cost stacks. Specific site conditions (both on land and at sea, if sea bed sequestration is pursued) may present appreciable cost variations, however.

The geologic storage costs also reflect commonly understood costs in the oil and gas industry associated with: injection wells construction and maintenance, equipment, site specific factors such as well depth and reservoir characteristics (porosity, thickness, etc.). When carbon dioxide sequestration is combined with EOR, some of the capture and storage costs will likely be offset by the benefits from the oil recovery operations. In fact, these benefits, coupled with the extensive industry experience in EOR, may make EOR sequestration a good candidate for early selection by the government for authorized CCS.[46]

As many commentators report, once mandatory GHG requirements have been legislatively imposed, entities pursuing CCS will begin to incur substantial costs.[47] As a result, a powerful case can be made that the federal government should provide incentives and other types of financial support to enable CCS's use and encourage utilities and industry participants to invest in it. The Lieberman-Warner Bill provides for a declining cap-and-trade system to reduce GHG emissions from fossil-fuel power plants and industrial facilities. However, coal-based power plants predominate in the Midwest and Southern states, the Mountain states, and Texas; therefore, ratepayers in these areas could bear a disproportionate share of the costs of CCS—an outcome that seems inequitable given the global nature of the warming intended to be averted and the happenstance that finds such ratepayers in parts of the country that are served by coal-fired plants.[48] Congress can provide CCS incentives through offering tax credits for CCS technology, for example, oxyfuel technology and IGCC, and the EPA can support consideration of EOR as a geologic sequestration option through recognition in its final UIC regulations.[49] The U.S. government should substantially increase its current funding for research and development and demonstration projects with regard to these carbon capture technologies, including the seven Regional Sequestration Partnerships, recognizing that private industry is neither financially equipped nor motivated to incur the anticipated large costs for new CCS technologies and applications, and the attendant potential uncertainties of performance, while at the same time rigorously adhering to its shareholder responsibilities.

8. What Are the Potential Liabilities Arising from CCS?

Long-term sequestration of carbon dioxide presents several areas of possible liability: the legal risks of CO_2 releases to the ground surface, property rights issues regarding transport and storage of CO_2, and liability during operation and after closure of the CO_2 injection well. Regarding the first, an owner or operator of an injection well may confront "credit" loss liability, that is, the removal of tradable credits allocated to it due to an unexpected CO_2 release to the surface from the geologic formation. As well, a release of CO_2 to the surface may also present potential harm to human health or the environment. Given the experience to date with EOR wells, a mature regulatory framework upon which new rules will be based, and the expected due diligence for site characterization for future geologic sequestration wells, these liability risks will likely be quite small. Regarding subsurface risks, the owner of the CO_2 and the operator of the injection well will face potential liability for any subsurface release beyond the subsurface CO_2 reservoir, especially if underground sources of drinking water are impacted. Under the UIC program the owner and operator already incur such liability. However, the owner and operator ("o/o") may be able to shift the above liability risks through contract or mitigate their potential costs through insurance arrangements, surety bonds, or other financial instruments.[50]

Property rights issues will arise regarding CCS. Easements may be required to permit transport of pipeline CO_2 from the CO_2 source to the injection well. Acquisition of, and rights with respect to, surface and subsurface property to construct the well and related facilities, and allow injection of CO_2 deep below the surface likely will be governed by state law, and the states have legislated in these areas for years. Generally, the surface property owner owns the subsurface, or mineral rights, and transfer of the latter, only, is often permitted under state laws.[51] However, it is possible that the operator may need to acquire separate rights in the groundwater that resides in subsurface formations, such as deep saline aquifers.[52]

The UIC regulations provide that the o/o of a facility or activity subject to RCRA, UIC, NPDES or 404 programs[53] bears liability for an injection well. Enhanced oil recovery operations have been permitted under the UIC program for decades as Class II wells and their permit terms are well understood and accepted. To the extent that EOR wells may transition to geologic sequestration wells, the EPA may determine to amend typical permit conditions to reflect differences in the purposes of the CO_2 injection, that is, there may be "siting, well construction, or monitoring standards that could be different from those specified for a Class II well."[54] EPA's proposed rules published this past July included changes from this guidance as well. But the general regulatory regime is familiar: owners and operators will be liable for 1) defining the area of review (a prescribed area surrounding an injection

well); 2) constructing, operating, maintaining, and closing such a well; and 3) testing, monitoring, and reporting the CO_2 movement within the formation, among other subsurface conditions, and will be subject to post-closure care and financial responsibility for post-closure care. However, the desired longevity of CO_2 storage—perhaps a hundred years and more—raises the question of who bears responsibility for the CO_2 during the long tail of this time period. No other federal environmental regulatory program requires that owners or operators assume such a long-term liability (although the UIC program and RCRA program require certain long-term closure and post-closure obligations). Even Superfund remediation obligations imposed on responsible parties do not contemplate the scores of years that may be considered needed to oversee successful geologic capture of carbon dioxide. Since many of the CCS wells are expected to be used for only 30–40 years before the subsurface formations have been filled with CO_2, the post-closure phase will, indeed, be very long. A reasonable argument can be made that if the o/o has successfully operated and maintained the injection well and obtained favorable monitoring data for several decades, then the o/o should not be burdened with liability obligations for still many more decades; instead, the federal government or state governments should assume liability at this time, as Texas agreed pursuant to recent legislation passed to win approval of the FutureGen project. Of various liability scenarios, this seems particularly appealing since the governments will likely outlive the o/o and the well and formation will have already experienced a substantial time period of satisfactory operation and CO_2 retention.[55]

While comprehensive in many respects, S2191, America's Climate Security Act of 2007, does not provide a broad liability framework relating to carbon capture and storage. The bill would establish a task force, composed of various interested stakeholders, to "conduct a study of the legal framework, environmental and safety considerations, and cost implications of potential Federal assumption of liability with respect to *closed* geological storage sites."[56] No later than 18 months after enactment the task force would submit its report to Congress, including its recommendations. These provisions amount to a "punt" and may prove to be a substantial source of contention in the debate on this bill and a potential barrier to its passage. Task forces set up by Congress pursuant to federal law are not renowned for their weighty influence on legislators. Such reports are often late, and then frequently ignored. Here, the issue of private industry liability for CCS is already an electric issue, openly discussed among the public, private, and NGO communities. Delaying the resolution of long-term liability for CCS will present, for years, a Damocles sword of unknown cost risks hanging over the boardrooms of major corporate America—the entities likely to be engaging in CCS. Congress needs to devise a liability regime for this bill that allocates such long-term liability sensibly for closed CCS sites.

9. Summary

Carbon capture and storage must be included in our nation's collection of technology solutions to our increasing emissions of greenhouse gases. The state-of-the-art for CCS is already quite well developed, scientific understanding is high, engineering knowledge is considerable; the economics, however, remain a challenge. There exists a compelling need for demonstration and pilot projects funded, in large part, by the U.S. government, to enable acquisition of additional scientific knowledge and practical experience by the private sector with respect to CCS. From such projects innovative approaches will arise and CCS costs will diminish, and what is for now only a potential partial response to anthropogenic climate change will evolve into an achievable partial solution.

Endnotes

1. The Intergovernmental Panel on Climate Change, or IPCC, in its Fourth Assessment Report, found that stabilizing GHG concentrations in the atmosphere at a level that will prevent such dangerous human-induced interference with the climate system will require a worldwide effort to reduce emissions of greenhouse gases by 50% to 85% below 2000 levels by 2050. The IPCC was established in 1988 by the World Meteorological Organization and the United Nations Environmental Programme. Its purpose is to provide policy makers and others involved in climate change with an "objective source of information about climate change. The IPCC does not conduct any research nor does it monitor climate related data or parameters."
2. Greenhouse gases include carbon dioxide, methane, nitrous oxide, perfluorocarbons, hydrofluorocarbons, and sulfur hexafluoride. Carbon dioxide is accepted as responsible worldwide for well over 50% of the greenhouse effect attributed to all the GHG. However, water vapor, present for millions of years, is easily the most abundant GHG, causing over 97% of the greenhouse effect and enabling human life on the planet.
3. The European Union, subject to the Kyoto Protocol, recently announced that its GHG emissions had increased 1.1% in 2007. *See* CLIMATE WIRE, April 3, 2008. Interestingly, the total GHG emissions in the United States reportedly declined in 2007.
4. While actual costs of capture and storage must await meaningful commercial experience, Scott Klara of the National Energy Technology Laboratory (NETL), citing NETL department projections, has estimated an 80% increase in the cost of electricity for a new pulverized coal plant with CCS and a 35% increase if CCS is added to a new advanced gasification plant. CLIMATE WIRE, March 27, 2008. Julio Friedmann, Ph.D., Carbon Management Program APL, Global Security Principle Directorate, Lawrence Livermore National Laboratory, estimates the range of carbon capture and separation costs for a typical pulverized coal plant at $40–60/ton; $30–45/ton for a typical gasified plant; and $40–60/ton for an oxyfuel plant. Julio Friedmann, Reducing Emissions in California Through Carbon Capture and Sequestration, unpublished .ppt presentation (2007). In testimony before Congress on March 6, 2007, Stu Dalton, Director of Generation, Electric Power Research Institute, estimated a net present value 60%–80% increased cost in electricity prices if CCS, using amine solvents to capture the CO_2 and a short pipeline to transport it to a geologic injection site, were added to a new pulverized coal plant. This cost excludes storage site monitoring and liability insurance, among other indirect costs that may arise.
5. IPCC SPECIAL REPORT, CARBON DIOXIDE CAPTURE AND STORAGE (Sept. 2005) (hereinafter CCS REPORT).
6. For the purpose of this article, "storing" and "sequestering" are used interchangeably and only in the context of CO_2 injection into

geologic formations, such as deep saline aquifers (sedimentary rocks saturated with dissolved salts in ground water), oil and gas fields, and unmineable coal beds. Terrestrial sequestration, involving the absorption of CO_2 by trees, grasses, and crops, as well as the enormous uptake of CO_2 by the oceans, is not considered here.

7. CCS Report: Summary for Policymakers, *supra*, note 5 at 15.

8. China starts up a new coal-fired plant every week and none currently captures and sequesters the CO_2 emitted. The United States has dozens of coal-fired plants in various planning stages but many states are reluctant to issue site permits or air permits to such plants without CCS commitments from the utilities. These proposed U.S. plants comprise in total only about 10% of the coal-fired plants currently projected for construction worldwide, with most such plants anticipated to be built in China and India. In the U.S., even in the absence of clear statutory language authorizing the regulation of CO_2 as an air pollutant or otherwise, several states have denied air permits for proposed coal-fired plants which fail to require CCS. Some states (e.g., California) have required CO_2 mitigation measures pursuant to environmental impact reviews as conditions precedent to issuance of air permits. Many new coal-fired plants may be required, de facto, to be CCS retrofit-capable or integrally designed with CCS to enhance permit issuance. The Rainforest Action Network and Coal Moratorium NOW, two environmental groups, recently released a report, *Coal Plants Cancelled in 2007*, which claims that 59 coal-fired power plants were cancelled, delayed, or abandoned in 2007. It should be noted, however, that the absence of GHG emission laws has created an uncertain regulatory environment unfavorable to utilities' multi-year planning to construct coal-fired power plants, and cancellations may have been prompted by this uncertainty as well.

9. Energy Information Administration, Emissions of Greenhouse Gases in the United States 2005 ix, 13 (Nov. 2006).

10. Department of Energy Nat'l Energy Tech. Lab., Tracking New Coal-Fired Power Plants: Coal's Resurgence in Electric Power Generation, unpublished .ppt presentation (May 1, 2007), excerpted from K. Berlin & R.M. Sussman, *Global Warming and the Future of Coal*, Center for Am. Progress, May 31, 2007, http://www.americanprogress.org/issues/2007/05/coal_report.html.

11. CCS Report: Summary for Policyholders, *supra* note 5 at 3.

12. While not included in the Energy Independence and Security Act of 2007, a carbon capture and sequestration title had been written for this bill and is now percolating within Congress. The so-called Lieberman-Warner Bill, America's Climate Security Act of 2007 S. 2191, 110th Cong. (2007), formerly the leading candidate for Senate consideration, contains various provisions regarding CCS, as do other Congressional climate change bills. S. 2191 provides a legal framework for geological sequestration of CO_2, authorizing the USEPA to issue underground injection control permits for such CO_2 injection. It also provides a limited supply of allowances, at no cost and for a certain time period, to companies that sequester carbon dioxide. An allowance would permit the bearer to emit one metric ton (2,200 pounds) of carbon dioxide.

    In late January 2008 the European Commission proposed a Directive on the geological storage of carbon dioxide. The Explanatory Memorandum accompanying the Directive openly recognized the impossibility of mitigating world CO_2 emissions by 50% in 2050—the EU's stated goal—absent CCS. In light of China (now the leading GHG emitter in the world), India, Brazil, South Africa, and Mexico's rapidly growing energy consumption, alternative power sources (wind, solar, etc.) will not keep pace and CCS is required, according to the Directive. In California, the state with the most aggressive legislative and regulatory global warming agenda, respected members of the academic community are advocating CCS as a significant technology to mitigate dramatically GHG emissions, and the California Air Resources Board ("CARB") is listening. CARB is charged with the responsibility to promulgate regulations and implement the California Global Warming Solutions Act of 2006 which requires economy-wide GHG emissions in 2020 to be no greater than 1990 GHG emission levels.

13. For an introduction to carbon capture techniques, see P. Luby & M. Susta, *Exploring the Many Carbon Capture Options*, POWER Magazine, April 1, 2007.

14. Research Reports Int'l, Coal Gasification for Power Generation 10-11 (Sept. 2005).

15. DOE Nat'l Energy Tech. Lab., Carbon Sequestration and Technology Roadmap and Program Plan 9 (2006). NETL has a goal of meeting a 90% carbon capture rate by 2012.

16. Luby & Susta, *supra* note 13.

17. *Id*.

18. Praxair, Inc., with other major industrial gases companies and a prominent worldwide engineering service provider, have combined efforts to try to educate members of Congress and other thought leaders regarding the benefits of employing oxyfuel technology as an advanced coal solution to reduce GHG emissions. A variety of coals and biomass may be used in the fuel mix and oxyfuel appears to offer significant potential for lower cost technology opportunities than alternative combustion methods in coal-fired power plants.

19. CCS Report, *supra* note 5 at 12. "Observations from engineered and natural analogues as well as models suggest that the fraction retained in appropriately selected and managed geological reservoirs is very likely* to exceed 99% over 100 years and is likely to exceed 99% over 1,000 years." The IPCC assigns a probability of between 90% and 99% for "very likely." "Likely" means a probability between 66% and 90%.

20. S. Julio Friedmann, Carbon Sequestration Risks and Hazards: What We Know and What We Don't Know, unpublished .ppt presentation. Dr. Friedmann works in the Carbon Management Program, Global Security Principle Directorate, Lawrence Livermore National Laboratory.

21. Initially, structural and stratigraphic trapping of CO_2 is likely to be overtaken by mineral, residual phase, and solubility trapping over the millennia to contain CO_2 volumes indefinitely.

22. CCS Report, Summary for Policyholders, *supra* note 5.

23. Sally M. Benson, Carbon Dioxide Capture and Storage in Deep Geological Formations, presented at the Public Workshop on Carbon Capture and Sequestration, Feb. 13 and 14, 2008, by the University of Southern California in Sacramento, CA. Professor Benson is employed by the Energy Resources Engineering Department and is the Executive Director, Global Climate and Energy Project, Stanford University.

24. One 1,500 megawatt coal-fired power plant alone generates approximately 10 million metric tons/year of CO_2.

25. *See* Nat'l Energy Tech. Lab., Office Fossil Energy, U.S. Dep't Energy, Carbon Sequestration Atlas of the United States and Canada (March 2007) (hereinafter Atlas). The Atlas has been specifically listed in section 8002 of S. 2191 (see note 12) as a report to be considered by the Secretary of the Interior in completing an assessment of the geologic capacity for storage of carbon dioxide in the U.S.

26. The seven partnerships are West Coast Regional Carbon Sequestration Partnership; Big Sky Carbon Sequestration Partnership; Plains CO_2 Reduction Partnership; Midwest Geological Sequestration Consortium; Midwest Regional Carbon Sequestration Partnership; Southwest Partnership on Carbon Sequestration; and Southeast Regional Carbon Sequestration Partnership. Among them, they have identified one trillion metric tons of CO_2 geologic storage potential—sufficient to store all the CO_2 emitted in the United States for hundreds of years. J. Litynski, *Summary of DOE's Regional Carbon Sequestration Partnerships*, in affiliation with the Carbon Sequestration Program, National Energy Technology Laboratory, Office of Fossil Energy, and presented at Pre-Workshop to the Proposed UIC Regulations for Geologic Sequestration of Carbon Dioxide, Washington, D.C. (Dec. 3, 2007).

27. Three projects were selected in 2007 and will be located in the areas of the Plains, Southeast, and Southwest Partnerships.

28. CCS Report, Summary for Policyholders, *supra* note 5 at 9.

Moreover, the costs, time to obtain rights-of-way, and logistics to enable construction of a lengthy CO_2 pipeline to connect CO_2 sources to geologic formations will be significant.

29. Atlas, *supra* note 25, at 12.
30. *Id.* at 15.
31. *Id.* at 67.
32. Friedmann, *supra* note 20.
33. CCS Report, *supra* note 5, at 12.
34. Suzanne Kelly, *Geological Sequestration of Carbon Dioxide*, presented at EPA Public Workshop: Geological Sequestration of CO_2, Hotel Washington, Washington, D.C. (Dec. 3 & 4, 2007). Ms. Kelly works in the Office of Ground Water and Drinking Water in the U. S. Environmental Protection Agency.
35. Commenting on both the technical challenges and safety issues in a comprehensive body of work on coal-fired power plants, researchers for the Massachusetts Institute of Technology stated: "There do not appear to be irresolvable open technical issues underlying these questions [subsurface engineering and safety]. Of equal importance, the hurdles to answering these technical questions well appear manageable and surmountable. As such, it appears that geological carbon sequestration is likely to be *safe, effective, and competitive* with many other options on an economic basis." Mass. Inst. Tech., The Future of Coal: Options for a Carbon-Constrained World, at 36 (2007) (Executive Director James Katzer) (hereinafter the MIT Report) (emphasis added). *See also* Benson, *supra* note 23.
36. *Massachusetts v. U.S. Envtl. Prot. Agency,* 127 S. Ct. 1438 (2007).
37. Charles Christopher, *Implementing CO_2 Capture and Storage in a Carbon-Constrained World*, presented at the EPA Public Workshop: Geological Sequestration of CO_2, Washington, D.C. (Dec. 3 & 4, 2007). Mr. Christopher is a CO_2 Storage Consultant for BP.
38. In February 2008 a key advisory panel on clean coal technologies urged Congress to create a $1 billion fund to finance CCS demonstration projects. *See* InsideEPA.com, Inside EPA Weekly Report (February 22, 2008), http://www.insideepa.com/. Yet, the EPA's budget request for the entire UIC program is only $10.9 million, merely $170,000 more than FY 08 enacted levels. Several state officials responsible for implementing their states' underground injection programs (Ground Water Protection Council) have requested a $56 million funding level for the EPA's UIC program.
39. Under 40 C.F.R. § 146.3, an experimental technology well is one involving "technology which has not been proven feasible under the conditions in which it is being tested."
40. EPA representatives at the workshops have repeatedly stated that the UIC program is not intended to address the liability of operators or owners of the injection wells, or the generators of the sequestered CO_2, arising from CO_2 releases to the surface or CO_2 migration to third party owners of mineral rights. These views are consistent with the provisions of the current EPA UIC regulations. The EPA's mantra has been uniform: we issue permits to protect underground sources of drinking water. Third party liability issues, significant to the private sector, must await possible legislation or, in its absence, contractual resolution. However, the latter would still leave substantial tort liability risks unaddressed (e.g., trespass, nuisance). Understandably, there may be few companies willing to invest in CCS without defined liability protocols in place in the United States—and protocols that do not leave owners/operators, generators, or transporters of the CO_2 with unlimited and perpetual liability.
41. *See supra* note 3.
42. CCS Report, *supra* note 5, at 353.
43. *Id.* at 353.
44. MIT Report, *supra* note 35, at xi.
45. CCS Report, *supra* note 5, at 356.
46. Recognizing these complementary factors and the obvious potential future benefits to Wyoming's economy, that state in March 2008 passed legislation recognizing EOR, if certain criteria are met, as carbon sequestration and authorizing the allocation of carbon credits for such storage. However, EPA chose not to apply its July 2008 proposed UIC regulations to EOR operations. Rather, it determined to allow EOR activities to continue to be permitted under the Class II program but sought comments on this approach. *See* 73 Fed. Reg. 43,502.
47. CCS Report, *supra* note 5; MIT Report, *supra* note 35. *See also* U.S. Envtl. Prot. Agency, Environmental Footprints and Costs of Coal-based Integrated Gasification Combined Cycle and Pulverized Coal Technologies (July 2006).
48. As pointed out by Berlin and Sussman, *supra* note 10, if CCS makes coal noncompetitive, the economic impact could adversely affect coal mining communities, erode political support, and dampen enthusiasm for addressing climate change issues at all.
49. S. 2191 provides in section 4403 for funding for demonstration projects and deployment incentives pursuant to an advanced coal and sequestration technologies program.
50. *See* Am. Bar. Assoc. Section of Env't Energy & Resources, Global Climate Change and U.S. Law, 718 (Michael Gerrard ed. 2007).
51. *Id.* at 719.
52. For a discussion of the various groundwater rights regimes, see Mark A. De Figueiredo, Property Interests and Liability of Geologic Carbon Dioxide Storage (Sept. 2005) (Special Report to the MIT Carbon Sequestration Initiative).
53. RCRA means the federal Resource Conservation and Recovery Act; NPDES means the National Pollutant Discharge Elimination System wastewater discharge permit program under the Clean Water Act; and "404" refers to the dredge and fill discharge permit program under the Clean Water Act, administered by the U.S. Corps of Engineers. The RCRA hazardous waste program and the NPDES program are administered by the EPA or the states.
54. "Using the Class V Experimental Technology Well Classification for Pilot Geologic Sequestration Projects—UIC Program Guidance (UICPG #83)" from Cynthia Dougherty, Director, Office of Ground Water and Drinking Water, and Brian McLean, Director, Office of Atmospheric Programs, USEPA, to Water Management Division Directors, Air Division Directors, Regions I–X (March 1, 2007).
55. EPA's July 2008 draft regulations require the owner or operator to monitor the injection site for at least 50 years after cessation of CO_2 injection unless "monitoring and other site-specific data, [demonstrate] that the geologic sequestration project no longer poses an endangerment to USDWs, . . ." Other possible liability scenarios include having the owner or operator 1) remain liable and rely on carbon credits or CO_2 storage fees to pay for potential liability risks; 2) purchase long-term liability insurance or guarantees (if available) for post-closure liabilities; and 3) create a special contingency fund supported by credits or sequestration payments.
56. Emphasis added. The implication here is that owners and operators of ongoing CCS activities, that may last several decades, will bear the liability for harm to any underground source of drinking water and for personal injuries, property damages, and harm to the environment under state law and common law principles (trespass, nuisance, e.g.). Section 8001(d)(1) of S. 2191 provides that the EPA, within one year of enactment, must promulgate regulations for permitting commercial-scale geologic sequestration, including provisions "relating to long-term liability associated with" such sequestration. Meeting this short timetable would be a feat in and of itself.

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Regional and State-Based Climate Change Initiatives in the United States

By Catherine S. Hill and Margreta Morgulas

Catherine S. Hill

"We're in a giant car heading toward a brick wall and everyone's arguing over where they're going to sit."

—David Suzuki [1]

Margreta Morgulas

Introduction

We are in a crisis and the federal government is not doing enough. In the face of mounting evidence and scientific opinion that climate change is real, is caused by man, and will have devastating impacts on the planet, international economies, and the world's population,[2] the United States' federal government's response has been, at best, timid. There are a number of proposals currently pending in the U.S. Congress that are aimed at limiting the emission of greenhouse gases,[3] but to date the only federal initiative is a voluntary 18% greenhouse gas intensity (the ratio of emissions to gross domestic product) reduction target announced by President George W. Bush in 2002.[4] Unfortunately, the most likely effect of this voluntary target will be an increase in greenhouse gas emissions. After all, if the economy grows, then greenhouse gas emissions will also grow (albeit at a slower rate than they would have without the program).

The saving grace for meaningful climate change in the United States has been the states. States across the nation are expending significant resources developing and implementing policies and programs aimed at reducing greenhouse gas emissions, encouraging energy demand reduction and efficiency, increasing the use of renewable energy, and aiding investment in climate-friendly technologies. By doing so, the states are not only actively working to make significant reductions in dangerous greenhouse gas emissions but also are serving as laboratories to test the viability of climate change policies and programs that may ultimately be adopted on a national and/or international basis.

This article is intended to serve three purposes: first, to provide a brief overview of initiatives and incentive programs currently being utilized in certain states to combat the negative impacts of climate change. Most of the state programs are incentive and initiative programs that focus on increasing energy efficiency and the deployment of renewable energy resources. Second, this article will try to convince the reader that although these mitigation and incentive programs are vitally important, a climate strategy focused almost entirely on mitigation cannot be successful in the short or long term. Accordingly, this article challenges policy makers to question the viability of any strategy that doesn't include adaptation, at least of the energy infrastructure, to accommodate the different nature of renewable energy. Finally, this article will try to convince the reader that long-term, competing carbon cap-and-trade programs at the state level must be designed to anticipate the introduction of a federal cap-and-trade program, embrace an international cap-and-trade program, and accommodate the existing voluntary carbon market.

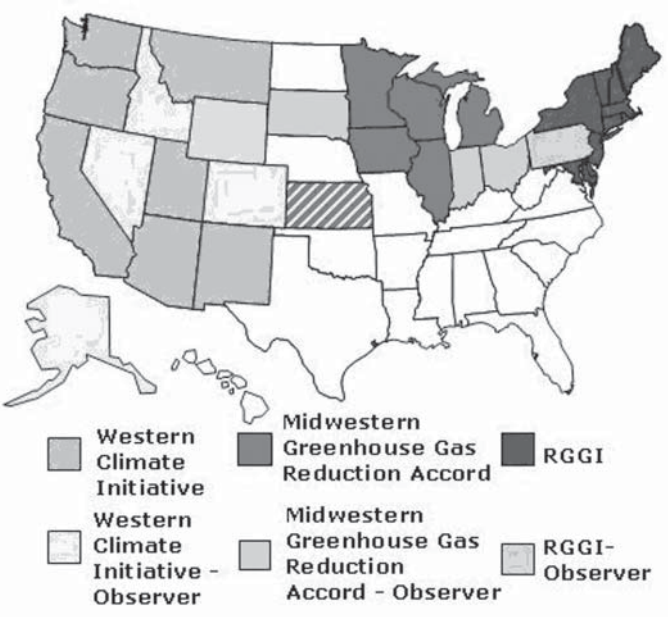
"We are in a crisis and the federal government is not doing enough."

Regional Initiatives

States have begun banding together to work on a solution to the climate change crisis on a regional level. The perceived benefits of such regional initiatives include cost savings and the creation of uniform regulations. In addition, coordinated state action gives advocates for federal programs a testing ground. While critics question whether real progress on a piecemeal basis is possible, advocates continue to push for the development and expansion of climate change initiatives and incentive programs.[5]

What follows is a brief overview of some of the more significant regional initiatives that have been undertaken to date.

Regional Initiatives



Source: Pew Center on Global Climate Change, Regional Initiatives (2007).

Midwestern Regional Greenhouse Gas Reduction Accord[6]

In November 2007, nine states and one Canadian province executed the Midwestern Greenhouse Gas Reduction Accord (MGA), a regional agreement aimed at reducing greenhouse gas emissions in the midwestern United States and combating the negative effects of climate change. The signatories, Minnesota, Wisconsin, Illinois, Indiana, Iowa, Michigan, Kansas, Ohio, and South Dakota, have identified the following as the primary goals of the initiative:

- establish greenhouse gas reduction targets and time frames consistent with MGA member states' targets;
- develop a market-based and multi-sector cap-and-trade mechanism to help achieve those reduction targets;
- establish a system to enable tracking, management, and crediting for entities that reduce greenhouse gas emissions; and
- develop and implement additional steps as needed to achieve the reduction targets, such as a low-carbon fuel standards and regional incentives and funding mechanisms.

The MGA is unique among regional initiatives in that in addition to identifying reduction goals, the MGA also provides for the origination and implementation of regional incentives and funding mechanisms. The MGA has committed to establishing its emissions credit trading system by 2010. While no reduction targets have been agreed to, it is popularly reported that the deal will likely mean emissions cuts of 60 to 80% from 1990 levels by 2050. These reductions will likely come from the increased use of wind power, improved energy efficiency and the mandatory sequestration of carbon dioxide from all coal-fired power plants built after 2020.

Western Climate Initiative[7]

In February 2007, the governors of Arizona, California, New Mexico, Oregon and Washington launched the Western Climate Initiative (WCI). Subsequently, the governors of Utah and Montana and the premiers of British Columbia and Manitoba joined the WCI as participating members and at least six additional U.S. states have joined the WCI as observers.

The stated regional goal of the WCI is an aggregate reduction in greenhouse gas emissions of 15% below 2005 levels by 2020. This goal does not replace existing goals of the WCI's members. Rather it is a goal being pursued simultaneously with the individual member states' respective reduction goals. The initiative members are currently working on a market-based mechanism (a cap-and-trade program) to help achieve stated reduction goals, which mechanism they reportedly hope to announce by August 2008.

Each of the initiative members has joined the Climate Registry,[8] which will provide important reporting and accounting functions in support of the initiative's goals. The Climate Registry, which was launched in May 2007, began accepting data in January 2008 and will record and track the greenhouse gas emissions of businesses, municipalities and other organizations in 39 states across the country. Participation is voluntary but data will be independently verified to ensure its accuracy.

Regional Greenhouse Gas Initiative[9]

In December 2005, northeastern and mid-Atlantic states joined together to form the first regional greenhouse gas initiative ("RGGI"). Currently, ten states that include Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island and Vermont are participating members in the RGGI. Pennsylvania, the District of Columbia and certain Canadian provinces have signed on as initiative observers.

The RGGI participating states are developing a regional strategy for controlling greenhouse gas emissions from power plants. The memorandum of understanding executed by each of the member states calls for members to stabilize carbon dioxide emissions from electric power generators at 2009 levels during the course of the first six years of the initiative's implementation (2009–2014). Thereafter, the members have committed to initiating an emissions decline of 2.5% per year for the next four years (2014–2018).

Central to this initiative is the implementation of a mandatory multi-state cap-and-trade program whereby the participating members will auction nearly the entire annual regional emissions budget, which initially is approximately 188 million short tons of carbon dioxide. Each ton of carbon dioxide will constitute an "allowance." As announced on March 17, 2008, the participating states have agreed to participate in uniform regional auctions for the allowances that each state will be offering for sale. The initial auction, which will be the first-ever carbon dioxide auction, is currently planned for September 10, 2008 with a second auction scheduled for December 17, 2008.[10]

Western Governors Association Clean and Diversified Energy Initiative[11]

The Western Governors' Association (WGA) is an independent, nonprofit organization representing the governors of 19 states and three U.S.-flag islands in the Pacific.[12]

In recent years, the WGA has announced several environmental initiatives. Primary among such initiatives is the Clean and Diversified Energy Initiative. In June 2006, the WGA passed a resolution based on the recommendations contained in the report issued by the WGA's Clean and Diversified Energy Advisory Committee, which was established by the WGA in 2005. Significantly, the June 2006 resolution approved the implementation of changes in state and federal policy necessary to realizing the WGA's stated goals of achieving:

- 30,000 megawatts of new clean and diverse energy generation by 2015
- a 20 percent increase in energy efficiency by 2020
- adequate transmission capacity for the region over the next 25 years.

The WGA has requested ongoing progress reports concerning the achievement of its stated goals. The first such report was prepared and presented in June 2007.[13]

Conference of New England Governors and Eastern Canadian Premiers 2001 Climate Agreement[14]

The Conference of New England Governors and Eastern Canadian Premiers is an international collaboration between U.S. states and Canadian provinces (NEG/ECP) that was formed in 1973 to address regional, cross-boundary issues. Participating states and provinces are: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, New Brunswick, Newfoundland and Labrador, Nova Scotia, Prince Edward Island and Quebec.[15]

In 2001, the NEG/ECP accepted the *Climate Change Action Plan*,[16] a voluntary agreement to pursue coordinated actions on climate change including measures such as: shifting to lower/zero carbon energy resources where economically feasible; implementing actions that will support and develop the regional economy; maintaining secure and reliable energy supplies in the region; fostering long-term environmental and economic sustainability; and working with the federal governments to seek additional solutions that can be addressed at the national and international level.

Powering the Plains[17]

In 2001 the non-profit Great Plains Institute (GPI) convened a group of officials from the public and private sectors and launched its Powering the Plains (PTP) program. Participating states include North Dakota, South Dakota, Iowa, Minnesota, and Wisconsin.

The PTP program is aimed at developing energy and agricultural climate change initiatives. PTP participants outlined the following goals for the PTP program:

- achieve ever greater levels of energy efficiency;
- be based on an affordable, reliable and diversified portfolio of regional energy resources;
- enhance the region's economy and further develop its energy, agriculture and other key economic sectors; and
- avoid, reduce and offset emissions of CO_2 and other negative environmental impacts.

State-Based Initiatives

In addition to participating in regional, national and international initiatives, individual states have announced their own climate change initiatives and have implemented related incentive programs aimed at achieving their climate change goals. What follows is an overview of certain of the key initiatives adopted by states in various regions of the county and the programs they have implemented to meet their goals. The list of initiatives is not intended to be comprehensive but rather to provide the reader with a sense of the type of initiatives and programs that are being utilized by various states around the county to combat climate change.

California

On June 1, 2005, California Governor Arnold Schwarzenegger issued an Executive Order establishing greenhouse gas targets and a Climate Action Team,[18] which has been charged with implementing climate change emission reduction programs and reporting on the progress made toward meeting the statewide greenhouse gas targets that are established as part of the state's comprehensive climate action plan. The Climate Action Team is led by the Secretary of the California Environmental Protection Agency and includes the heads of several California state agencies.[19] To date, the Climate Action

Team has prepared and issued one report on the progress made by California with respect to achieving its reduction goals.[20]

The statewide greenhouse gas targets and the division of responsibility for meeting the same were formalized by the legislature in the Climate Change Solutions Act of 2006 (A.B. 32), which was signed into law in September 2006. Significantly, A.B. 32 requires the California Air Resources Board (CARB) to develop regulations and market mechanisms that will ultimately reduce California's greenhouse gas emissions by 25% (down to 1990 levels) by 2020. Mandatory emissions caps will begin in 2012 for significant sources and will be ratcheted down to meet the 2020 goals.[21] These caps build on those established by Governor Schwarzenegger's June 1, 2005 Executive Order committing the state to greenhouse gas reduction targets equivalent to reaching 2000 emissions levels by 2010, 1990 levels by 2020, and 80% below 1990 levels by 2050.[22]

As mandated by A.B. 32, CARB has developed an *A.B. 32 Scoping Plan*, which contains the main strategies California will use to meet its reduction targets. The draft *A.B. 32 Scoping Plan* was released to the public in June 2008 and reportedly will have a range of greenhouse reduction actions which can include direct regulations, alternative compliance mechanisms, monetary and non-monetary incentives, voluntary actions, and market-based mechanisms such as a cap-and-trade system.[23]

In furtherance of reaching the targets established by A.B. 32, in January 2007, Governor Schwarzenegger signed an Executive Order establishing a first-of-its-kind Low Carbon Fuel Standard (LCFS) for transportation fuels sold in California. By 2020, the standard will reduce the carbon intensity of California's passenger vehicle fuels by at least 10%. The LCFS will use market-based mechanisms that allow providers to choose how they reduce emissions while responding to consumer demand. For example, providers may purchase and blend more low-carbon ethanol into gasoline products, purchase credits from electric utilities supplying low carbon electrons to electric passenger vehicles, diversify into low-carbon hydrogen as a product and more, including new strategies yet to be developed.[24]

The LCFS is intended to complement the previously announced vehicle emissions standards for cars sold in California. The standards, enacted by law in 2002, are the toughest in the nation. California's emissions law would have forced automakers to cut greenhouse gas emissions by 30% in new cars and light trucks by 2016. Because California's standards exceed those imposed under federal law, California was required, under the federal Clean Air Act, to obtain a waiver from the Environmental Protection Agency (EPA) in order to successfully enforce such standards.[25] In December 2007, the EPA, however, rejected California's request for a waiver, a denial that is being appealed by California.[26] In anticipation of California receiving the required waiver, at least twelve other states have adopted California's vehicle emissions standards.[27]

California also aims to reduce its emissions by increasing the use of renewable energy sources. California's renewable portfolio standards program requires retail sellers of electricity to increase their sales of eligible renewable-energy resources by at least 1% of retail sales per year, so that 20% of their retail sales are served with eligible renewable energy resources by 2010. Governor Schwarzenegger has set a longer-term state goal of 33% by 2020, and currently the California Public Utilities Commission and the California Energy Commission are considering ways to achieve that goal.[28]

In order to assist in the achievement of the renewable portfolio standard, California has adopted the Million Solar Roofs Program (MSRP), pursuant to which California has set a goal to create 3,000 megawatts of new, solar-produced electricity by 2017. Charged with implementing the MSRP, the California Public Utilities Commission is providing incentives over the next decade for existing residential homes and existing and new commercial, industrial and agricultural properties.[29] The California Energy Commission manages a 10-year, $400 million program to encourage the installation of solar technology in new home construction through its New Solar Homes Partnership.[30]

Washington

Washington State has responded to concerns about climate change in several ways.[31] As with California, Washington has established a sweeping climate change program that is aimed at reducing Washington's greenhouse gas emissions and increasing the amount of energy obtained from renewable sources.

In 2006, Washington joined California and several other states by establishing renewable portfolio standards. Washington's standards were set by popular initiative passed in November 2006.[32] Pursuant to Initiative 937, by 2012, 3% of the electricity obtained by the state's larger utilities (those with more than 25,000 customers) must come from renewable resources. By 2016, 9% must be obtained from renewable resources, and by 2020 the requirement reaches 15%. In addition, all electric utilities serving more than 25,000 customers must provide customers the option of purchasing renewable energy.

Local utilities offer various incentives for increased efficiency and the use of renewable energy.[33] For instance, Washington residents have access to several forms of rebates and assistance for solar, wind, energy efficient appliances, weatherizing homes, and installing heat pumps. In addition to homeowners, the incentives extend to include renewable energy producers, schools, and manufacturers.

On May 3, 2007, Washington's governor signed S.B. 6001 into law, thereby establishing statewide greenhouse gas emissions reduction goals and strategies.[34] Under the law, Washington has committed to reduce statewide emissions to 1990 levels by 2020, 25% below 1990 levels by 2035, and 50% below 1990 levels by 2050. Further, Washington has committed to the creation of thousands of new jobs in the clean energy sector by 2020. S.B. 6001 established a greenhouse gas performance standard for all new, long-term baseload electric power generation. Under the standard, all baseload generation for which utilities enter into long-term contracts must meet a greenhouse gas emissions standard of 1,100 pounds per megawatt-hour beginning in July 2008.[35]

In January 2008, Washington's governor introduced legislation that would direct the state Department of Ecology to design a regional carbon cap-and-trade proposal; require annual emissions reporting by all significant generators of greenhouse gases; and create new "green collar jobs" programs to provide training and apprenticeship opportunities.[36] The legislation, H.B. 2815/S.B. 6516, which is known as the Climate Action and Green Jobs Bill, was passed by the Washington State House of Representatives on February 19, 2008 and the Washington State Senate on March 5, 2008. It is expected to shortly be signed into law by the governor.[37]

New Jersey

The New Jersey Board of Public Utilities has adopted an aggressive renewable portfolio standard. After being refined in 2006, the standard requires that utilities meet 6.5% of customers' electricity needs from qualifying renewable energy sources by May 31, 2009. The standard increases to 22.5% by 2021.[38]

In what can only be interpreted as an attempt to encourage the development of solar power, the New Jersey renewable portfolio standard contains a requirement for photovoltaics to meet 2.12% of the state's consumption—representing about 1,500 MW—by 2021.[39] New Jersey also offers a full exemption from the state's 7% sales tax for all solar and wind energy equipment. This exemption is available to all taxpayers and covers all major solar energy equipment types.[40]

In addition, New Jersey supports and oversees a Solar Renewable Energy Certificate ("SREC") program, which is available to all solar system owners in New Jersey with grid-connected generators. Under the SREC program, each time a solar electric system generates 1,000 kWh of electricity, an SREC is issued that can then be sold or traded. New Jersey has provided an independent verification and trading system for the SRECs, and has encouraged their generation and trading through the implementation of solar power requirements in connection with New Jersey's renewable portfolio standard.[41]

In July 2007, New Jersey joined California and Washington by enacting legislation making greenhouse gas emissions goals enforceable state law. The legislation, referred to as the Climate Change Response Act (A3301), calls for New Jersey to reduce greenhouse gas emissions to 1990 levels by 2020, approximately a 20% reduction, followed by a further reduction of emissions to 80% below 2006 levels by 2050. In addition, the legislation requires the state's Department of Environmental Protection to develop a greenhouse gas emission inventory for 1990 and to create a system for monitoring current greenhouse gas levels so that New Jersey's progress can be accurately tracked.[42]

As with the other states highlighted in this article, New Jersey offers numerous different incentive programs to encourage the realization of its climate change goals.[43]

New York

New York led the way to the development of the Regional Greenhouse Gas Initiative, the first regional project to limit the emission of greenhouse gases. As previously delineated, under the RGGI, the member states have committed to working toward a 10% reduction in greenhouse gas emissions from power plants below 2009 levels by 2020. To that end, the member states have negotiated an initial regional carbon dioxide budget of approximately 188 million tons, and have apportioned it among themselves. New York's initial carbon dioxide budget will be approximately 64.3 million tons.

Under the RGGI, each of the member states is charged with developing rules and regulations to implement the planned carbon dioxide trading program, based upon a "Model Rule" issued by the RGGI participants. New York was the first of the member states to announce proposed regulations, which it did in October 2007.[44] The regulations would create the first in the nation cap-and-trade program for greenhouse gas emissions and would cover approximately 90 power plants in New York State. If adopted as proposed, the power companies will have to buy pollution credits at auction, rather than be given credits based on the amount they currently pollute. The money generated from this auction will be invested into renewable energy projects and other environmental initiatives.

The New York Public Service Commission adopted a renewable portfolio standard (NY RPS) in September 2004 and issued implementation rules in April 2005. New York's RPS has a target of 25% by 2013. Of this, approximately 19.3% of the target will be derived from existing (2004) renewable energy facilities and 1% of the target is expected to be met through voluntary green power sales. The remainder will derive from new, eligible resources centrally procured by the New York State Energy Research and Development Authority (NYSERDA). NYSERDA manages an RPS fund gathered through a surcharge

on each kilowatt-hour sold by the state's investor-owned utilities.

In order to reach the state's climate change goals, New York offers several agricultural, commercial, municipal, and residential incentive programs.[45] Such incentives include tax deductions and/or exemptions relating to the installation and/or use of renewable energy—specifically, wind and solar power. In addition, several loan, rebate, and grant programs are offered by the state and local utility providers in connection with the purchase, installation and/or use of energy efficient products.[46]

Texas

According to the Associated Press, which analyzed state-by-state emissions of carbon dioxide from 2003, the latest U.S. Energy Department numbers available, Texas is the leading emitter of greenhouse gases in the United States. Texas reportedly produces more than twice the amount of greenhouse gases than the next two biggest producers combined, California and Pennsylvania, which together have twice Texas' population.[47]

Texas has made a concerted effort in recent years to combat its greenhouse gas emissions problem. Significantly, Texas has the largest number of wind farms of any state in the nation. According to one recent report, Texas has reached the point that more than 3% of its electricity, enough to supply power to one million homes, comes from wind turbines.[48] This puts Texas well on its way to achieving the renewable portfolio standards established by legislation in 2005.[49]

Texas' renewable portfolio standards currently call for the state to obtain 5,880 MW, or about 5% of the state's electricity, from renewable energy by 2015. Of the total, 500 MW must come from renewable energy sources other than wind energy, thereby indirectly promoting solar power and biomass in Texas. The law sets a long-range target for the state to get 10% of its electricity from renewable energy by 2025. The legislation also streamlines the ability of the Texas Public Utility Commission to order construction of new transmission lines to meet the state's renewable goal.[50]

Although Texas does not have a program that provides funding of renewable energy equipment on an individual basis, there are tax exemptions available in certain instances. For example, businesses that use, manufacture or install solar or wind energy can receive franchise tax deductions and/or exemptions. There also exists a property tax exemption for business installation or construction of systems involving solar, wind, biomass, and anaerobic digestion energy.[51] In addition, several local utility providers in Texas have energy efficiency programs that offer low-cost loans/rebates and advice on renewable energy technologies.[52]

Policy Analysis

As the federal government struggles to formulate a politically feasible response to climate change, states have been forced to act alone and/or in conjunction with other states in fashioning and implementing policies and programs designed to combat the negative effects of climate change. This may result in two distinct problems: 1) the potential for conflicting policies, programs and incentives at the state and federal level, and 2) the inability of states to take full advantage of the benefits of the renewable energy they are encouraging the production of due to an outdated and outmoded energy infrastructure.

One potential problem with addressing greenhouse gas emissions on a state-by-state basis is the risk that it will result in a hodgepodge of legislation and policies that are inconsistent and incompatible with any national or international policies that may later be implemented. For instance, if, as is widely predicted, a national climate change policy is enacted during the next presidential administration, what will happen to the myriad of state-based initiatives and incentive programs? Preemption does not seem like a legally or politically feasible alternative for the federal government. However, unless the federal government matches or exceeds the standards and goals adopted by progressive states like California, New York, New Jersey and Washington, it seems equally unlikely that states would voluntarily suspend their existing programs in favor of a national program. In such an event, the country will continue to struggle with multiple (potentially conflicting) laws on energy efficiency, renewable energy and the regulation of carbon and other greenhouse gases for years to come. Whatever the outcome, the federal government's long overdue reaction will likely exact a heavy toll on an already overburdened system.

Admittedly, it would be an overstatement to suggest that having climate change policies set and enforced on federal and state levels would be all bad. For instance, the states' involvement in efforts to improve energy efficiency is essential. Arguably, state and local governments are in the best position to enforce initiatives and incentive programs aimed at increasing the energy efficiency of homes and commercial buildings as they control the legal systems that regulate the construction and operation of such structures (e.g., building, construction and energy codes). Similarly, the siting and regulation of power plants and the deployment of renewable energy resources, other than nuclear energy, have traditionally been within the jurisdiction of the states. Unless Congress preempts state jurisdiction on the siting of power plants, federal and state programs regarding renewable energy could likely coexist in harmony. If there is a federal renewable portfolio standard, states can always have a higher target as a part of their renewable portfolio standard. If there are federal financial incentives in addition to the production tax

credit[53] for siting, manufacturing, and research and development of renewable energy technologies,[54] these policies can work in harmony with state incentive programs.

However, there are several instances where having both state and federal programs and policies may not benefit the effort to combat the negative effects of climate change. This is most aptly demonstrated in the case of carbon cap-and-trade policies and programs. States need to consider the interplay of carbon cap-and-trade programs with existing and potential carbon markets. The European Union implemented cap-and-trade programs years ago. New York plans to implement a cap-and-trade program by the end of September. California and other states have announced that they too will adopt cap-and-trade programs. The environmental advisors to the presidential candidates (Barack Obama and John McCain) are talking about a federal cap-and-trade program. In addition, there are multiple voluntary markets for carbon trading. If there is no clarity as to measurement, verification and pricing mechanisms for carbon, then the potential for carbon trading to reduce greenhouse gas emissions may be lost.

In addition to the concerns about the implementation of varied and potentially conflicting policies and programs, concerns exist regarding the inability of states to take full advantage of the benefits of the renewable energy they are encouraging the production of due to an outdated and outmoded energy infrastructure. With few exceptions, state programs have failed to marry the intended outcome of encouraging increased renewable energy and distributed generation with the energy infrastructure. Renewable energy and distributed generation are often intermittent, variable, potentially unreliable and expensive. It is essential to plan now to address those concerns through modernizing the existing energy infrastructure and making sure it can carry renewable energy to the load centers, installing advanced energy meters (that can react to demand reduction and net metering), installing energy storage facilities to mitigate variability and intermittency of supply, and implementing other infrastructure upgrades.

To successfully adapt the energy infrastructure to renewable resources, states must deal with two significant issues. First, many renewable energy resources are variable and intermittent. Second, most people, even if they want renewable energy, don't want a windmill or nuclear power plant in their back yard, and even if they did, it might not be the best place to put one.

Reliability and the transmission and distribution infrastructure, which address the issues of variability and the location of renewable energy resources, are technically outside of the control of most state governments, at least to some extent. Reliability in most deregulated states is controlled by independent system operators. Independent system operators are typically not part of state governments, but are independent, not-for-profit organizations designed to assure the reliability of the power supply and guard against anti-competitive pricing in the energy markets. The transmission and distribution infrastructure is subject to the jurisdiction of the Federal Energy Regulatory Commission (FERC), and to a lesser extent state public service commissions.

Despite the apparent lack of authority, there are state policies that can be implemented to increase the likelihood of success of renewable energy as a part of a state's energy portfolio. First, states can modify their state energy plans to account for the expected impacts of the mitigation measures they have enacted or expect to enact shortly. This process is likely to lead states with significant portfolios of variable renewable energy resources to start considering the need for energy storage technologies to complement their other resources. For example, most independent system operators are discounting the value of wind energy as part of their reliability planning because the resource is intermittent. Therefore, if energy storage facilities can be sited to take advantage of the inexpensive energy generated by wind at non-peak times, then the value of wind from a reliability perspective will be increased. More importantly the amount of energy that can be utilized from non-fuel-consuming energy resources will be increased.

This planning exercise may also lead states to reconsider how much power these states really need to generate, when that energy needs to be generated, and what technologies they want to encourage through incentives programs to become part of their energy mix. New Jersey, for example, has clearly selected solar as a part of its energy mix. Arguably, however, New Jersey isn't one of the sunnier states in this nation. Without incentives and the election of solar as part of New Jersey's renewable portfolio standard (which impacts the price of renewable energy certificates for generation), New Jersey is not the first place you would think to site solar. But clearly New Jersey has decided that fuel-free, carbon-free peak power is worth it.

In addition, states need to work with FERC to plan for the transmission and distribution of power from renewable resources. In some states, the siting of wind and solar resources is no longer a land rush, but rather a rush to the transmission and distribution infrastructure. In a state like New York, where significant hydro, nuclear, and non-shoreline wind resources are far removed from the load centers in New York City and the Hudson River corridor, the constraining factor on the development or purchase of renewable energy will be the existing distribution infrastructure. Policy makers should act now to work with FERC to re-envision a transmission and distribution infrastructure that accommodates renewable energy resources, and that anticipates net metering in the design of the system.

Conclusion

In conclusion, we applaud the efforts and creativity of the states in thinking broadly and implementing strategies to combat climate change. We believe that the next step in the process is a careful consideration of the interplay of state climate change policies with potential federal climate change polices and a re-envisioning of the energy infrastructure. This is a historic opportunity for states to lead the country in developing effective, ground breaking strategies to truly combat this global problem.

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Empowering the States: Why a Federal-State Partnership Is Needed for an Effective American Response to Climate Change

By J. Jared Snyder

Introduction

Over the past seven years that the Bush Administration has been in office, the states have led the way in developing regulatory and other strategies for addressing climate change. The state efforts include energy programs such as renewable energy portfolio standards and energy efficiency programs, including New York's program to reduce energy demand 15% by 2015. These programs also include more direct environmental regulations such as the Northeast States' Regional Greenhouse Gas Initiative (RGGI), the motor vehicle greenhouse gas (GHG) emission standards enacted by California and adopted by over a dozen other states, and performance standards enacted by California, Oregon and other states. In addition, many states are developing strategies for extremely ambitious emission reduction goals of 80–90% by 2050.[1]

Against this background of state action and federal inaction, Congress is considering legislation that will create an expansive new federal program for reducing GHG emissions, with a relatively modest role for the states. The various bills under consideration are not based on the traditional framework of the Clean Air Act (CAA), under which the EPA sets air quality targets (National Ambient Air Quality Standards or NAAQS) and the states develop plans (state implementation plans or SIPs) to meet those targets. Instead, the federal bills provide for economy-wide cap-and-trade programs that will be administered directly by the EPA. Under this approach, continued state efforts—that involve sectors of the economy covered by the cap—may be of limited value because nationwide GHG emissions likely will rise to the level of the cap regardless of the actions taken by any individual states.

A better approach is available that creates a federal-state partnership in reducing GHG emissions and achieving the emission reduction goals that scientists have identified as necessary to stabilize the global climate. Such an approach might build upon the framework of a federal cap-and-trade program but enlist the state and local governments in taking actions to achieve the goals of the bill. This partnership approach would recognize that actions at all levels of government are needed to achieve the ambitious emission reduction targets called for by the scientific experts, and it would facilitate implementation of the most cost-effective programs identified by economists.

Development of this partnership of federal-state actions would have three distinct benefits. First, state activities that reduce carbon emissions can reduce the overall societal cost of compliance with an emission cap. Second, state action can resolve market imperfections and surmount market barriers to action that would reduce GHG emissions nationally. Third, state actions in areas outside the cap, or state actions that have the effect of lowering the cap, can help achieve reductions beyond those needed to meet a federal cap, which may be inadequate to achieve the United States' share of the reductions needed worldwide. In short, enabling state action will lead to greater emission reductions than can be achieved by the federal government acting alone, thereby placing the United States on track to achieve its share of the ambitious emission reductions needed to stabilize the climate.

Background

State Efforts

In the absence of federal leadership on climate change, many of the states have taken action. Some of the first efforts were in the Northeast, where the governors of New England states joined with eastern Canadian premiers in creating a Climate Change Action Plan in 2001, with targets of reducing emissions to 1990 levels by 2010, to 10% below 1990 levels by 2020 and by 75–85% in the long term.[2] New York was one of the first states to undertake a comprehensive GHG emission planning analysis, resulting in a 2003 report that identified numerous options for reducing GHG emissions.[3] Many other states followed suit in developing GHG reduction plans, strategies and targets, which have become more and more comprehensive. To date, at least 17 states have enacted GHG reduction targets.[4] Perhaps the most important of these efforts is California's Global Warming Solutions Act (AB32), enacted in 2006, which commits California to reduce GHG emissions 25% from 1990 levels by 2020 and 80% by 2050.

As a result of, and in addition to, these planning efforts, states have implemented a variety of GHG reduction programs, including programs to address emissions from the two largest sectors: motor vehicles and power plants. The leading effort to control CO_2 emissions from motor vehicles is the California motor vehicle greenhouse

gas emission standards, which subsequently have been adopted by over a dozen other states. These standards take effect in 2009 and would require a reduction of approximately 33% in GHG emissions from new motor vehicles by 2016. However, the EPA has blocked the states from implementing these programs by refusing to grant California a waiver from Clean Air Act preemption, a step that it has never previously taken in the 40 years since Congress gave California the authority to enact its own motor vehicle emission standards.[5]

The leading state effort to control GHG emissions from the power sector is RGGI, a cap-and-trade program for the power sector initiated by New York and joined by nine other New England and mid-Atlantic states. RGGI is targeted for a January 2009 start and will require a 10% reduction in GHG emissions (compared to the baseline) from the electricity sector across the northeastern region by 2018.[6] Other multi-state cap-and-trade efforts are following in RGGI's wake. Seven states in the Western Climate Initiative issued design principles for an economy-wide cap-and-trade program in July 2008.[7] Most recently, nine midwestern and plains states and the province of Manitoba created in November 2007 the Midwestern Regional Greenhouse Gas Reduction Accord, and at least six of the member states have committed to develop a multi-sector cap-and-trade system.[8]

A number of states have also enacted performance standards for new power plants. For example, California's standard requires new power plants and new contracts for long-term supply of power to meet a standard that is based on the emissions of a combined cycle natural gas–fired power plant.[9] Similarly, Oregon requires new power plants to reduce their carbon emissions below the level of a combined cycle gas plant, but allows the use of offsets in meeting the standard.[10] In February 2008, the DEC held a public stakeholder session regarding the development of a similar standard.

State renewable portfolio standards reduce GHG emissions indirectly, as nonpolluting renewable energy sources replace GHG-emitting fossil fuel–fired sources of power. To date, 26 states have adopted such programs.[11] In addition, several states have enacted energy conservation programs, which also reduce GHG emissions indirectly. Foremost of these is New York's "15 X 15" program, which will reduce energy demand 15% below forecasted levels by 2015 through a combination of efficiency standards, state subsidies and other efforts, to be determined by the New York State Public Service Commission (PSC) in a proceeding to implement the program.[12]

CAA Framework

The Clean Air Act provides one possible framework for joint federal-state regulation of GHGs. In general, the Act sets up a partnership under which the EPA sets certain overarching standards, which the states are charged with implementing. The standards set by the federal government include specific emission standards for new sources and hazardous pollutants under sections 111 and 112 respectively,[13] and standards for motor vehicles under section 202 of the Act.[14] In addition, for certain ubiquitous pollutants, the EPA sets NAAQS at levels sufficient to protect public health and the environment.[15] Section 110 of the Act then requires states to adopt the implementation plans known as SIPs to achieve compliance with the applicable NAAQS.

The federal government has not yet regulated GHG emissions comprehensively.[16] But the United States Supreme Court's decision that GHGs are pollutants under the Act[17] makes clear that the EPA has the authority to regulate GHG emissions under the Act. Such regulation could include direct regulation of GHGs under standards set by the EPA, such as motor vehicle emission standards under section 202 of the Act and establishment of emission standards for new sources of GHG emissions under section 111.[18] In addition, commentators have suggested that the NAAQS/SIP structure can be used with minor regulatory or statutory changes. For example, the EPA could set a CO_2 standard at a level that would prevent dangerous interference with climate (one possibility is 450 ppm, based on the recommendations of the IPCC, followed by the development of SIPs directed to achieving each state's share of the emission reductions needed in the United States to avoid exceeding that standard globally).[19]

Application of this framework to GHG emissions would be a process with which the states are familiar. EPA would set the target and level the playing field with emission standards for motor vehicles and new sources of pollution. The states would then be charged with doing what they have been doing for decades for some pollutants and for the last decade in the case of CO_2: developing and implementing strategies for reducing emissions.

Federal Legislation

Following years of EPA inaction and resistance to the use of its existing authority, Congress is developing from scratch a new approach to the regulation of GHGs. The approach embodied in all the federal bills departs from the federal-state partnership reflected in the Act, replacing it with cap-and-trade approaches that largely relegate the states to the sidelines. Instead of being based on Title I of the Clean Air Act, which sets forth the federal-state partnership summarized above, the federal bills look much more like Title IV, the Act's acid rain program, which enacts a cap-and-trade program for sulfur dioxide, the primary acid rain precursor.

The most likely legislative vehicle is the Lieberman-Warner Bill, "America's Climate Security Act" (the "Bill"), which was voted out of the Senate Environment and Natural Resources Committee in December 2007, and reissued in May 2008, with amendments, as the Boxer-Lieberman-Warner substitute. The Bill's coverage is very broad; it covers about 85% of the GHG emissions produced

economy-wide.[20] From these sectors of the economy, it requires a 70% reduction on a straight line basis between 2012 and 2050. Therefore, it provides for an overall reduction in emissions of approximately 60% from the U.S. economy by 2050 (compared to the 80% generally deemed to be needed).[21]

As a cap-and-trade program, the Bill lets the market dictate where emission reductions will occur within the economy. The Bill requires users of coal and refiners, producers, and importers of other fuels to hold allowances equivalent to their emissions, or the carbon content of the fuel they import or produce. The Bill allocates allowances through a combination of free allocations and auctions, with the portion of allowances being auctioned plateauing at 58.75% in 2031, when the free allocation to emitting sources is phased out. For the bulk of the allowances that will be auctioned directly by the federal government, the Bill creates a number of federal funds, each of which is to be given allowance proceeds to use for specific purposes: energy technology development, natural resource protection, worker training and tax relief.

The Lieberman-Warner Bill relegates the states to a relatively minor role. A portion of the allowances is allocated to states, increasing from 10% of the allowances at the outset to 18% by 2031. These allowances fall into three categories: (1) allowances to states that rely heavily on manufacturing and coal (starting at 3% and increasing to 4% by 2031); (2) allowances to be used for adaptation (increasing from 3 to 4%); and (3) allowances to the states that demonstrate leadership in reducing GHG emissions (increasing from 4 to 10%). The proceeds from sale of the allowances issued for adaptation must be used to support adaptation to climate change. Allowances falling into the other two categories can be retired or used for a variety of purposes specified in the legislation including: mitigation of impacts on low-income consumers; promotion of energy efficiency; investing in carbon-free energy sources and carbon sequestration technology; development of public transportation; adaptation to climate change; and economic assistance to businesses harmed by climate change or the economic impacts of the cap-and-trade program.[22]

Portfolios of Actions Needed

To evaluate the sufficiency of a federal cap-and-trade approach to meet the emission reduction goals outlined above, it is useful to consider the full suite of actions that are needed to reduce emissions substantially in the United States. A number of analyses have been undertaken on the global, national and state level of the opportunities available for emission reduction. For example, Professor Robert Socolow of Princeton University has identified a number of "wedges" that would be needed worldwide to achieve the emission reductions necessary to stabilize CO_2 concentrations at levels that would not pose the threat of dangerous interference with climate.[23] These include, for example, cutting the energy use of buildings by 25%; doubling automobile fuel economy; increasing photovoltaic energy production 700-fold; and implementing carbon capture and sequestration at coal-fired power plants.

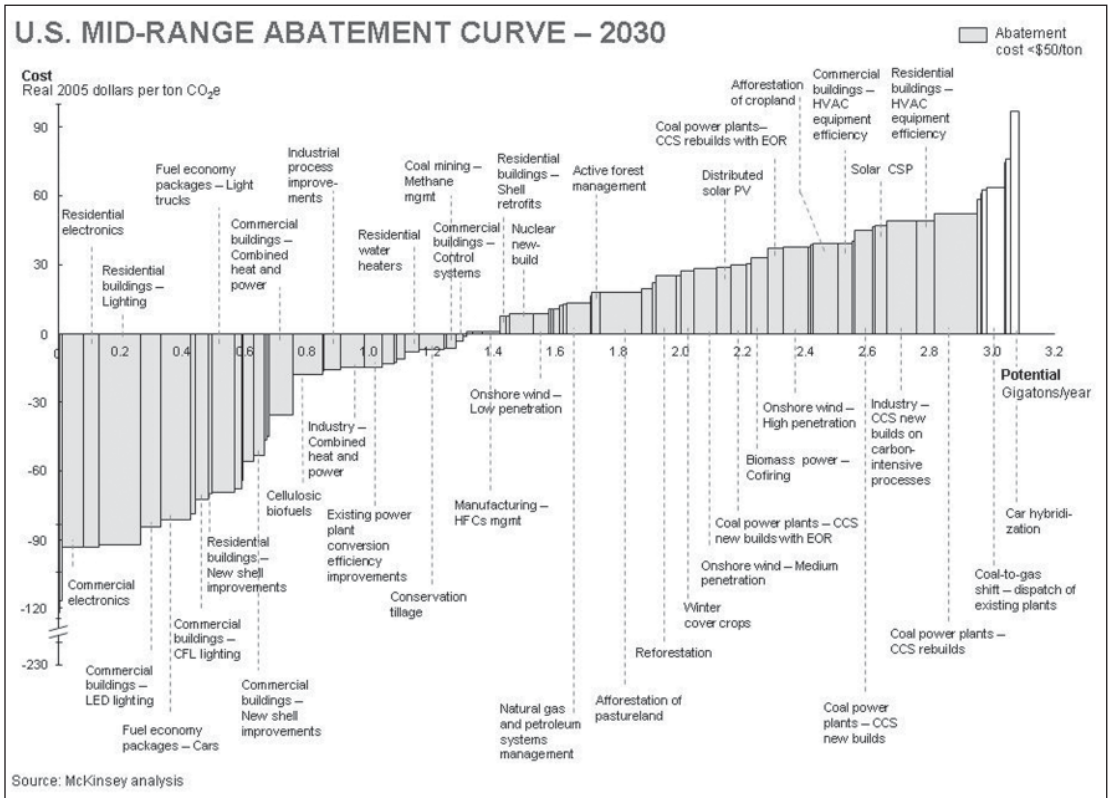

Figure 1:
Reprinted with permission from "Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost?," *McKinsey Quarterly,* Dec. 2007, p. 20.

In December 2007, McKinsey & Company unveiled its greenhouse gas abatement mapping initiative, which identified dozens of cost-effective strategies that are available, many at a cost of less than $50 per ton of carbon reduced. (See Figure 1).[24] To put this into perspective, a Prius buyer pays a premium of well in excess of $50 per ton to drive a hybrid vehicle, even when the lifetime savings are considered. Therefore, all the strategies identified by McKinsey are more cost-effective than buying hybrid vehicles. Indeed, half of these reductions can be achieved at a negative net cost, meaning that money is actually saved by the imple-

mentation of the programs. Many of the actions identified are traditionally taken at a state or local level, including energy efficiency programs; building efficiency standards, for both new and existing buildings; development and expansion of clean renewable energy sources; and waste management, forestry and agriculture programs.

One important message of the McKinsey analysis is that market signals alone will not lead to the needed actions. Fully half of the programs identified by McKinsey—the entire left half of the supply curve—are activities that actually save society money, in terms of reduced energy and fuel costs. The fact that these actions have not yet been undertaken shows that market signals alone are not sufficient, that market barriers exist to the implementation of these programs. This holds true for many energy conservation investments. When the person incurring the cost of an investment is not the person receiving the benefit of reduced energy bills, there is little incentive to incur the cost. For example, a developer may not incur the cost of energy efficient building materials or design if the purchaser, who will benefit, is unwilling to pay more for the house. Or a landlord will not spend money on new energy efficient windows or appliances if it is the tenant who pays the utility bills. Thus, simply establishing a national price for carbon does not ensure that these measures will be undertaken.

The same holds true for activities that would theoretically become economic to undertake once the price for carbon becomes high enough. For example, one of the most productive opportunities for carbon abatement identified in the McKinsey report is carbon capture and sequestration, which will not be undertaken until a regulatory infrastructure is in place. More simply, the rising gas prices resulting from a cap-and-trade program will not induce a commuter to take a bus to work if no buses serve the commuter's suburban subdivision. Other opportunities for reducing carbon levels, such as reforestation and afforestation, fall outside the scope of the Lieberman-Warner Bill, so they will be unaffected by the price signal provided by a cap-and-trade program.

Toward a State-Federal Partnership

An effective partnership approach would preserve and empower state action to complement federal action, thereby reducing the cost of the program, ensuring that the least cost efforts are undertaken, and achieving additional reductions. A few fundamental principles can guide the structuring of a federal program to take advantage of the tools available to state and local governments. First, a federal program should preserve state and local authority to take additional actions to prevent climate change. Second, states should have a major role to play in investing the proceeds of allowance sales in areas traditionally regulated and developed by the states, such as energy conservation, renewable energy, and mass transit or smart growth. Third, a federal program should incentivize and empower states to take action, and ensure that actions taken by the states have value within a federal cap-and-trade program.

Recognition and Preservation of State/Local Authority

Most fundamentally, the federal program that is enacted should preserve rather than preempt state authority, including local authority. A federal cap-and-trade program will not, by itself, harvest the low-hanging fruit identified in the McKinsey study. Additional programs—involving incentives, mandates, performance standards and the like—are needed to overcome the market barriers that exist. These programs are best taken at the state level, where they can be tailored to take advantage of local opportunities and conditions. But state efforts cannot help achieve the goals of the federal program if those efforts are preempted.

The Lieberman-Warner Bill comes close to getting this right; section 9003 preserves the right of states to enact more stringent provisions, but it preempts states from implementing programs that are "less stringent" than the federal program. This structure is based on the current provisions of the Clean Air Act, which preserve state authority to enact more stringent requirements.[25] Seemingly simple on its face, however, this provision is capable of mischief in the context of climate change efforts. Is a cap-and-trade program that governs one sector less stringent than a federal multi-sector program? Is a program that obtains steeper and earlier reductions than the federal program initially, but lower reductions in the long run, more or less stringent than the federal program? Is an energy efficiency portfolio standard less stringent than specific performance standards for new appliances? Indeed, stringency is largely in the eye of the beholder. For example, EPA Administrator Steven Johnson has claimed that the California standards for CO_2 emissions from motor vehicles are less stringent than the federal Corporate Average Fuel Economy (CAFE) standards contained in the 1977 Energy Bill, even though the CAFE standards do not regulate CO_2 emissions and are not fully implemented until 2020, four years after the California standards are fully implemented in 2016. Valuable state efforts could be chilled by uncertainty over how a court might interpret the stringency language.

Congress should resist the temptation to import this stringency concept from the Clean Air Act, because a federal cap-and-trade program for regulating GHG emissions is fundamentally different from the usual Clean Air Act programs that are implemented by the states in place of, or on behalf of, the EPA. For example, a state program implementing the EPA's Clean Air Interstate Rule (CAIR)[26] that is less stringent than the EPA requirements would have the effect of weakening the federal program. The same does not hold true for the types of federal cap-and-trade programs envisioned by the bills before Congress. Under such federally implemented programs, nationwide emissions are limited by the federal cap, independent of

and regardless of the efforts undertaken by the states. Nothing that a state can do would excuse a source governed by the federal program from the requirement that it hold allowances in an amount equal to its emissions.

Instead, because all sources must comply with the federal program, any state or local requirements are cumulative—they are in addition to the requirements imposed by the federal program. Because of the nature of the global warming challenge—the changing scientific knowledge regarding the reductions needed, the technology being developed, etc.—it is essential that states maintain the flexibility to innovate and adopt new requirements to address the challenge of global climate change. In structuring a federal program, Congress should take care not to chill such state innovation and creativity.

That state authority should be preserved, however, does not mean that federal law should not include measures to simplify the coordination of federal and state efforts. For example, the current approach of the Clean Air Act to motor vehicle regulation could be maintained, limiting state CO_2 standards for motor vehicles to standards enacted by California, with other states permitted to adopt the California standards. Another possibility is limiting state cap-and-trade programs to the same "currency" as the federal program. For example, a state might adopt a program requiring its own sources to hold or surrender federal emissions allowances in addition to those being used in the federal program. Thus, states could achieve reductions from their sources subject to the federal program that go beyond those required by federal law, without requiring sources to hold, acquire and surrender two different types of allowances.

States as Partners in Administration of Allowances

In the last year, the states participating in RGGI have coalesced around the concept of auctioning nearly all the allowances to be allocated, using the proceeds to promote the goals of the program through investment in energy conservation, renewable energy, and similar measures.[27] RGGI will therefore be the world's first emission cap-and-trade program to rely primarily on auctions as a means of distributing allowances. Most of the federal bills have followed RGGI's lead and propose to eventually auction most of the allowances. For example, the Lieberman-Warner Bill starts with the auction of 20% of allowances, and eliminates any free allocation in 2031. As a result, a federal cap-and-trade program could generate a substantial amount of revenue to use on programs to further reduce GHG emissions. For example, the value of the auction proceeds to be generated under Lieberman-Warner is estimated to range from approximately $20 billion in the first couple of years to over $100 billion a year after 2040.

Most of the federal bills also create new federal programs to spend the allowance sale proceeds, which will require the creation of a massive new federal bureaucracy. This approach fails to recognize that the states have much more experience in funding and undertaking the programs that would be supported with auction proceeds. States are the primary regulators of the electricity power industry, and they are also responsible for transportation planning. In New York, for example, state agencies like the Department of Public Service and the New York State Energy Research and Development Administration (NYSERDA) have developed substantial expertise through their administration of the system benefits charge and the state's renewable portfolio standard. The same pattern holds true in other states, most of which have developed similar programs. Transportation programs—including development of mass transit—are implemented at the state or local level. Likewise, land use planning, which is needed to reduce the miles we drive, is primarily a local function.

States and localities are better attuned to the opportunities that may be available within their jurisdictions. Congress should tap this expertise and provide states with a greater role in the allocation of allowances and use of allowance proceeds. Congress should resist the temptation to create a massive new federal bureaucracy to replace these roles for which the states are better prepared and situated.

Facilitate, Enhance and Incentivize State/Local Action

Preserving state authority is necessary, but not sufficient by itself, to fully unlock the potential benefits of state and local efforts. In order to achieve the nationwide emission reductions deemed necessary by scientists, states must be empowered to develop programs that would help achieve the low-cost solutions identified in the McKinsey report. Therefore, a federal program should be designed to facilitate, enhance, and incentivize state actions.

Federal allowances and revenues from the sales of such allowances can facilitate complementary state efforts and provide incentives for states to undertake the actions needed to reduce GHG emissions. While many states have well-developed GHG reduction programs in place, others have some ground to make up. Federal allowances can be used to enable states to develop and implement plans for reducing GHG emissions. An initial investment of proceeds from the sale of allowances in the development of energy efficiency programs and other carbon reduction plans can have a future payoff in terms of reduced state emissions.

In addition to providing the seed money for development of complementary state efforts, a federal program should also link the allocation of allowances or revenues from the sale of allowances to the actions that each state takes to reduce GHG emissions. The states that devote more effort to achieving the shared goals of reducing emissions to the levels supported by science would be rewarded with more allowances or allowance proceeds. The states would then be entitled to retire the allowances or use the proceeds to support a variety of additional

GHG reduction programs. The Lieberman-Warner Bill takes a step in this direction, with its proposal to allocate up to 10% of the allowances to states that undertake actions to reduce carbon emissions. This fairly modest program should be expanded to provide incentives for the full menu of state actions that will reduce GHG emissions, with particular focus on the type of activities that states are best situated to implement, including efforts in the areas of energy efficiency, renewable power, land use, transportation, agriculture and forestry.

A federal GHG program should also ensure that state actions have value from a carbon reduction perspective. The emission reductions that will be achieved under most of the proposed federal bills, including Lieberman-Warner, will fall short of the 80% reduction level that scientists recommend that the developed world achieve by 2050. Therefore, those reductions will have to be supplemented by other efforts taken by states and municipalities. State actions that simply count toward the reductions that will be achieved by the federal cap anyway are of limited value. They may reduce market barriers to implementation of least cost solutions, thereby reducing the societal cost of meeting the federal cap. But they will not necessarily result in reductions beyond the cap unless precautions are taken to ensure that the emission reductions achieved under state laws are not offset by increased emissions at other sources covered by the federal cap.

State efforts can help achieve the needed reductions in two ways. First, state action in areas outside the cap—waste management, agriculture, and forestry—provides additional benefit, helping increase the overall reduction level. In designing a federal program, however, care should be taken to ensure that actions taken to meet state requirements do not qualify as offsets under a federal program. For example, the Lieberman-Warner Bill allows a source to use offsets to meet up to 15% of its compliance obligation. If offsets are generated for activities required by state law in areas outside the cap, the offsets generated will have the effect of increasing emissions within the cap, thereby reducing the efficacy of the state-imposed requirements. Therefore, a federal program should ensure that emission reductions required by state laws outside the capped area do not generate offsets.

Second, for areas within the cap—such as energy efficiency and renewable energy programs that reduce emissions from the power sector—care should be taken to ensure that the state activities have value in reducing overall emissions. If a state program is encompassed within the cap, there is a danger that those programs will just shift emissions from the sector covered by the state program to other sectors or other states. For example, a state's investment in energy conservation reduces the demand for electricity in that state, thereby reducing the allowances that will be needed by in-state utilities. As a result, more allowances will be available to emitters in other states or other industries, with the result that the state program would provide no net environmental benefit (though it might reduce the cost of compliance with the federal program). To provide the state activities with value, the federal program therefore should allow, or even require, a state taking action to retire federal allowances, or otherwise provide for a reduction of the federal cap in an amount commensurate with the reductions achieved by the state program.

Similar issues have arisen under the sulfur dioxide cap-and-trade program of Title IV of the Clean Air Act, which established the acid rain program in 1990. Because acid rain continued to harm New York's Adirondack Park region, state officials implemented a variety of strategies for reducing sulfur dioxide emissions. These included filing lawsuits under the Clean Air Act's new source review provisions, enacting regulations imposing an in-state cap-and-trade program that was more stringent than the federal program, and enacting legislation effectively barring the transfer of allowances to sources located in upwind states. Because the U.S. Court of Appeals for the Second Circuit found that the state restriction on transfer of allowances interfered with the federal program in violation of the Constitution,[28] New York's efforts that resulted in substantial reductions in in-state sulfur dioxide emissions ended up having little effect on nationwide sulfur dioxide emission levels.[29] For acid deposition and most types of air pollution, such in-state emission reduction programs still have value in the state where they are undertaken due to the fact that in-state emissions generally have a greater effect on local pollution levels than the equivalent amount of out-of-state emissions. But that does not hold true for greenhouse gas emissions; a ton of emissions has the same effect on global (and local) carbon dioxide levels, regardless of where it is emitted. Therefore, it is essential that states be empowered to retire federal allowances to ensure that their efforts have value.

Finally, a federal program should respect the leadership that the states have shown so far and thereby give credit to programs that the leadership states have enacted. With regard to cap-and-trade programs like RGGI, the legislation should provide a mechanism for a smooth and fair transition into the federal program. By the time that a federal program comes into effect—2012 for the Lieberman-Warner Bill—the RGGI states will have auctioned at least three years' worth of allowances, including some allowances for future vintages. Because of the availability of banking, some of these allowances will likely be banked for future years. To ensure fairness to sources taking part in the RGGI program, these allowances should be given value in a federal program if the RGGI cap-and-trade program is to be discontinued. In the absence of such a mechanism, RGGI sources, which have had to buy allowances at auction, will be punished for the leadership role taken by the RGGI states.

Conclusion

A comprehensive federal program is sorely needed if the world is to make sufficient progress in reducing emissions, but a federal cap-and-trade program will not achieve the necessary reductions without complementary state and local efforts. Federal legislation should therefore recognize, preserve and enhance the fundamental role of the states and local governments in any national effort to reduce GHG emissions.

Endnotes

1. These reduction targets are based on the recommendation of the Intergovernmental Panel on Climate Change (IPCC) that 55–80% reductions are needed worldwide to avoid carbon dioxide (CO_2) concentrations in the atmosphere above 450 ppm, thereby reducing the likelihood of dangerous anthropogenic interference with the climate system. Because the developing world's emissions will continue to increase over the next couple of decades, reductions of 80–90% are needed from the developed world to meet the IPCC target.
2. *See* New England Climate Coalition, http://www.newenglandclimate.org/background.htm.
3. Center for Clean Air Policy, Recommendations to Governor Pataki for reducing New York State Greenhouse Gas Emissions (2003).
4. These are Arizona, California, Connecticut, Florida, Hawaii, Illinois, Maine, Massachusetts, Minnesota, New Hampshire, New Jersey, New Mexico, New York, Oregon, Rhode Island, Vermont and Washington. *See* Pew Ctr. on Global Climate Change, Greenhouse Gas Emissions Targets, http://www.pewclimate.org/what_s_being_done/in_the_states/emissionstargets_map.cfm.
5. The denial of the waiver was initially expressed in a letter that EPA Administrator Steven Johnson sent California Governor Schwarzenegger on December 19, 2007. Subsequently, the EPA issued a formal decision, which was published in the Federal Register on March 7, 2008. Several states sued the EPA on January 2, 2008 over its denial of the waiver.
6. RGGI is described further in an article in this issue by Peter Iwanowicz.
7. *See generally* Western Climate Initiative, http://www.westernclimateinitiative.org.
8. The states fully participating include Illinois, Iowa, Kansas, Michigan, Minnesota and Wisconsin. Midwestern Governors Association, http://www.midwesterngovernors.org/govenergynov.htm.
9. *See* California Energy Commission, SB 1368 Emission Performance Standards, www.energy.ca.gov/emission_standards/index.html.
10. *See* Oregon.gov, Specific Standards for Siting Facilities (345-024-0500, Standards for Energy Facilities That Emit Carbon Dioxide), http://egov.oregon.gov/ENERGY/SITING/docs/rules/div24.pdf.
11. *See* Pew Center on Global Climate Change, Learning from State Action on Climate Change (2007), *available at* http://www.pewclimate.org/docUploads/States%20Brief%20Template%20_November%202007_.pdf.
12. Order Establishing Energy Efficiency Portfolio Standard and Approving Programs, No. 07-M-0548 (N.Y. Pub. Serv. Comm'n), *available at* http://www.dps.state.ny.us/fileroom.html.
13. Clean Air Act, 42 U.S.C. §§ 7411, 7412 (2000).
14. *Id.* § 7521.
15. *Id.* §§ 7408, 7409.
16. The CAA and its implementing regulations contain some limited requirements for reporting of emissions of CO_2 and some incidental regulation of methane.
17. *Massachusetts v. E.P.A.*, 127 S. Ct. 1438 (2007).
18. States have already petitioned the EPA to set standards and sued the EPA over its failure to do so. *See Massachusetts*, 127 S. Ct. at 1446 (failure to set motor vehicle standards under section 202); *New York v. E.P.A.*, 443 F.3d 880 (D.C. Cir. 2006) (failure to set standards for new power plants under section 111). On July 30, 2008, EPA published an advance notice of proposed rulemaking that identifies and seeks comment on various ways of regulating GHGs under the Act. 73 Fed. Reg. 44353 (July 30, 2008).
19. This approach is described more fully in T. Peterson et al., *Developing a Comprehensive Approach to Climate Change Policy in the United States That Fully Integrates Levels of Government and Economic Sectors*, 26 Va. Envtl. L.J. 227 (2008).
20. The approximately 15% excluded includes methane emissions from waste management and agriculture; users of small amounts of coal; and anything to do with wood, such as burning, composting, and forestry management.
21. The Bill contains a few discrete substantive provisions in addition to the cap-and-trade requirements, including requirements for appliance and building efficiency standards, and a requirement that the EPA enact a low carbon fuel standard. Because these standards should reduce the consumption of carbon-based energy falling within the cap, they will not result in emission reductions in addition to those achieved by the cap-and-trade program. The efficiency standards, however, can be expected to dampen the demand for emission allowances, lowering the overall cost of the allowances.
22. The Lieberman-Warner Bill did not survive a procedural vote in June 2008, before the Senate recessed.
23. S. Pacala & R. Socolow, *Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies*, 13 Science 968-72 (2004).
24. McKinsey & Co., Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost? (Dec. 2007), *available at* http://www.mckinsey.com/clientservice/ccsi/pdf/US_ghg_final_report.pdf.
25. *See* 42 U.S.C. § 7416.
26. 70 Fed. Reg. 25162 (May 12, 2005), vacated by *North Carolina v. EPA*, 2008 WL 2698180 (D.C. Cir. July 11, 2008).
27. On March 17, 2008, the RGGI states announced the principles that will govern the auctions. Regional Greenhouse Gas Initiative, Design Elements for Regional Allowance Auctions under the Regional Greenhouse Gas Initiative, *available at* http://www.rggi.org/docs/20080317auction_design.pdf.
28. *Clean Air Markets Group v. Pataki*, 338 F.3d 82 (2d Cir. 2003).
29. In settlements of new source review cases, the defendants agreed to certain restrictions on the sale or transfer of sulfur dioxide allowances that have achieved, or will achieve, some reduction in overall national or regional SO_2 levels.

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The views in this article are those of the author and do not necessarily represent the views of the New York State Department of Environmental Conservation.

Climate Change's Opportunities and Challenges for Local Governments

By L. Margaret Barry

I. Introduction

The 50,000 residents of Masdar City, to be built adjacent to the international airport in Abu Dhabi, will not use cars and will stroll beneath the shade of canopies of photovoltaic panels.[1] In the Dongtan Eco-City, an hour's ferry ride from Shanghai, power will come from the sun, wind, biofuels, and recycled organic material.[2] The visions of these carbon-neutral model cities of the future can be captivating, and the communities themselves may eventually prove to be testing grounds for widely adaptable technologies that reduce greenhouse gas emissions and provide other environmental benefits. The impacts of these experimental communities could pale, however, compared to the potential impact of the wide range of less glamorous local climate change initiatives under way around the world and in the United States. For the most part, the success of these local efforts has yet to be measured quantitatively in terms of actual greenhouse gas emissions, but the acceleration of local activity, particularly in the past few years, indicates that local governments have felt compelled to confront the issue of climate change.

In the U.S., local governments are positioned to exercise influence over national climate change policies and to contribute to significant reductions in greenhouse gas emissions.[3] Municipal government operations themselves contribute materially to America's greenhouse gas emissions; moreover, many activities that contribute to greenhouse gas emissions and climate change are subject to regulation under local governments' police powers.[4] For instance, building codes enacted by municipalities affect energy use in residential and commercial buildings, a significant source of greenhouse gas emissions,[5] while local land use policies, as embodied in zoning resolutions, influence transportation choices.[6]

This article discusses the role that local governments have played and will continue to play in efforts to combat climate change. Part II looks at voluntary climate change initiatives undertaken by local governments. Part III considers how local governments in some U.S. states may increasingly be required to consider greenhouse gas emissions in environmental reviews performed pursuant to the state analogs of the National Environmental Policy Act (NEPA). Part IV discusses challenges that confront local governments as they strive to reduce greenhouse gas emissions.

II. Voluntary Emissions Reduction Initiatives

Hundreds of U.S. municipalities have adopted, at least in spirit, the greenhouse gas emissions reduction goals of the Kyoto Protocol within their communities by signing the U.S. Mayors Climate Protection Agreement.[7] The U.S. Conference of Mayors first endorsed the agreement at its 2005 annual meeting. As of March 2008, more than 800 mayors from cities in all 50 states, the District of Columbia, and Puerto Rico—representing a total population of almost 80 million—had signed the agreement, an increase of more than 100 percent in the past year in the number of participating cities.[8] The agreement states that the mayors will "strive to meet or exceed Kyoto Protocol targets for reducing global warming pollution by taking actions in our own operations and communities," and identifies 12 types of actions that cities may take to achieve their emissions reduction goals, including land use and transportation policies to reduce vehicle traffic, tree planting initiatives, recycling programs, and various policies that would increase energy efficiency or increase use of clean, alternative energy sources.[9] Cities also agree to advocate for state and national policies geared toward achieving the reduction goals of the Kyoto Protocol and for federal bipartisan legislation to include clear timetables, emissions limits, and a flexible market-based system of tradable allowances among emitting industries.

The goals expressed in the U.S. Mayors Climate Protection Agreement are aspirational. To date, there has not been a comprehensive report on progress made by cities toward achieving these goals. A number of U.S. municipalities have, however, developed concrete emissions reduction strategies involving the areas of action set forth in the agreement. For instance, approximately 170 U.S. local governments have developed Climate Action Plans under the auspices of the Cities for Climate Protection (CCP) Campaign of the International Council for Local Environmental Initiatives. The CCP Campaign grew out of Local Agenda 21 from the 1992 Earth Summit in Rio de Janeiro, Brazil, and the ensuing Local Action 21, which was launched in 2002 at the World Summit in Johannesburg, South Africa. To participate in the CCP Campaign, municipalities must formally adopt a policy to reduce greenhouse gas emissions both in local government operations and throughout the community. They then must work toward five milestones defined by the CCP Campaign: (1) establishment of a baseline emissions inventory and forecast; (2) adoption

of an emissions reduction target for the forecast year; (3) development of a Local Action Plan to achieve the reduction target; (4) implementation of policies and measures pursuant to the plan; and (5) monitoring and verification of results.

Portland, Oregon was the first U.S. city to adopt a comprehensive plan for the reduction of carbon dioxide emissions.[10] Since then, hundreds of municipalities have adopted comprehensive climate change plans or more targeted energy-efficiency or conservation initiatives. In New York State, for example, a number of local governments have adopted policies to reduce greenhouse gas emissions. In December 2007, Mayor Michael Bloomberg of New York City signed into law the New York City Climate Protection Act, which commits New York City to a 30% reduction (from 2005 levels) in citywide greenhouse gas emissions by 2030 and a 30% reduction (from 2006 levels) in greenhouse gas emissions from city government operations by 2017.[11] The City's baseline emission levels are keyed to an inventory of greenhouse gas emissions published by the City in April 2007.[12] The Climate Protection Act provides that the City will implement actions set forth in its sustainability plan, PlaNYC 2030, to meet the reduction goals of the new legislation.[13] A number of other New York State local governments have established greenhouse gas emissions reduction goals, including Westchester County, which in February 2008 published the *Westchester Action Plan for Climate Change and Sustainable Development*, establishing county-wide emissions reduction goals of 20% below 2005 emissions by 2015 and 80% below 2005 levels by 2050, and encouraging Westchester communities to develop their own emissions inventories and emissions reduction plans.[14]

To meet such reduction targets, local governments have proposed and begun to implement a range of measures to reduce the greenhouse gas emissions associated with their communities. This article does not provide an in-depth survey of the types of actions that local governments have taken, but a catalog would include green building requirements for public and private construction; other energy efficiency measures keyed to, for instance, the federal Energy Star program; adoption of high performance building codes; bicycling incentives; hybrid or alternative-fuel municipal vehicle fleets; congestion pricing; public transit projects; conversion of methane gas from municipal landfills to energy; smart growth land use policies; urban forestry programs; green roof incentives; renewable energy mandates; solar access protections; and tree-shading ordinances for parking lots.[15]

Furthermore, new strategies are constantly devised and previously developed strategies are adapted to a particular city's circumstances. A number of readily available resources provide assistance for those interested in keeping up to date on what is happening in communities around the U.S. For example, the U.S. Conference of Mayors has created the Climate Protection Center, which serves as a resource for municipalities developing and implementing climate change policies. The Climate Protection Center has published a *Climate Protection Strategies and Best Practices Guide* that reports on strategies implemented by municipalities across the U.S.[16] A number of other resources are available that catalog federal, state, regional, and local initiatives. For instance, the Database for State Incentives for Renewables and Efficiency (DSIRE) is an online source of information that is updated regularly, usually daily.[17]

III. Mandatory Emissions Reductions

In addition to any voluntary commitments, many local governments may increasingly be compelled to include analysis of climate change impacts in environmental reviews prepared pursuant to the state analogs of NEPA. For instance, the New York State Department of Environmental Conservation has indicated that it is preparing guidance documents to address the consideration of greenhouse gas emissions in environmental review documents prepared pursuant to the State Environmental Quality Review Act (SEQRA).[18] That guidance is expected in the next few months.

On the West Coast, local governments in California have already begun to grapple with climate change issues in environmental review documents prepared pursuant to the California Environmental Quality Act (CEQA).[19] The lessons learned there may be instructive for local governments in other states. In April 2007, the Attorney General of the State of California initiated a lawsuit against San Bernardino County for failing to consider climate change impacts in its approval of a General Plan update.[20] The Attorney General argued that the County had failed to evaluate and disclose the reasonably foreseeable effects of the General Plan update on global warming.[21] Specifically, the Attorney General claimed that the County's environmental impact report should have contained an inventory of the current baseline greenhouse gas emissions in the County, estimated the increase in greenhouse gas emissions that would result from the General Plan update, and analyzed the effects of the update's increases in greenhouse gas emissions on the reductions required under A.B. 32 (the state law requiring, among other things, that statewide emissions be reduced to 1990 levels by 2020).[22] The San Bernardino County lawsuit ultimately resulted in a settlement that required the County's environmental impact report to inventory historical, current, and projected greenhouse gas emissions and to devise a Greenhouse Gas Emissions Reduction Plan with (1) a reduction target for emissions attributable to the County's discretionary land use decisions and internal government operations and (2) feasible greenhouse gas emission reduction measures.[23] In addition to the Attorney General's lawsuit, a number of other CEQA lawsuits have been brought by environmental groups charging that local government environmental reviews did not give adequate consideration to climate change issues. Partly in reaction to this litigation, a state law was passed in August 2007 requiring the Governor's

Office of Planning and Research to develop CEQA guidelines on climate change by July 2009, for certification and adoption by January 2010.[24]

In the interim, however, local governments and other entities in California must determine how to consider greenhouse gas emissions in their environmental reviews. The Attorney General has sponsored workshops that would address questions such as how cities and counties should analyze the global warming-related impacts of development, what mitigation strategies local governments should employ to reduce their CO_2 emissions, and how cities and counties can undertake the required analysis efficiently and on limited budgets.[25] The Attorney General's office has also published a list of measures that may be implemented to mitigate climate change emissions, as well as an online chart with links to modeling tools available to local governments attempting to estimate the impacts of proposed actions.[26]

In addition to the materials made available by the California Attorney General, the California Air Pollution Control Officers Association (CAPCOA) has published a white paper "to provide a common platform of information and tools to support local governments" in their evaluation of greenhouse gas emissions under CEQA.[27] The CAPCOA white paper formulates and analyzes alternative approaches for defining the significance threshold for an action's contribution to greenhouse gas emissions.[28] The white paper also evaluates analytical methodologies and modeling tools for characterizing projects' emissions and provides guidance on mitigation measures based on their economic, technological, and logistical feasibility, and emission reduction effectiveness.[29] Though produced for reviewing agencies in California and with the statutory framework of CEQA in mind, the CAPCOA white paper serves as a useful resource for local governments in other states in the absence of other guidance.

IV. Obstacles and Challenges

Regardless of whether local governments voluntarily adopt emissions reduction requirements or are compelled to create policies and implement programs to reduce emissions, they face challenges in actually achieving the reductions.

A. Technical Difficulties

A report prepared by the Institute for Local Self-Reliance (ILSR) in 2007 identified a number of technical obstacles to achievement of local climate change goals.[30] In particular, the report found that there could be problems with the data municipalities use for their emissions inventories. The ILSR report examined the results of greenhouse gas reduction efforts of ten cities that had committed to achieving the targets of the Kyoto Protocol: Austin, Ann Arbor, Berkeley, Boulder, Cambridge, Minneapolis, Portland, San Francisco, Salt Lake City, and Seattle. The ILSR report found that the cities did not gather information about and report greenhouse gas emissions in a consistent manner. Cities also reported frustration with their lack of access to data about greenhouse gas emissions. The report found that, at a minimum, greenhouse gas emissions should be reported by sector and by energy source, but that very few cities have achieved this level of reporting, which is labor intensive. In addition, the report concluded that protocols used to develop inventories were not consistent and could lead to a lack of transparency, due to variations in the protocols developed to create greenhouse gas emissions inventories for various programs such as the California Climate Action Registry, Chicago Climate Exchange (which has several municipal members), and the CCP Campaign. It is likely that even in the ensuing months since the ILSR report was published, progress has been made toward improving the information available to local governments about the protocols and methodologies available to local governments. For instance, the CAPCOA white paper published to assist local governments in their CEQA reviews devotes a chapter to discussing the appropriate analytical methodologies for various types of projects. As noted above, the California Attorney General has provided an overview of the models available to assist agencies in their greenhouse gas impact analyses.[31]

The CAPCOA white paper also identifies limitations in current methodologies and indicates that future work will allow for more accurate planning. For instance, many emissions reduction goals are framed as percentage reductions below the baseline emissions of a given year. To determine whether a given project would achieve such goals, the CAPCOA white paper suggests that a "service population metric," which would rely on establishment of an efficiency-based significance threshold, could eventually be appropriate. The metric would allow local governments to determine whether the per-capita greenhouse gas emissions for a given project were less than the existing statewide average.[32] However, the CAPCOA white paper indicated that such a methodology is not viable in the short term because its development requires substantial data and modeling.[33]

B. Funding

A primary concern for all municipalities undertaking climate change goals is how they will pay for the emissions reductions. The ILSR report identified a lack of local funding commitments as a potential barrier to communities' achievement of their climate change goals.[34] It appears that only a few cities have implemented climate-specific fundraising measures, perhaps because many local governments may lack authority to do so.[35] One of the cities that does have its own funding mechanism—Boulder, Colorado—pays for its climate action plan with a carbon tax based on consumption of electricity. The tax is collected by Xcel Energy (an electric franchisee) and is authorized through March 31, 2013. It supports an annual climate program budget of up to $1.3 million.

The federal Energy Independence and Security Act of 2007 (EISA) provides a potential boon to local government energy efficiency efforts in the form of the Energy Efficiency and Conservation Block Grant Program, for which Congress authorized $2 billion for each of the fiscal years 2008 through 2012.[36] The block grants are intended to assist local governments in implementing strategies to reduce fossil fuel emissions, reduce total energy use, and improve energy efficiency in the transportation, building, and other appropriate sectors.[37] The U.S. Conference of Mayors, the National League of Cities, and others have been working to ensure that Congress appropriates funds for the first year of the program.[38] A separate provision of EISA authorizes at least $30 million annually from 2008 to 2012 to local governments for electric vehicles and plug-in hybrid electric vehicles.[39] Other federal programs that provide funding to municipal governments for programs that may contribute to greenhouse gas emissions reductions include the federal New Starts program, which provides federal funding for mass transit projects in a number of localities across the country.[40]

In addition to and in support of these existing programs, an alliance of local governments known as Climate Communities has been invited by congressional leaders to propose amendments to the Lieberman-Warner Climate Security Act to provide cap-and-trade incentives to local governments.[41] The Climate Communities proposals include measures to fund local climate change initiatives such as: (1) allocating 10% of the allowances provided by the bill each year to the Environmental Protection Agency (EPA) to implement a program to directly support local and regional government initiatives to reduce and adapt to impacts of greenhouse gas emissions; (2) devoting 10% of allowance auction proceeds to a fund to directly support such initiatives through federal programs such as the Energy Efficiency and Conservation Block Grant Program and the U.S. Department of Energy's Clean Cities Program; and (3) making local and regional government land use projects eligible as offsets that regulated emitters could purchase to achieve compliance.[42]

There are other means by which municipalities may make implementation of their climate change policies affordable. For instance, cities may use their collective influence to garner better deals on products they need to implement emissions reduction initiatives. In the past year, the U.S. Conference of Mayors has partnered with the Clinton Climate Initiative (CCI), allowing more U.S. cities access to volume discounts on energy-efficient and clean energy products and technologies through a purchasing consortium established by CCI.[43]

C. "Stubborn" Emissions

The most difficult hurdle faced by municipalities may be the intransigence of the emissions themselves. With the constraints of existing infrastructure and development, there are limits to what municipalities can do to reduce emissions.[44] In many localities, the existing transportation network and land use patterns are geared toward exclusive automobile use. Addressing these issues requires expensive, long-term commitments to public transit systems and the rethinking of land use policies. The CAPCOA white paper noted this difficulty and indicated that new development projects might have to meet higher emission-efficiency goals to make up for the emission levels of existing development.[45] Many, if not most, of the climate change programs already in place target new development. For instance, in states that have adopted some version of the International Code Council's (ICC's) International Energy Conservation Code, new residential and commercial buildings must already meet increased efficiency standards.[46] As the ICC prepares to update its model code in fall 2008, energy conservation advocates are pressing for a "30 percent solution" that would reduce energy use in new homes by that amount.[47] In addition, a growing number of localities require new construction to meet "green" building standards that include energy efficiency requirements.[48]

The problem of emissions from existing sources is more difficult to tackle, but there are potential policy solutions. For instance, some local governments have taken steps toward enacting laws that require energy efficiency upgrades for existing buildings that do not meet specified standards. In San Francisco, for instance, the Residential Energy Conservation Ordinance has, since the 1980s, required compliance with energy-efficiency standards before residential buildings are sold, renovated, or converted to condominium ownership.[49] In addition, some municipalities have begun to require that residential and commercial remodelings and renovations meet "green" building requirements.[50] Municipalities have also begun to amend existing local laws that impede local initiatives or individual projects that could potentially result in emissions reductions.[51]

V. Conclusion

The current boom in local government climate change initiatives could potentially result in significant greenhouse gas emissions reductions. Technical and financial issues remain, but it appears that the political will to address climate change at the local level is strong enough to compel municipalities to confront their communities' emissions contributions and overcome these hurdles.

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Engaging Individuals in Climate Change Mitigation

By John C. Dernbach

Introduction

Environmental law tends to draw a bright line between regulated parties, on one hand, and citizens on the other. In adopting climate change legislation, Congress should turn that bright line into a dotted line because individuals, too, have a role in reducing greenhouse gas emissions.

Environmental law regulates utilities, sewage treatment plants, landfills and similar facilities. Operators of these facilities must first get permits. They must limit their emissions and environmental impacts in specific ways. If they don't obey these and other requirements, they are subject to fines, court orders, and even jail time.

Citizens—all of us—are given a role in enforcing these laws. The public gets notice of permit applications. We get to speak at hearings. Under many state and federal laws, we can even be "private attorneys general," enforcing laws when the government is unwilling or unable to do so.

"If Congress does not recognize that individual behavior contributes to climate change and can be harnessed to reduce greenhouse gas emissions, the legislation we get will not likely respond to the magnitude of the challenge in front of us."

Federal climate change legislation—when (not if) it is adopted—will need to soften this distinction. Yes, we will need to regulate major facilities. Yes, citizens will need to help enforce this legislation. But—and this is a key to making the legislation work as effectively as it should—citizens also need to be encouraged and prodded to change their own behavior. Individuals act in a variety of roles: as citizens and consumers; as members of families and communities; as employees, managers, and leaders in organizations; and as investors. Appeals to individuals are likely to influence their behavior in all of these roles. If Congress does not recognize that individual behavior contributes to climate change and can be harnessed to reduce greenhouse gas emissions, the legislation we get will not likely respond to the magnitude of the challenge in front of us.

This article explains why individual behavior is so important in addressing climate change. It then briefly summarizes the basic provisions of the Lieberman-Warner Climate Security Act of 2008 (S. 2191).[1] While the bill was killed by the Senate on June 4, 2008, the House is actively

discussing an alternative bill (H.R. 6186, the Investing in Climate Action and Protection Act), which was introduced the same day, and something like one of these bills will eventually be enacted. Finally, the article explains changes in individual behavior that will likely lead to deeper and faster reductions in greenhouse gas emissions. Addressing individual behavior is not a substitute for controls on major sources of emissions; it is a necessary supplement.

I. Why Individual Behavior Matters for Climate Change

If we are truly serious about reducing greenhouse gas emissions in the United States, we need to engage not only the major sources of emissions, but also the individuals whose demand for goods and services (and particularly energy) contributes to those emissions. The sheer size of U.S. greenhouse gas emissions mandates this approach. The United States is the largest energy producer and consumer in the world.[2] The U.S. has also been the world's largest emitter of greenhouse gases,[3] although China's carbon dioxide emissions recently surpassed those of the U.S.[4]

Individual behaviors contribute significantly to U.S. greenhouse gas emissions. Activities that fall within the "direct, substantial control of the individual and that are not undertaken in the scope of the individual's employment" are responsible for about one-third of U.S. greenhouse gas emissions and 8% of global greenhouse gas emissions.[5] By another estimate, about one-third of the energy consumed in the United States "is directly controlled by households."[6] About 80% of all U.S. carbon dioxide emissions result from the burning of fossil fuels for energy.[7] Individuals use energy every day in a variety of ways that indirectly and less substantially affect energy use, but whose influence is nonetheless real.

Perhaps surprisingly, the industrial sector is responsible for the least growth in U.S. greenhouse gas emissions of any economic sector between 1990 and 2005. The greatest growth in carbon dioxide emissions in the United States has been in the transportation sector, followed by the commercial and residential sectors. Across all sectors, electricity is the dominant cause of growth in carbon dioxide emissions, representing 55.6% of the growth in carbon

dioxide emissions between 1990 and 2005.[8] A cooperative relationship between individual homeowners and utilities is key to programs and technologies that encourage reduced greenhouse gas emissions, such as "smart meters," which enable consumers to monitor their electricity consumption and cost in real time.

Another important reason to engage individuals in reducing greenhouse gas emissions is the high level of per capita energy consumption in the United States, both in absolute terms and relative to people in other countries. Per capita energy consumption in the United States is approximately 340 million BTUs per year.[9] With only 5% of the world's population, the United States is responsible for about 25% of the world's annual energy consumption.[10] U.S. citizens use twice as much energy as their European counterparts, almost seven times as much as the Chinese, and more than 21 times that of Africans.[11] No one seriously argues that the rest of the world can safely consume energy at the same per capita level as currently consumed by U.S. citizens. In fact, most international climate negotiators and analysts assume that per capita emissions in all countries will someday need to converge at a level that is far below current U.S. levels.

Climate change also implicates deeply held moral, ethical, and even religious principles.[12] Such principles could powerfully and positively justify, and help motivate, any national effort if handled respectfully and in a nonsectarian manner. The principle with the broadest possible appeal, perhaps, is environmental stewardship. A second principle is social justice, particularly to the extent that climate change caused primarily by developed countries adversely affects people living in developing countries.[13] This principle, of course, also involves national self-interest. A third principle is the value modeling of sustainable development, an objective that is grounded in both morality and national self-interest. Sustainable development attempts to reconcile conventional development with environmental protection, not by compromising one or the other, but by achieving both at the same time, for the benefit of present and future generations.[14] Conventional development in industrialized countries tends to be imitated or sought by less industrialized countries. If the United States were to significantly reduce its per capita energy consumption while the prosperity and well-being of its citizens increased, for instance, the country would provide a better model of sustainable development.

So how do we effectively engage individuals in this effort? If we assume that the purpose of engaging ordinary Americans is to maximize the effectiveness of the legislation, and not simply to make symbolic gestures, then it is vital to know what works and what does not work. Homeowners frequently do not take advantage of available and cost-effective energy efficiency opportunities, and research on the effectiveness of energy conservation and efficiency laws adopted in the 1970s and 1980s indicates that these laws were often less effective than anticipated. At the same time, much is now known about why these laws did not work as well as anticipated, and how laws and policies to engage individuals can be made more effective.[15]

A framework for changing individual behavior, the "value-belief-norm" theory of environmentally significant behavior, has been developed by Paul Stern and others.[16] The idea is that "individual choice can be driven by personal norms, that is, an internalized sense of obligation to act in a certain way."[17] Personal norms for pro-environmental behavior can be activated in a specific situation (1) when a person is made aware that a particular action would adversely affect something the person values and (2) where, by taking that action, the person would have "significant responsibility for those consequences."[18] The most effective way of providing this information, according to Stern, is to make sure that it "arrives at the time and place of decision, is linked to the available choices, is delivered from trusted sources, and is delivered personally."[19]

Thus, while information is at the heart of this approach, information by itself is not enough. The focus of any effort should not simply be to provide information, but rather to change individual behavior.[20] As Doug McKenzie-Mohr and William Smith[21] explain, individual behavior can be changed by increasing the benefits and reducing the obstacles of acting in a particular way. Similarly, competing behaviors can be changed by decreasing the benefits of those behaviors and increasing the obstacles. [22] Household collection of recyclables, for instance, is encouraged not just by the ready availability of good information, but also by the actual availability of convenient opportunities to recycle, such as curbside collection and the ability to mix or commingle different types of material (such as cans and bottles) in the same collection container.[23] Similarly, financial and other incentives can be used to encourage certain behaviors, discourage others, or both.[24] For instance, Congress and many states have made available a number of tax credits and deductions for energy efficiency and renewable energy.[25]

II. Lieberman-Warner Climate Security Act of 2008

The heart of the Lieberman-Warner bill is a cap-and-trade program for greenhouse gas emissions that focuses on "covered facilities." Essentially, the bill would require the U.S. to reduce its greenhouse gas emissions from these sources by about 70% over nearly 40 years—from 5,775 million tons in 2012 to 1,732 million tons in 2050. The definition of "covered facility" includes facilities that use large amounts of fossil fuels (e.g., facilities that use more than 5,000 tons of coal in a calendar year) and generate large amounts of greenhouse gases (e.g., facilities that emit hydrofluorocarbons in amounts equivalent to 10,000

tons of carbon dioxide). These facilities are responsible for 87% of U.S. greenhouse gas emissions.

These reduction requirements create an emissions cap or limit for covered facilities, and the level of this cap declines over time. Covered facilities can meet this cap more or less as they see fit—by, for example, becoming more energy efficient, switching to a less carbon-intensive fuel (coal to natural gas), or using more renewable energy. Another option for covered facilities is trading—or purchasing emissions allowances. Some facilities will be able to reduce their greenhouse gas emissions—on a per-ton basis—more cheaply than others. Some will even be able to reduce their emissions further than required at relatively low cost. Those that do can trade or sell their "excess" reductions—in the form of allowances that are equal to one ton of carbon dioxide—to facilities where control costs are greater. This way, one group of facilities is able to profit from its excess reductions, and another group is able to comply with the required reductions more cheaply than it would otherwise.

The Lieberman-Warner bill contains a great many other provisions, to be sure. Many of these are directed at making sure that the emissions trading market is transparent, reliable, and functions smoothly. Others are directed at ensuring that the price of allowances doesn't get so high that the program becomes unaffordable for many facilities. Some provisions allow covered facilities to purchase "offset allowances" in the U.S., primarily from foresters and farmers, to meet their emissions caps. Offset allowances are allowances generated by non-covered facilities in the form of reduced greenhouse gas emissions or increased carbon sequestration or storage. The bill would also establish a system of national emissions reporting. What the bill does not do, however, is fully engage individuals in this major national effort to address climate change. To be sure, the bill's trading and allowance program would ripple through the economy, encouraging greater energy efficiency, more use of renewable energy, and lower greenhouse gas emissions. But the bill does little to directly assist individuals on how to best respond to, and take advantage, of the changes wrought by the legislation.

The bill's goals—or the goals of any climate change bill—would be attained more quickly and effectively if it expressly engaged individuals in the national climate change effort. As already noted, individuals are responsible for a significant share of greenhouse gas reductions. Although regulation of covered facilities will indirectly address some of these emissions, it will not address all of them. In addition, considerable reductions can be achieved now, using existing technology and know-how. Many of these reductions—through more energy efficient homes and commercial buildings, for example—can be achieved by individuals in the immediate future. Individual purchasing decisions, in the aggregate, also have significant climate change consequences. Individual engagement would accelerate the deployment of existing cost-effective technologies, and would take advantage of the creativity and knowledge of ordinary Americans. For all these reasons, climate change legislation will achieve greater reductions more quickly if it expressly engages the American public.

III. Suggested Legislative Elements for a Citizen Engagement Strategy

Here is a sketch of the range of changes that could—and should—be considered to engage individuals fully:

Findings and purposes. Congress should identify full engagement of the citizenry in the national climate change effort as a necessary and important purpose of the legislation. Congress should also include in the bill a specific finding that efforts to mitigate climate change can create jobs, foster the development of new technology, reduce other air pollutants, reduce the vulnerability of individuals and businesses to high and fluctuating energy prices, and improve domestic security. Such a finding would help enable the American public to see the opportunities present in this challenging situation, and could strengthen a broad-based understanding that the legislation is consistent with our personal and national self-interest.

Finally, Congress should include a finding that individual effort and engagement are needed to make the legislation work more effectively, quickly, and cheaply. Evidence from the 2000–2001 California energy crisis indicates that households are responsive to public appeals,[26] which indicates that they may be responsive to public appeals contained in climate change legislation.

Targets and timetables. While the Lieberman-Warner bill contains an overall emissions reduction target, Congress could more effectively engage individuals and other entities if it directed the U.S. Environmental Protection Agency (EPA) to translate its overall targets and timetable into specific goals for the transportation, industrial, commercial, and residential sectors. Similar targets and timetables for the electricity sector, which involves energy use in each of the other four sectors, would also be useful. These targets and timetables could be further divided (e.g., type of energy use, region) in ways that would be relevant to specific groups of similarly situated individuals and other entities.

Consumer information. Congress should require disclosure of more information about the climate change impacts of new products. For example, it should require disclosure of the estimated monthly or annual energy costs of operating motor vehicles. It could also encourage or direct states to provide public information about energy use and greenhouse gas emissions in policy areas

where states ordinarily regulate. Thus, Congress could require development and publication of information on the estimated monthly or annual energy costs of operating new or existing residential and commercial buildings. Congress could even require EPA to publish information on the energy or carbon footprint of individuals. Such information would enable individuals to compare their footprint with that of others who are similarly situated in their part of the country, along with information on what others have done to reduce their energy or carbon footprint.[27]

Public information on available choices. Congress should direct EPA and other agencies to make publicly available, in a variety of contexts, information about how individuals can reduce their energy use. This information would be particularly effective in the context of the required disclosure of information about the energy use or greenhouse gas emissions associated with the purchase and use of particular products and services.

Congress could also direct the publication of comparative information about the energy efficiency and operating cost of various appliances and types of equipment. Such information would enable consumers to easily compare the energy and dollar cost of their current refrigerator, air conditioner, or furnace with the ones now available for sale. This kind of comparative information could be made available as part of a broader effort to inform individuals that upgrades or retrofits for appliances, equipment, or insulation in residential and commercial buildings offer some of the largest, if not the largest, energy and cost savings (as well as greenhouse gas reductions) available to them.

Public information on climate change effects. Public information about the impact of climate change on U.S. citizens is a necessary part of any national climate change program, particularly because climate change is already under way. Such information would provide state, local, and regional decision makers, as well as individuals, with useful information about the likely effects of climate change, and enable them to better plan their activities.

Incentives for individual action. It is one thing to provide individuals with information about energy use and the greenhouse gas impacts of their choices, to identify and provide information about alternatives, and to make those alternatives more readily available. It is quite another to provide them with specific affirmative incentives to act on that information. Congress could do much more to provide those incentives. The combination of information and incentives can be very effective in inducing individuals to change their behavior, and considerable opportunity exists to create incentives for individuals. These opportunities include tax incentives, distribution of allowances, the ability to generate and trade allowances, the distribution of proceeds from allowances, and other incentives. Mutually reinforcing incentives for the same behavior, moreover, may be particularly effective.

- **Tax incentives**. Congress should provide the fullest possible set of tax credits and other incentives, particularly for behaviors that involve significant initial financial outlays. These tax incentives should not be limited in time or to a specified number of taxpayers, as many of the tax incentives under the Energy Policy Act of 2005 were. They should focus on encouraging such decisions as the purchase of more fuel-efficient vehicles and on energy efficient upgrades or renovations to existing residential and commercial structures. It may also be appropriate to provide some form of reduced taxation to individuals who can demonstrate that their actions over the previous year have been carbon neutral.

- **Distribution of allowances.** A major issue in implementing any trading system is how to allocate allowances. One option is to allocate a significant fraction of available allowances to individuals and entities that can establish that they have significantly reduced their energy use or greenhouse gas emissions. In this way, the government provides an economic incentive or reward to those persons or entities equivalent to the market value of the allowances themselves. Such an award would provide a financial incentive to reduce energy use or greenhouse gas emissions, and the incentive would not result in reduced revenue to the treasury. While any individual reduction in greenhouse gas emissions might not be significant in itself, reductions by many individuals could be aggregated in ways that economically benefit these individuals.

- **Ability to generate and trade offset allowances.** Another way to reward and encourage individual behavior that reduces greenhouse gas emissions or energy use is to authorize individuals to create and market allowances themselves. Like the previous option, this approach takes advantage of the trading system created by the legislation, and does not involve a loss of funds to the treasury. This option, however, may be more attractive in that it allows individuals to generate the allowances themselves rather than depend on allocation by the government. This option may also generate a suite of cost-effective reductions that would not otherwise have occurred. S. 2191 explicitly provides this ability to foresters and farmers but not to other persons who could generate offset allowances (e.g., owners of residential and commercial buildings, which could generate considerable reductions through energy efficiency).

- **Distribution of proceeds from sale of allowances.** Any government auction or sale of allowances will result in receipt of money by the government. This money could, in turn, be distributed to individuals who have made significant demonstrated reductions in their greenhouse gas emissions. It could also be distributed directly or indirectly to low income persons for home weatherization or the purchase and installation of other energy efficient or greenhouse gas reducing technologies. The distribution of funds from the sale of allowances, in other words, could be used to provide incentives or overcome disincentives.

- **Other incentives.** If Congress wants to engage individuals fully, it will look to provide other incentives as well. The social science literature on incentives indicates a greater variety of potential incentives than are ordinarily provided in legislation. Many of these incentives are specific to particular economic sectors. Congress should authorize EPA to recommend to Congress additional incentives within a specified period after the legislation is enacted. This report should be prepared in conjunction with the National Academy of Sciences, which has a long track record studying behavioral issues associated with energy use.

Role of states. Congress could require or allow states to adopt individual or public engagement plans. In such plans, states would explain what they intend to do to engage individuals in addressing climate change. Such plans would allow particular states to tailor individual engagement efforts to their own economic, geographic, and demographic situation. The legislation could contain a relatively brief list of issues that state plans should address, and provide funds to states in proportion to their demonstrated success in reducing greenhouse gas emissions or energy consumption through changes in individual behavior.

Evaluation and improvement. One of the most basic things Congress could do is to give an appropriate federal agency (probably EPA) broad responsibility for continually finding better and more effective ways to inform individuals of the greenhouse gas effects of their choices, for developing and recommending more effective incentives, and for conducting ongoing research on the effectiveness of their efforts. This evaluation would best be conducted in cooperation with the National Academy of Sciences (like the report mentoned above), and should include evidence from the United States and other countries. Congress should also require that this evaluation be updated on a regular basis, say every three to five years. The legislation should also make clear that EPA and other agencies are expected to enter into appropriate partnerships with the private sector and other nongovernmental entities, including entertainment media and advertisers.

Conclusion

Climate change legislation is likely to be much more effective if Congress engages individuals as much as possible. The problem is too daunting to focus simply on the large facilities, and there is considerable reason to believe that individuals can make a significant contribution—as citizens and consumers, as well as in other roles. A congressional effort to engage individuals fully would take advantage of some of our nation's key strengths—individual initiative, engaged citizenship, and collective sense of purpose. Such legislation would more likely be at least equal to the challenge in front of us.

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SEQRA and Climate Change

By Michael B. Gerrard

New York's State Environmental Quality Review Act (SEQRA) is the centerpiece of environmental decision-making in the state. It requires state and local agencies to prepare environmental impact statements (EISs) for actions that could significantly affect the environment. SEQRA has become the principal framework for the identification and mitigation of environmental impacts.

The text of SEQRA provides that EISs should discuss the "effects of the proposed action on the use and conservation of energy resources, where applicable and significant."[1] EISs under SEQRA are also required to consider, among many other things, a project's effects on air pollution.[2] Since the main source of greenhouse gases (GHGs) is the use of energy, and also since the most important GHG, carbon dioxide, has been declared by the U.S. Supreme Court to be an air pollutant,[3] the New York State Department of Environmental Conservation (DEC), which is responsible for promulgating the statewide regulations under SEQRA, would seem to have ample authority to require consideration of climate change in EISs.

There have been informal indications that DEC intends to require its staff to address climate issues in EISs when DEC is the lead agency. This may be followed by formal regulatory action to reference climate change in the environmental assessment form.

Progress has been relatively slow. No formal pronouncements have been issued. However, DEC has begun including climate issues in the scope for a number of EISs. One such scope is discussed in greater detail below. Because of the lack of formal activity, the Municipal Art Society of New York, a leading citizens' organization focused on New York City land use and planning issues, has undertaken a project to propose protocols for assessing climate issues under SEQRA and its New York City equivalent, City Environmental Quality Review (CEQR).

The New York State Department of Transportation (DOT) has been requiring GHG analysis for more than three years. In November 2003 DOT issued three "draft interim guidance" documents setting forth, in some detail, how to calculate carbon dioxide emissions from proposed projects as well as from Transportation Improvement Programs and Long Range Plans. These documents were written for inclusion in DOT's guidance document, the *Environmental Procedures Manual*. Though they have not been finalized, DOT is already applying them in project reviews. The process involves examination of direct vehicle use of fuel; GHG emissions from that fuel; and emissions in roadway and rail line construction and maintenance. The stated authority for this analysis is the 2002 State Energy Plan, which adopted a goal of reducing GHG emissions 5% below 1990 levels by 2010, and 10% below 1990 levels by 2020.[4]

No judicial decision under SEQRA appears to have addressed the issue of climate change. However, one early decision upheld DEC's decision to impose energy conservation conditions in approving an action (a shopping center).[5]

Belleayre Scope

DEC's most detailed public discussion of what it would like to see in EISs is the scope it released in February 2008 for the proposed unit management plan amendments to the state-run Belleayre Mountain Ski Center and for the Belleayre Resort at Catskill Park, a private development proposed alongside the Belleayre Mountain Ski Center. DEC's scope, issued in February 2008, required a very detailed discussion of climate issues. Because this scope may become a template for other EISs, it is worth setting forth at length. There are three parts to the scope. Part A concerns the Unit Management Plan, which is the State's management plan for its ski center. Part B concerns the scope for the supplemental draft EIS being prepared for the private development. Part C looks at the cumulative impacts from changes proposed for the ski center and the private development. DEC imposed similar requirements on itself as to what it required of the private developer.

The Belleayre scoping document (Part A) required:

> A . . . [B]oth a quantitative (where practicable) and qualitative discussion of the GHG emissions resulting from construction activities, including the manufacture or transport of the construction materials, specifically including the following:
>
> 1. A qualitative analysis of how the building products will be environmentally-preferable . . .
>
> 2. A quantitative analysis of GHG emissions resulting from construction activities and the transport of building supplies from the supplier to the work site.

B. A quantitative estimate of both direct and indirect GHG sources during the post-construction operation of the project should be included:

1. Direct GHG emissions will include emissions from combustion processes or industrial processes conducted on-site, including but not limited to the heating and cooling systems and boilers, snow making guns and from fleet vehicles owned (or leased) and operated by the project proponent and associated with the project.

2. Indirect GHG emissions will include emissions generated by energy generating plants (off-site) supplying energy to the proposed project during its operation, and from vehicle trips generated by the project where vehicles are not owned or operated by the project proponents (i.e. freight deliveries, employee commuting, customer visits). A potential source of indirect emissions is the generation, transportation, and treatment or disposal of wastes. Waste generation should also be expressed as GHG emissions and included in the quantification of total annual emissions.

The Belleayre scope acknowledged that "[s]ite build-out will result in loss of forested area and therefore some loss of CO_2 sequestration capacity." The scope required a quantitative and qualitative analysis of this loss, and referenced a U.S. Department of Agriculture guide on how to perform that study.

The scope required a "[q]uantitative analysis, or where impracticable, a qualitative analysis, of the relative increase or decrease of GHG emissions resulting from each of the alternatives" required to be studied. It also required "a description and evaluation of the range of reasonable and relevant potential mitigation measures which would reduce GHG emissions with respect to technology, scale, design, or use and their implications on GHG emissions." The scope included an illustrative list of potential mitigation measures for consideration only.

Among the potential mitigation measures to be studied are building energy efficiency design measures, utilizing EPA's Energy Star program and/or other energy efficient design standards as a basis for comparison. For transportation emissions, transportation demand management measures are to be identified and assessed.

The scope also required an analysis of the effect of climate change on the project itself. In particular, the scope required a discussion of:

- The potential increase in winter surface air temperatures in relation to:
  - increase in melt rate for snow cover
  - decrease in the length of the snow making season
  - earlier periods of peak runoff and stream flow due to earlier snowmelt
  - changes in total amounts, timing or patterns of precipitation falling as snow
  - overall decrease in the number of snow-covered days available for winter recreation
- The potential increase in summer surface air temperatures in relation to:
  - change in composition of native plant and animal species
  - increase in the prevalence of invasive species and pests
- The potential decrease in summer and fall soil moisture in relation to:
  - increased water requirements for maintaining turf grass and other landscaped areas
  - increased stress on native vegetation
  - increased surface water runoff from areas with stressed vegetation
- To the extent surface waters and their related watershed are affected, the potential increase of water temperatures of surface water, including ponds and stream systems, in relation to:
  - physiological stress and resultant population impacts to heat sensitive aquatic biota, especially coldwater fisheries
  - decrease in dissolved oxygen levels and in the assimilative capacity of the aquatic system.

All analyses are required to assume a lifespan of at least 50 years.

The DEIS is to include a discussion of existing ski centers located in the southeastern United States (presumably because the climate of New York is projected to increasingly resemble that of more southerly portions of the country as the century progresses) as a comparison to demonstrate viability of the proposed facility in light of future potential climate change.

Draft GEIS on RGGI

Another important document is the draft generic environmental impact statement (DGEIS) issued in October 2007 for DEC's proposed regulations implementing the

Regional Greenhouse Gas Initiative (RGGI), a ten-state effort to reduce carbon dioxide emissions from electric power plants.[6]

Among the topics discussed in the DGEIS are the regional impacts of global climate change; the carbon dioxide emissions reductions anticipated under RGGI; RGGI's relationship to other plans, programs, policies and initiatives; the alternative actions considered (including a command and control/emission rate program, variations of carbon dioxide budget trading, and a no-action alternative); the environmental impacts of RGGI; and mitigation of potential adverse impacts.

Energy Efficiency Portfolio Standard

Another important effort under SEQRA is the Final Generic Environmental Impact Statement (Final GEIS) issued by the Department of Public Service in March 2008 for the Energy Efficiency Portfolio Standard.[7] This is part of the state's effort to reduce electric energy consumption in New York by 15% from expected levels by the year 2015.

Interestingly, DEC commented on the Draft GEIS by saying that the document should give greater emphasis to the GHG reduction benefits of the proposal. In response, the Final GEIS contained further discussion of the benefits. The Final GEIS did include some discussion of climate issues, and it projected that the proposal would result in lifetime reductions of 16 million metric tons of carbon dioxide.

Federal Law

SEQRA, enacted in 1975, is based on the National Environmental Policy Act (NEPA), enacted in 1969 and signed into law by President Nixon on January 1, 1970. NEPA requires the preparation of an EIS for "major Federal actions significantly affecting the quality of the human environment."[8] EISs must address not only direct effects, but also indirect effects that are "reasonably foreseeable."[9] Among the topics to be discussed are "[e]nergy requirements and conservation potential of various alternatives and mitigation measures."[10] The idea of disclosing indirect as well as direct energy impacts in NEPA documents was first discussed many years ago.[11]

In 1997 the Council on Environmental Quality (CEQ), the White House office charged with implementing NEPA, issued a draft guidance document finding that the available scientific evidence indicates that climate change "is reasonably foreseeable" and therefore should be assessed in NEPA documents.[12] Though the scientific evidence has become considerably more definitive in the past decade, this draft guidance has never been made final. In February 2008 the International Center for Technology Assessment, the Natural Resources Defense Council, and the Sierra Club filed a petition with CEQ asking it to amend its regulations to clarify that climate change analyses should be included in environmental review documents under NEPA.[13]

Several federal courts have addressed the question of whether a particular action required an EIS-level discussion of climate impacts. The first such decision was *City of Los Angeles v. National Highway Traffic Safety Administration*.[14] It concerned the setting of the Corporate Average Fuel Economy (CAFE) standard. The complaint alleged that a lower standard would worsen global warming. The court found that plaintiffs had standing to bring the lawsuit (itself a significant holding), but that the one-mile-per-gallon change in the CAFE standard at issue was not so significant as to require an EIS. This court—like all subsequent federal courts to address the question—did not doubt that global warming was a proper subject for analysis under NEPA; it merely found a particular action's impacts to fall below the threshold of significance.

The next decision, *Border Power Plant Working Group v. Department of Energy*,[15] concerned the construction of transmission lines to carry electricity from new power plants in Mexico to users in southern California. The court found that carbon dioxide emissions from the new plants should have been analyzed under NEPA. The same year, the Eighth Circuit in *Mid States Coalition for Progress v. Surface Transportation Board*[16] considered the construction of a rail line to bring coal from mines in Wyoming to power plants in Minnesota and South Dakota. The court found that the EIS should have considered the air emissions (including carbon dioxide) from the power plants. The agency went back and supplemented its EIS, including a cursory discussion of climate change impacts; when that new document was challenged, the court found it to be sufficient.[17]

In another case, plaintiffs have won several procedural motions. *Friends of the Earth, Inc. v. Mosbacher* concerns the actions of the Overseas Private Investment Corporation (OPIC) and the Export-Import Bank (Ex-Im Bank) in financing several energy projects abroad. Plaintiffs said these projects would generate GHGs that would affect the climate in the United States, and OPIC and Ex-Im Bank should have analyzed the projects under NEPA. The U.S. District Court for the Northern District of California ruled that the case should go forward. It found that, because domestic effects were alleged and the relevant decisions were made in the U.S., the case did not fail for alleging only extraterritorial impacts. It found disputed issues of fact as to whether the federal actions in financing the projects were so significant that EISs should have been prepared.[18] The district court subsequently certified several key issues in the case for interlocutory appeal to the Ninth Circuit.

Most recently, the Ninth Circuit annulled the average fuel economy standards for light trucks, in part because no EIS had been prepared. The court declared, "The impact of greenhouse gas emissions on climate change is precisely the kind of cumulative impacts analysis that NEPA requires agencies to conduct."[19]

Massachusetts

Some states are farther along than New York in analyzing climate change as part of their environmental impact review processes. The state that was first out of the blocks was Massachusetts. Its policy[20] applies to many (but not all) projects undergoing analysis under that state's equivalent of NEPA, the Massachusetts Environmental Policy Act (MEPA).[21] The policy requires quantification of project-related GHG emissions, and states that "MEPA will also require that proponents consider a project alternative in the [EIS] that incorporates measures to avoid, minimize, or mitigate such emissions. For projects subject to the policy, MEPA will immediately begin incorporating into new scoping certificates the requirement that the proponent identify and describe sources of, and propose measures to avoid, minimize, or mitigate for, project-related GHG emissions."

The state formed a technical advisory committee to formulate a protocol for quantifying GHG emissions. The resulting document includes a useful list of suggested ways to mitigate climate impacts through siting, site design, building design and operation, and transportation.[22]

California

California has received a great deal of attention for its Global Warming Solutions Act of 2006, also known as A.B. 32. But that law delegates formulation of detailed regulations to the California Air Resources Board, and they are not due to be adopted until January 1, 2011, and to be effective by January 1, 2012.

Meanwhile, several lawsuits have been filed alleging that environmental impact reports issued under California's impact assessment law, the California Environmental Quality Act (CEQA),[23] should consider climate change. The only two of these cases decided to date challenged development projects that were approved without consideration of the potential impact of climate change and resulting regulations. In a tentative ruling in the first of these, the court found that petitioners had not demonstrated that significant new information had become available, with regard to climate change and its effect on the particular project, between certification of a supplemental environmental review document and the approval of the permits for the project. The court took pains to explain the narrowness of its ruling:

> Petitioners have made a persuasive showing that there is a growing consensus on the issue that has caused state environmental agencies to give it closer attention. As the projected effects of climate change become clearer and can be related to specific sites, there is little doubt that those effects will have to be factored into the analysis of many projects under CEQA.[24]

California Attorney General Jerry Brown has submitted formal comments to at least 13 local governments seeking analysis of climate change in CEQA documents. In April 2007 he brought a lawsuit against the County of San Bernardino, in southeastern California, the largest county (by square miles) in the contiguous 48 states with one of the fastest growing populations. The lawsuit was so controversial that critics (who feared that GHG analysis would make it harder to build new housing and other needed projects) held up passage of the state budget hoping to obtain a prohibition on CEQA climate litigation; they did obtain a limited and temporary ban on certain kinds of this litigation, and also a mandate for guidelines on climate analysis under CEQA. Specifically, the California Legislature adopted S.B. 97, which requires the state Office of Planning and Research to develop guidelines for mitigation of GHG emissions and their effects, and bars all legal actions for failure to adequately analyze the effects of GHG emissions in an environmental document, but only for projects funded under certain transportation and flood control bond acts.[25] In August 2007 that lawsuit was settled under terms that require the county to develop an inventory of GHG emissions related to land-use decisions and county operations, set emissions reduction goals, and adopt mitigation measures. At the end of a 30-month period, the county will amend its general plan, which governs growth in the county. Among the measures that the county may include in its general plan are parking spaces for high-occupancy vehicles and car-share programs; electric vehicle charging facilities; high-density developments that reduce vehicle trips and use public transit; parking limits; transportation impact fees on developments that fund public transit; standards requiring energy-efficient buildings, appliances and lighting; methane recovery at landfills; and renewable energy options.

In September 2007, Brown settled another CEQA dispute by reaching an agreement with ConocoPhillips to reduce the GHG emissions and energy consumption at an oil refinery in Contra Costa County.

To help local agencies cope with the uncertainty associated with the environmental review of climate change, a California-based professional society issued a white paper on how to analyze GHGs in CEQA documents.[26] The paper lays out several possible approaches, several of which involve an inventory of GHG emissions expected from a project, and an assessment of the project's compliance with emission reduction strategies contained in a report of the California Climate Action Team to the governor. (A more comprehensive list of strategies is being developed to help implement A.B. 32.) The white paper also discusses the consideration of offsite mitigation, such as reforestation, planting/replanting, and carbon trading. Subsequently, the California Air Pollution Control Officers Association (CAPCOA) released a detailed discussion of analysis methodologies, "CEQA and Climate Change."[27]

Discussion of climate change issues has already become routine in CEQA documents. In fact, the California Governor's Office of Planning and Research State Clearinghouse maintains a list of environmental assessment documents containing a discussion of climate change; the March 3, 2008 edition of that list has 194 entries.

King County, Washington

The Executive of King County, Washington (which includes Seattle) issued an order requiring county agencies to consider climate change in their review of projects.[28] The order provides "that climate impacts, including but not limited to those pertaining to greenhouse gases, be appropriately identified and evaluated" for every public or private project where a county department is acting as lead agency under SEPA. In this respect it goes farther than the Massachusetts rule, which applies only to projects that meet certain criteria. The county circulated a draft worksheet that project proponents can use in estimating their GHG emissions, and issued several executive orders with details on actions that county agencies must take.[29]

What to Analyze

As is apparent from the above, there is no settled method for analyzing climate change in the impact assessment of a project. Several different protocols have been circulated. Those from Massachusetts and California were discussed above. The others are:

- Canadian Environmental Assessment Agency, Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners (November 2003)
- Levett-Therivel Sustainability Consultants, Strategic Environmental Assessment and Climate Change: Guidance for Practitioners (May 2004) (designed for use in England and Wales)
- The World Resources Institute and the World Business Council for Sustainable Development have developed a GHG Protocol Initiative that includes a project activity protocol that is useful in making many of the calculations described above.[30]

These protocols differ considerably in their form and details, but they, and the other emerging technical literature on the subject, generally call for consideration of five different kinds of impacts:

1. *Direct operational impacts*: Smokestack emissions from the facility; fugitive emissions, such as methane escaping from oil and gas wells; emissions of methane and nitrous oxide from agricultural operations; methane from landfills and wastewater treatment plants; and impacts on carbon "sinks" such as forests, agricultural soils, and wetlands. A publication of the U.S. Energy Information Administration, *Documentation for Emissions of GHGs in the United States 2003*, provides factors that are useful in such analysis. The California Climate Action Registry has published a GHG reporting protocol that can be used as well.

2. *Purchased electricity*: The GHGs emitted in generating the electricity that is produced off-site and purchased by the facility. Energy modeling software is available that quantifies projected energy usage of various kinds of buildings. The total purchased electricity usage is then multiplied by an emissions factor that calculates the carbon dioxide emitted per unit of power. This will vary by region, depending on the fuel used in generating the power consumed by the facilities being analyzed. An area with mostly coal plants will have much higher emission factors than an area with mostly hydro and nuclear plants, for example. The independent system operators in some regions have published marginal emissions reports with the factors that can be used.

3. *Induced trips*: Employee, customer and vendor travel; the transport of raw materials, manufactured goods, and other freight to and from the facility. The daily vehicle miles of travel are projected, and that is multiplied by emission factors.

4. *Construction impacts*: The GHG emissions from extracting and fabricating the construction materials (such as cement, whose manufacture is energy intensive), and from the equipment at and servicing the construction site. This element is not as widely accepted as the others, and the methodologies are not as advanced.

5. *Impact of climate change on project*: How climate change affects the project, rather than (like the preceding four categories) the other way around. Among the topics here could be the effects of rising sea levels and water tables, increased flooding, greater temperature variations, water shortages, reduced snow pack, and activities needed to adapt to climate changes. Also possibly considered here would be the effect of anticipated future regulations of GHG emissions.

Role in the Impact Assessment Process

It is unlikely that a climate impact would alone trigger the need for an EIS. Most activities with major GHG emissions would already trigger the EIS requirement because of non-climate impacts (unless the projects were exempt from review for other reasons, such as being "as of right"). When an EIS is prepared, however, the five categories listed above could all be examined, and alternatives could be assessed with lower impacts. The approving agencies might then decide to select an alternative that minimizes GHG impacts, or to impose mitigation requirements to reduce such impacts if they were significant. This, of course, begs the question of what is "significant" for these purposes; no single project will by itself have a discernible impact on the global climate, but that should not excuse analysis and mitigation. Rather, thresholds might be developed, based either on absolute GHG emissions from a project or on its

excess emissions over a low-emissions baseline. An additional important policy question will be whether offset purchases or trading should be considered as acceptable mitigation.

The impact assessment process offers numerous opportunities for public participation. During the scoping process, in which interested persons may offer suggestions on the contents of the EIS, and during the hearing and public comment period on the draft EIS, comments may be submitted urging consideration of GHG impacts. After final agency action on a project, litigation may be brought.

The federal and state agencies that conduct environmental impact review already appear to have statutory authority to consider climate impacts, and thus, unless the executive branch is resisting, there is no necessity for action by Congress or, in those states with NEPA equivalent laws, by the state legislatures. To the extent that the agencies do not use the authority they have, rulemaking petitions may be an available approach. Agencies also may also consider creating incentives for GHG reduction by setting emissions thresholds or technology standards; applicants that meet the thresholds and standards might be exempt from further requirements for review of their GHG impacts.

Many of the current state and regional efforts to fight climate change are undertaken because of the federal government's refusal to adopt a regulatory program, and may become unnecessary and possibly even be preempted if such a program comes into being. Because of the considerable GHG impacts of buildings and other projects that have no federal involvement, however, state-level impact review would continue to be important even after a mandatory federal program takes effect.

Endnotes

1. N.Y. Envtl. Conserv. Law § 8-0109(2)(h) (2008); *similarly*, N.Y. Comp. Codes R. & Regs tit. 6, § 617.9(b)(5)(iii)(e) (2008).
2. N.Y. Envtl. Conserv. Law § 8-0105(6) (2008); N.Y. Comp. Codes R. & Regs tit. 6, §§ 617.2(1), 617.2(ab), 617.7(c)(1)(i) (2008).
3. *Massachusetts v. Envtl. Prot. Agency*, 127 S. Ct. 1438, 549 U.S. ___ (April 2, 2007).
4. N.Y. Dep't. of Transp., Subtask 7a: Draft Energy Analysis Guidelines for Project-Level Analysis,(November 25, 2003) (draft); Subtask 7b: Draft Greenhouse Gases (CO_2) Emissions Estimate Guidelines for Project-Level Analysis, (November 25, 2003) (draft); and Subtask 12a: Draft Energy Analysis Guidelines for TIPs and Plans (November 25, 2003) (draft).
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6. Draft Generic Environmental Impact Statement (October 11, 2007) (to be codified at N.Y.Comp. Codes R. & Regs tit. 6, § 242) *available at* http://www.dec.ny.gov/regulations/39215.html.
7. Final Generic Environmental Impact Statement (March 24, 2008), *available at* http://www3.dps.state.ny.us/pscweb/WebFileRoom.nsf/Web/02A06C847B4823058525740C005577E6/$File/266_07m0548.pdf?OpenElement.
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12. Dinah Bear, General Counsel, CEQ, Memorandum to All Federal Agency NEPA Liaisons, Draft Guidance Regarding Consideration of Global Climatic Change in Environmental Documents Prepared Pursuant to the National Environmental Policy Act (October 8, 1997).
13. *Petition Requesting that the Council on Environmental Quality Amend Its Regulations to Clarify that Climate Change Analyses be Included in Environmental Review Documents* (February 28, 2008), *available at* http://www.icta.org/doc/CEQ%20Petition%20Final%20Version%202-28-08.pdf.
14. 912 F.2d 478 (D.C. Cir. 1990), *overruled by Florida Audubon Soc. v. Bentsen*, 94 F.3d 658 (D.C. Cir. 1996).
15. *Border Power Plant Working Group v. Dep't of Energy*, 260 F. Supp. 2d 997 (S.D. Cal. 2003).
16. *Mid States Coal. for Progress v. Surface Transp. Bd.*, 345 F.3d 520 (8th Cir. 2003).
17. *Mayo Found. v. Surface Transp. Bd.*, 472 F.3d 545 (8th Cir. 2006).
18. *Friends of the Earth, Inc. v. Mosbacher*, No. C 02-04106 JSW, 2007 WL 962955 (N.D. Cal., March 20, 2007).
19. *Center for Biological Diversity v. Nat'l Highway Traffic Safety Admin.*, Nos. 06-71891, 06-72317, slip op. at 14909 (9th Cir., Nov. 15, 2007).
20. Massachusetts Executive Office of Energy and Envtl. Affairs, Greenhouse Gas Emissions Policy (April 23, 2007).
21. Mass. Gen. Laws. ch. 30, §§ 61-62H (2008).
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23. Cal. Pub. Res. Code §§ 21000 *et seq.* (West 2008).
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30. *See* The Greenhouse Gas Protocol Initiative, http://www.ghgprotocol.org/.

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Responding to the Threat of Global Climate Change

By Peter M. Iwanowicz

Mitigating the impacts of New York's warming climate represents one of the most pressing environmental challenges for the state, the nation and the world. Extensive scientific work demonstrates the need for immediate worldwide action to reduce emissions from burning fossil fuels, as well as the great benefits that will accrue if such emissions are reduced. In fact, scientists today agree that the Earth's temperature is growing warmer, that this warming is caused by burning fossil fuels, and that the climate changes from the increased temperatures threaten our resources and our way of life.

Scientists have already observed significant warming in New York's climate, due, in part, to increased concentrations of greenhouse gases (GHGs) in the atmosphere.[1] Since 1970, the Northeast United States has been warming at a rate of 0.5 degrees Fahrenheit per decade. Winter temperatures have risen even faster, at a rate of 1.3 degrees per decade from 1970 to 2000. Temperature increases in the coastal areas of the state have been more dramatic. The observed warming has resulted in the following impacts to the Northeast climate:[2]

- More frequent extreme-heat days (maximum temperatures greater than 90°F);
- A longer growing season;
- Earlier leaf and bloom dates for plants;
- Shifts in the mating cycles of frogs to earlier in the year;
- Earlier migration of Atlantic salmon in northeastern rivers;
- An increase in heavy rainfall events;
- Earlier breakup of winter ice on lakes and rivers;
- Earlier spring snowmelt resulting in higher and earlier spring river flows;
- Less precipitation falling as snow and more as rain;
- Rising sea surface temperatures and sea level; and
- Reduced snow pack and increased snow density.

In summary, scientists have concluded that the New York climate has already begun migrating south, gradually taking on the characteristics of the climate formerly found in the states south of New York.[3]

In addition to examining the observational changes that have already occurred in the New York climate, scientists have invested considerable effort in attempting to identify the future trends for the Northeast climate. The extent of the environmental threat of future regional climate change depends largely on whether atmospheric GHG concentrations and emissions of CO_2 and other GHGs are reduced.

In order to estimate the effect of climate change on the region, a group of 40 independent scientists is cooperating in a study to examine climate changes under two future CO_2 emission scenarios. The first scenario represents a world with fossil fuel–intensive economic growth resulting in atmospheric CO_2 concentrations of more than triple pre-industrial levels by 2100 (the Higher Emissions Scenario). The second scenario assumes a world with high economic growth with a shift to less fossil fuel–intensive industries and the introduction of clean and resource efficient technologies (the Lower Emissions Scenario). Under the Lower Emissions Scenario, atmospheric CO_2 concentrations approximately double from pre-industrial levels by 2100.

Under the Higher Emissions Scenario, where the burning of fossil fuels remains unabated, scientific projections for the Northeast climate show:

- By the end of the century, winters are expected to warm by 8 to 12°F and summers by 6 to 14°F.
- An increase in the number of extreme heat days. In New York City, for example, scientists have estimated that we can expect the number of 90°F days to increase from an average of between 15 and 20 days per year from 1961 to 1990, to between 35 and 50 days per year from 2040 to 2069. Similar relative increases are projected for Buffalo, New York.
- Winter precipitation is projected to increasingly fall as rain rather than snow, and there will be increased risk of winter flooding.
- By the end of the century, the southern and western parts of the Northeast could experience as few as 5 to 10 snow-covered days, compared with 10 to 45 days historically.
- The frequency of heavy rainfall is projected to increase across the Northeast. In addition, extreme storms are expected to travel farther up the East Coast and affect the Northeast.
- Rising temperatures will increase the evaporation rates and reduce soil moisture in New York and the Northeast. This evaporation may lead to increases in the frequency of short-term droughts and extension of summer low-flow periods.

- Rising winter and spring temperatures mean earlier snow melt and earlier high spring flows.
- Northeastern sea surface temperatures are projected to rise by 8°F.
- Northeastern sea levels are projected to continue to rise between 8 and 33 inches by the end of the century.

It is clear that potential future climate changes would have adverse impacts on New York's environment and human health. However, the scientific literature confirms that reducing emissions of GHGs like CO_2 will help to mitigate the potential impacts of climate change. It is also clear that the New York State Department of Environmental Conservation (DEC or the "Department") has the authority to promulgate regulations to control greenhouse gas emissions.

The State Legislature has declared, in the Environmental Conservation Law (ECL), section 19-0103 that it is the policy of New York State to maintain a reasonable degree of purity of air resources.[4] In carrying out such policy, the Department is required to balance public health and welfare, the industrial development of the state, propagation and protection of flora and fauna, and the protection of personal property and other resources.[5] To that end, the Department is required to use all available practical and reasonable methods to prevent and control air pollution in the state.

ECL section 19-0105 declares that it is the purpose of article 19 of the ECL to safeguard the air resources of New York State under a program which is consistent with the policy expressed in section 19-0103 and in accordance with other provisions of article 19.[6]

ECL section 19-0107 defines the terms "air contaminant" and "air pollution." "Air contaminant" is defined as "a dust, fume, gas, mist, odor, smoke, vapor, pollen, noise or any combination thereof." "Air pollution" is defined as "the presence in the outdoor atmosphere of one or more air contaminants in quantities, of characteristics and of a duration which are injurious to human, plant or animal life or to property or which unreasonably interfere with the comfortable enjoyment of life and property throughout the state or throughout such areas of the state as shall be affected thereby."[7] CO_2 and other GHGs fit well within these definitions because they are gases that are present in the outdoor atmosphere in quantities that engender and/or provoke climate change, which is injurious to life and property in New York State.

Recently, the United States Supreme Court in *Massachusetts v. USEPA* ruled that the United States Environmental Protection Agency (EPA) has the authority to regulate CO_2 and other GHGs under the Clean Air Act's (CAA) definition of "air pollutant."[8] Under the CAA "air pollutant" is defined as "any air pollutant agent or combination of agents, including any physical, chemical, biological, radioactive (including source material, special nuclear material, and by-product material) substance or matter which is emitted into or otherwise enters the ambient air."[9] The Supreme Court noted that the harms associated with climate change are serious and well recognized and the EPA does not dispute the existence of a causal connection between man-made GHG emissions and global climate change.[10] The Supreme Court further held that the EPA must regulate CO_2 and other GHGs under section 202 of the CAA, if the EPA determines that CO_2 and other GHGs contribute to climate change.[11]

Under ECL section 19-0301 the Department has the power to promulgate regulations for preventing, controlling or prohibiting air pollution and is directed to include in such regulations provisions prescribing the degree of air pollution that may be permitted and the extent to which air contaminants may be emitted to the air by any source in any area of the state.

This statutory provision clearly confers upon the department the authority to regulate the emission of greenhouse gases, and the Department is moving ahead to exercise this authority.

In response to the threat of climate change, the Office of Climate Change was created in 2007 under the authority provided by the ECL to ensure effective responses to climate change in New York State. Through the efficient use of public and private resources, the Office aims to reduce the severity of climate change, and to increase New Yorkers' success in anticipating and adapting to changes that cannot be avoided.

The office has two Bureaus: Science and Analysis, and Programs and Partnerships. The Science and Analysis Bureau reviews and interprets scientific information on global and local climate change, provides reliable information to support policy and regulation, and promotes technical solutions to reduce carbon. The Programs and Partnerships Bureau works to inform, assist and empower, so that state agencies, local governments, NGOs, institutions, businesses and individuals will respond to climate change by reducing carbon emissions and adapting successfully to unavoidable impacts.

Staff from the office is participating in projects of statewide significance, including the Climate Registry, related regulations, and climate change education. Currently, the most important of these initiatives is the Regional Greenhouse Gas Initiative (RGGI).

On December 20, 2005 the governors of 10 northeastern and mid-Atlantic states entered into a Memorandum of Understanding (MOU) under which they committed to cap and then reduce the amount of CO_2 that power plants are allowed to emit. Under the Model Rule issued in conjunction with the MOU (which is intended to serve as a template for each state's regulations), CO_2 emissions will be capped at current levels for the first six years of the program. In 2015 and the subsequent three years, the cap

will be reduced by 2.5 percent each year, for a total cut of 10 percent when RGGI is fully implemented. By that time, emissions are expected to be 16 percent lower than they would have been without the program. Burning fossil fuel for electric generation is a major contributor of CO_2. Because New York's electric power plants represent approximately one-quarter of all CO_2 emissions in the state, reducing emissions from power plants is a necessary part of the solution to climate change. RGGI uses a market-based approach to reducing CO_2 emissions called a "cap-and-trade program." Under this program, sources of CO_2 must hold sufficient CO_2 allowances to cover their total emissions. Allowances may be obtained through purchase or trade.

Under the MOU, states participating in RGGI first agreed on a cap (the regional CO_2 emissions budget) amounting to approximately 188 million tons of CO_2. That number represents the total amount of CO_2 that power plants in the region were expected to emit in 2009. Beginning in 2015, this cap will be reduced by 2.5 percent each year, for a total reduction of 10 percent by 2019. This phased approach, with initially modest reductions, will provide predictable market signals and regulatory certainty. Electricity generators will be able to plan for and invest in lower-carbon alternatives and avoid dramatic electricity price impacts.

Based primarily on previous emission histories, the RGGI states negotiated for shares of the total CO_2 emissions budget. As a result of this negotiation, New York received 64.3 million tons as its CO_2 emissions budget.

Under the Model Rule, an "allowance" is permission to emit one ton of CO_2 (accordingly, New York's share of the emissions budget will yield 64.3 million allowances). Instead of awarding these allowances directly to electric generators free of cost, the RGGI states committed in the MOU to sell a minimum of 25 percent of their allowances, using the proceeds for consumer benefit and strategic energy projects. As the program has evolved, the RGGI states have decided to sell most of their allowances and provide the revenues for consumer benefit and strategic energy purposes.

The RGGI states will sell their emissions allowances through auctions. After each auction, generators can buy and sell allowances on a secondary market. Sources that obtain more allowances than they need—or reduce their CO_2 emissions—will be able to sell the excess allowances, and sources needing additional allowances will be able to obtain them.

Proceeds from the sale of allowances will fund state programs that promote energy efficiency and projects for clean renewable energy, such as solar and wind power. Selling allowances will enhance the RGGI program's effectiveness at reducing greenhouse gases in the atmosphere.

An "offset," under the Model Rule, is a greenhouse gas emissions reduction or sequestration project at a source outside the electricity sector, which power companies may use to help meet their compliance obligations under RGGI's cap-and-trade program. Examples of offsets include landfill gas recovery and agricultural methane recapture, which reduce methane (a greenhouse gas even more potent than CO_2). Power companies may use approved offsets to comply with up to 3.3 percent of their emissions limitations. Offsets provide significant environmental and/or economic benefits for the generators, as well as flexibility for regulated sources.

Responsibility for implementing RGGI will be shared by three departments of New York State government: the Department of Public Service, DEC, and the Energy Research and Development Authority (NYSERDA). DEC and NYSERDA are currently engaged in rulemaking to implement RGGI.

DEC will establish New York's CO_2 Budget Trading Program through a new rule, title 6, part 242 of the N.Y. Codes, Rules and Regulations (N.Y.C.R.R.), and revisions to an existing rule, title 6, part 200. Under the new regulations, air facility permits will be amended to require fossil-fuel power plants larger than 25 MW (plants this size are responsible for approximately 95 percent of electric generation CO_2 emissions) to meet the CO_2 budget emissions limits. Monitoring plans that define CO_2 emissions and net energy output monitoring procedures will be incorporated into sources' operating permits.

New York's regulations will provide that almost 100 percent of the emissions allowances will be sold through auction. NYSERDA, which currently administers other complementary energy efficiency and clean energy technology programs, will administer New York's auction process. NYSERDA has proposed a new rule, title 21, part 507 of the N.Y.C.R.R. (which establishes the auction and specifies features for subsequent detailed design, and also sets up a dedicated account to receive the sale proceeds).

The NYSERDA rule, currently in draft form, stipulates that the auctions must be designed to achieve fully transparent and efficient pricing of allowances; promote a fluid allowance market (by making entry and trading as easy and low-cost as possible); facilitate participation by all eligible entities; safeguard against market manipulation; be held as frequently as is needed to achieve design objectives; avoid interference with existing allowance markets; align well with wholesale energy and capacity markets; and not act as a barrier to efficient investment in relatively clean existing or new electricity generating sources.

In other pollution reduction programs, power companies are given the allowances without charge and the companies then pass through the "market value" of these allowances in their bills to consumers. This means that the cost of electricity to consumers will include as much of the cost of allowances as the law permits generators to add, whether those allowances are purchased or obtained free of charge. Selling the allowances ensures that their proceeds

will benefit the public by funding projects to conserve energy, reduce CO_2 emissions, and develop clean technologies.

The decision to sell allowances takes into account the European Union's experience. The E.U. gave away 90 percent of its allowances, seeking to ease industry's compliance cost. However, that mechanism resulted in companies enjoying a windfall; power costs to customers increased to cover the cost of the allowances, but generators did not pay for them. In the U.K. alone, free allowances amounted to a $1 billion grant to the power industry.

Under RGGI, the cost of allowances, like the cost of fuel, will be built into generators' electricity prices. However, modeling analysis reveals that price impacts will be negligible. Projections from economic modeling show RGGI raising wholesale electricity prices by about 1.6 percent (78 cents per month for a typical residential customer) in 2015 and 2.4 percent ($1.13 per month for a typical residential customer) in 2021.

Economic models further project that the price for allowances will be $2/ton in 2009. These projections are considered to be sound, but the proposed state regulations do include some mechanisms to mitigate the risk of high prices for allowances, such as expanding the use of offsets, adjusting compliance periods and holding frequent auctions. There is also a mechanism for price relief that expands offsets if the price rises to $7/ton.

A regional stakeholder group was organized in connection with the implementation of RGGI, which included energy industry representatives and non-governmental organizations. The group met 14 times between 2003 and 2007; during that time, New York held about the same number of state stakeholder meetings. Public comment was solicited and reviewed on a variety of written documents, including draft reports of the RGGI working groups and the Model Rule. New York has also invited comments on an advance draft of the proposed regulations, and the draft regulations are currently undergoing public comment.

Beyond RGGI, the state is taking other actions needed to reduce greenhouse gas emissions and mitigate climate change. It set an ambitious 2015 goal of reducing electricity use by 15 percent through improved efficiency, along with greater use of clean and renewable energy sources. Other elements of the state's program include promoting the development of renewable energy sources through the State Task Force on Renewable Energy and the State Renewable Portfolio Standard and adopting California's strict vehicle emission standards to reduce passenger vehicle emissions of greenhouse gases by 30 percent.

As the state moves ahead to regulate greenhouse gas emissions, there will be increasing pressure to consider the potential impacts from greenhouse gases in the State Environmental Quality Review Act (SEQRA)[12] process. In fact, DEC has been sued for, among other things, failure to consider the impact of GHG emissions at the High Acres landfill in the Town of Perinton.[13]

Whether or not petitioners will be successful in requiring the consideration of climate change related impacts under SEQRA remains up in the air. In California, lawsuits surrounding the California Environmental Quality Act (CEQA) have not clarified the issue. Early decisions found that petitioners had not demonstrated sufficient evidence of a link between climate change and a specific project. However, at least one ruling also found that as new facts become known, the effects of climate change will have to be factored into the analysis of projects under CEQA. Currently several lawsuits are pending under CEQA, and the California legislature has recently passed a law requiring the Governor's office to issue CEQA guidance on climate change in 2009.

To the extent that lead agencies want to do so, they may exercise their existing authority to require the consideration of greenhouse gas emissions and the impact they will have in the context of SEQRA. It remains to be seen whether the courts will require that such analysis be conducted.

The things that are clear are that the threat of climate change is real and the state is responding to it. The Office of Climate Change welcomes your comments and questions.

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Endnotes

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5. *Id.*
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11. *Id.* at 1462-63.
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Trends in Climate in Northern New York and Western Vermont

By Kathie Dello

I. Abstract/Summary

Global surface air temperature has risen about 0.6ºC over the past century and temperatures are projected to continue rising through the 21st century.[1] Understanding the effects of climate change on the northern New York and western Vermont region is important as the area has a significant recreation and tourism industry that is heavily influenced by weather, is home to many unique ecosystems, and includes Adirondack State Park—the largest publicly protected area in the contiguous United States.[2]

This article reports the results of a trend analysis performed on annual, monthly, and seasonal average, maximum and minimum daily air temperature, as well as total annual, monthly, and seasonal precipitation.[3] Extreme precipitation at the 24-hour time scale was also examined.

"Understanding the effects of climate change on the northern New York and western Vermont region is important as the area has a significant recreation and tourism industry that is heavily influenced by weather, is home to many unique ecosystems, and includes Adirondack State Park . . ."

A total of 22 temperature, 14 precipitation, and 9 extreme precipitation sites were selected for analysis and the Mann-Kendall test was applied to determine 1950–2005 trends.[4] As discussed in some detail below, temperatures generally increased throughout the region; minimum daily temperature showed the largest increases.[5] The entire region experienced a rise in annual daily minimum temperature of 0.76ºC through the end of the 20th century. Summer annual minimum and daily air temperatures increased significantly for the entire area with p-values of < 0.01 and 0.02, respectively. Total annual precipitation increased at all sites; those at higher latitudes in general had a greater increase. Minimum, average, and maximum daily air temperatures have risen fairly steadily and significantly throughout the region from 1970 to 2005, and precipitation has increased by 106 mm in the latter half of the 20th century. Precipitation increased during June through October at almost every analysis site. Trends were also noted in maximum 24-hour precipitation, with the greatest increase at the stations with the highest latitude in the study area. These changes are likely to continue into the 21st century.[6]

II. Text

1. Introduction

1.1 Climate Change in the 20th Century

The observed 0.6ºC increase in the globally averaged surface air temperature in the 20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations.[7] The most abundant greenhouse gas in the atmosphere is carbon dioxide (CO_2); atmospheric carbon dioxide concentrations are currently at about 377 parts per million (ppm).[8] This value is almost 100 ppm more than the pre-industrial (1750) atmospheric carbon dioxide concentration of 280 ppm.[9] The current atmospheric carbon dioxide concentration has not been exceeded in the past 420,000 years and likely not during the past 20 million years.[10] The rate at which CO_2 has been increasing in the atmosphere is unique to at least the past 20,000 years.[11] In the past 20 years, fossil fuel burning accounts for about 75% of CO_2 emissions.[12] The remainder is attributed to changes in land use, predominately deforestation.[13] Collectively, the Northeast states are the world's seventh largest source of carbon dioxide emissions.[14] Atmospheric concentrations of two other greenhouse gases, methane (CH_4) and nitrous oxide (N_2O) have also both increased from their pre-industrial concentrations.[15] Increasing concentrations of atmospheric methane are very likely due to anthropogenic activities, primarily agriculture and fossil fuel use.[16] Human activity accounts for more than a third of nitrous oxide emissions, mostly due to agriculture.[17] Natural factors also account for changes in climate including solar irradiance and the presence of atmospheric aerosols that arise primarily from volcanic activity.[18] Model runs and observations over the last 1,000 years show that this forcing accounts for only a small portion of the 20th century warming.[19]

Most of the warming experienced over the last century occurred over the periods 1910 to 1945 and 1976 to 2000.[20] It is very likely that the 1990s were the warmest decade, with 1998 being the warmest year in the instrumental record. This warming is reflected in an increase in average atmospheric water vapor content and average sea surface temperatures over the latter half of the 20th century.[21] Globally averaged trends in precipitation have not exhibited trends of a magnitude similar to that of globally

averaged surface air temperature. Overall, records show that global land precipitation has increased by only about 9 mm over the 20th century.[22] The observed small change in global land precipitation can be attributed to the averaging of increases at higher latitudes and decreases at lower latitudes.[23] This latitudinal gradient of precipitation in the last century can be attributed to anthropogenic forcing. The changes exhibited are too large to be solely related to variability.[24]

1.1.1 Climate Change in the United States

Both temperature and precipitation trends for a majority of the 20th century in the United States are monotonic, but increasing. While these trends most certainly vary regionally, an observed, non-linear trend in mean temperature has been detected in the United States in the 20th century.[25] This trend is fairly consistent with the overall global trend over the same time period. The overall record exhibits a rise in temperature during the 1930s, a cooling in the 1950s to 1970s, and a steady increase through the end of the century.[26] Precipitation trends in the Northern Hemisphere are consistent with the observation that precipitation has increased more at higher latitudes. There has likely been an increase in precipitation in the mid-latitude Northern Hemisphere in the 20th century. Observed precipitation has increased about 1% per decade in the last century.[27] Across the contiguous United States, precipitation has mostly remained above the entire 20th century mean. This trend is powered by an increase in autumn precipitation in the latter half of the previous century.[28] In the contiguous United States, there has been an increase of about 10% in precipitation throughout most of the 20th century. Spring and autumn show the largest amplification, followed by summer and a slight rise in winter. In the upper-mid to upper latitudes of the Northern Hemisphere (40–70N), 50–55% of the 62 mm rise in precipitation in the latter 75 years of the previous century can be attributed to man-made activities.[29]

Extreme temperature and precipitation events are the driving force behind the noted trends in climate in the United States. These events have proven to be among the most problematic effects of climatic change on regions and municipalities. Consecutive days of extreme heat and short bursts of heavy precipitation have resulted in the loss of life and property across the country and are very likely to continue into the 21st century.[30] The observed steady increase in precipitation in the United States is driven by extreme one-day precipitation events.[31] The percentage of the country that has been affected by extreme (50.8 mm) one-day precipitation events increased from 9% in the early part of the century to around 11% in the latter part.[32] Heavy precipitation events are consistent with warming and observed increases in water vapor globally. Increases in heavy precipitation events are very likely to continue into the 21st century, over many areas worldwide.[33]

1.1.2 Climate Change in the Northeastern United States

The observed warming in the northeastern United States in the 20th century is 1.1ºC, almost twice that of the global increase.[34] The last three decades of the century show the most pronounced warming trend; the 1990s are the warmest decade on record, which is consistent with global observations.[35] Since 1970, the Northeast has been experiencing a warming of about 0.27ºC per decade. Winter temperatures have risen the fastest, at a rate of 0.72ºC per decade.[36] In New York, Degaetano and Allen (2002) observed (significant at a 95% confidence level) extreme warm minimum daily air temperature exceedances that are above the daily 95th percentile, in the years 1960–1996. Precipitation has increased in the Northeast about 5%–10% during the 20th century.[37] The 20th century precipitation record is dominated by a multi-year drought in the 1960s, perhaps the longest since European settlement.[38] The warming across the northeastern United States since 1970 has correlated with a plethora of climate-related changes such as a reduced snowpack and increased snow density, less winter precipitation falling as snow and more as rain, and earlier spring snowmelt resulting in earlier peak river flows.[39]

An attempt at understanding and predicting the impacts of global climate change at the regional level is crucial for planning, mitigation and adaptation. The northeastern United States as a whole has been examined extensively in a number of climate change and impacts studies using available meteorological data. It is especially relevant to study instrument-based climate change in regions such as the Northeast, as global climate models do not provide adequate resolution to predict regional climate change at a small scale, and do not account for regional land use change.[40] Due to variability in elevation and sources of moisture in a region, it is prudent to study regional climate change, even at small spatial scales. Few studies have focused exclusively on the trends in climate in the northern New York or Adirondack Region. Wake et al., studied Northeast climate change for the 20th century, but did not include many of the Adirondack sites in their analysis.[41] The Consortium for Atlantic Regional Assessment (CARA) examined six sites in Adirondack Park and concluded that annual temperatures have increased by about 1ºC over the last century and winter temperatures have increased 2ºC in the same time period.[42]

2. Study Area

The areas surrounding Adirondack Park, the northern New York and western Vermont region, are also home to an abundance of natural resources and ecosystems that are of historical, natural, societal, and economic importance. Recreation and tourism are an important part of the economy and vitality of this region, and warmer temperatures could be detrimental to both. The New England

Regional Assessment (2001) found that winters in New England since 1996 have been sufficiently mild to affect the financial bottom line of the ski industry.[43] Increasing awareness about climate change is crucial so that society can develop appropriate survival and adaptation techniques when faced with heat waves, flash floods, drought and other natural disasters. These events have occurred at an alarmingly increasing rate and are projected to continue on this upward trajectory as greenhouse gas emissions continue to rise.[44] In addition, society has made itself more vulnerable to natural disaster as evidenced by increasing populations in areas that are prone to extreme weather.[45] An understanding of how the climate has changed in the latter half of the century is important for prediction of future climatic change. This study will examine trends in temperature and precipitation using meteorological data collected over the last half of the 20th century and the first five years of the 21st century.

2.1 Study Area

The study area encompasses all land within fifty kilometers of Adirondack Park in the United States. This includes all or portions of seventeen counties in New York State and five counties in Vermont. The topography of the area varies greatly, from the peaks of the Adirondack Mountains to the low-lying valleys adjacent to Lake Ontario and Lake Champlain and the Hudson, Mohawk, and St. Lawrence Rivers. The region is rich in water resources; four major drainage basins are located within the region. They are the Black River, Hudson River, Lake Champlain, and St. Lawrence River drainage basins; all four eventually flow into to the Atlantic Ocean. This area is largely rural in nature, but there are three urban centers with a population over 50,000. They are the cities of Albany, New York; Utica, New York; and Burlington, Vermont. These cities fall on the southeastern, southwestern and northeastern edges of the study area respectively.

2.1.1 Adirondack Park

The centerpiece of the study region, the Adirondack Park, is the largest publicly protected area in the contiguous 48 states and encompasses about 21,373 km^2 (6 million acres) of land. The counties of Essex and Hamilton are completely within the park boundary, along with portions of St. Lawrence, Franklin, Clinton, Warren, Washington, Saratoga, Fulton, Herkimer, Oneida, and Lewis.[46] Forty-six Adirondack peaks, named the "High Peaks," rise to an elevation of 1,219 m or greater. The highest point in New York State, Mt. Marcy, is located in the region at an elevation of 1629 m.[47] The region is mainly composed of metamorphic rock over a billion years old and is a product of millions of years of uplifting and erosion. In the last 1.5 million years, the advancing and retreating of the glacial ice sheets carved the region that was once as high as the Himalayas. Soils are typically thin, sandy, and relatively infertile and have developed since the last glacial retreat 10,000 years ago. The Forest Preserve includes 10,035 km^2 of land owned by the State of New York[48] The remaining land is typically used for open space recreation, agriculture, and forestry. The region is predominantly rural with a population of about 130,000 in 105 towns and villages.[49]

2.2 Climate

The prevailing climate in the Northeast United States is broadly classified as humid continental, but there is small-scale variability across the region. Variations in topography, latitude and proximity to significant bodies of water create significant and differing effects on the climate in this small area.[50] These regional variations in climate result in seven distinct United States Climate Divisions that encompass the study area. The lowlands are covered by the Hudson Valley, Mohawk Valley, Great Lakes, St. Lawrence Valley, Champlain Valley, and western Vermont Climate Divisions. The Northern Plateau Climate Division includes the highlands of the Adirondack Mountains. The average temperature for the entire region (1950–2005) based on data from 22 United States Historical Climatology Network (USHCN) stations is 6.33°C, and ranges from 4.85°C in the Northern Plateau to 8.18°C in the Hudson Valley.

The Northern Plateau has a colder climate than that of surrounding Climate Divisions; both summers and winters alike are considerably so. Winter in the Northern Plateau produces 35 to 45 days with temperatures below -17.78°C. In contrast, the upper Hudson Valley division experiences such temperatures only 15–25 days per winter.[51] Moisture sources for this region are primarily the Atlantic Ocean and the Gulf of Mexico, though the Great Lakes also contribute. Locations on the southeastern side of the area can experience Nor'easter snow storms, while locations directly to the east of Lake Ontario, primarily the Tug Hill Plateau are privy to lake-effect snow. As a result of the topography of the area, many places are prone to large amounts of precipitation as a result of orographic lifting. Across the study area, precipitation tends to vary annually from about 760 mm around Lake Champlain to 1,260 mm in the western Adirondacks.[52]

3. Data Sources and Site Selection

3.1 Data Sources

Sites were selected based on two criteria from the United States Historical Climatology Network dataset. The United States Climate Division Dataset (USCDD) has been utilized in many previous climate change studies, as it is robust. However, in recent years, use of the USHCN data has been encouraged over the USCDD. The USHCN is a high-quality moderate sized network of stations spanning the contiguous United States. These sites, a subset

of the USCDD sites, have been corrected for changes in measurement techniques, station location changes, and urban heat island effects. Data from these sites consist of basic meteorological data and have been developed by the National Oceanic and Atmospheric Administration (NOAA) for use in climate change studies and analysis of climate in the United States.[53] Furthermore, the USCDD is prone to false trends in temperature and precipitation. These data are not always clearly documented; changes in station location and measurement technique are sometimes not described in the dataset. These changes have been shown to bias trend results.[54] For these reasons recent studies of climate change employ meteorological data from USHCN stations in lieu of similar data from the USCDD.

This study uses monthly data from the USHCN Serial Temperature and Precipitation Data package, released in early 2007.[55] The monthly data were selected over the daily data because the monthly dataset lends itself well to monthly and annual temperature and precipitation trend analysis. This is due to the number of adjustments made to the data to assure consistency across stations. The temperature data are edited to account for outliers more than three standard deviations from the period of record mean, time of observation bias, Maximum/Minimum Temperature System (MMTS) bias, station moves/changes bias, and lastly, the data are adjusted for urbanization. The precipitation data (liquid equivalent) undergo the same alterations, except for the urban heat adjustment.[56] These corrections produce a consistent and complete dataset that can be used with confidence in regional studies. For the maximum 24-hour precipitation analyses, raw daily data from the USHCN Daily Temperature, Precipitation and Snow Data were gathered. Raw daily data had to meet initial completeness criteria to ensure that missing data are not significantly biased.[57]

3.2 Site Selection

For inclusion in this study, the sites had to meet a specific set of criteria. At the onset of this project, only the Adirondack Park area was intended for study. Upon examining regional data however, I discovered that increasing the area to within 50 km of the park boundary (within the United States) increased the number of possible stations from six to twenty-two. This provides for a more complete and detailed analysis of climate change in the region. From these twenty-two sites, a uniform period of record was desired to ensure consistency across the sites. Many of the sites date back to 1948; the airport sites (Albany and Burlington) extend back to the 19th century. All twenty-two of the stations have a period of record beginning in at least January 1950 and continuing through December 2005. This provided 56 years of data, sufficient for long-term trend analysis. To reduce bias and to assure that the data are as complete as possible, the station was eliminated from consideration if three consecutive months or more within one year were missing from the data. For 24-hour maximum precipitation analyses, the raw daily precipitation record had to be at least 98% complete for the 56-year time period. An attempt at completing missing values to qualify more stations for precipitation analysis using multivariate regression was attempted, but stations were not highly correlated (low r-squared values) with one another. Nine precipitation stations were considered complete enough for analysis at the 24-hour time scale (Table 1). All of the daily precipitation sites were also included in the monthly analysis, with the exception of Lowville and Canton. These stations had sufficient raw daily precipitation values available, but the monthly-corrected totals for these stations were incomplete. After evaluating the data according to the inclusion criteria above, twenty-two temperature, fourteen precipitation, and nine 24-hour maximum precipitation stations were selected for analysis. Spatially, these stations are spread out well across the Adirondack study region, and represent seven of the United States Climate Divisions.

Table 1—
USHCN Climate Station Location and Description

Station Name	Latitude	Longitude	Elevation (m)	Data
Albany Airport	42.76	-73.80	84	T, P, M
Burlington Apt (VT)	44.47	-73.16	101	T, P, M
Canton 4SE	44.57	-75.12	134	T, M
Chasm Falls	44.76	-74.22	323	T
Chazy	44.89	-73.44	52	T
Cornwall (VT)	43.96	-73.22	149	T
Dannemora	44.72	-73.72	408	T, P, M
Gloversville	43.05	-74.35	247	T, P
Indian Lake 2SW	43.76	-74.29	506	T, M
Lake Placid 2S	44.26	-73.99	591	T, P
Lawrenceville	44.76	-74.66	152	T, P, M
Little Falls City Reservoir	43.07	-74.87	274	T, P
Lowville	43.80	-75.49	262	T, M
Ogdensburg 4NE	44.74	-75.44	85	T, P
Plattsburgh AFB	44.66	-73.47	50	T
Saratoga Springs	43.03	-73.82	94	T
Stillwater Reservoir	43.89	-75.05	512	T, P
Troy Dam	42.75	-73.69	7	T, P
Tupper Lake Sunmount	44.24	-74.44	512	T, P
Utica	43.08	-75.20	177	T
Wanakena Ranger School	44.16	-74.91	460	T, P, M
Watertown	43.97	-75.87	151	T, P, M

T: Monthly Temperature Data Available; P: Monthly Precipitation Data Available; M: 24-hour Maximum Precipitation Data (Daily) Available

4. Methods

4.1 Temperature

Upon gathering the data, monthly air temperature data were averaged to obtain an annual temperature value. In addition, the monthly air temperature data were averaged across seasons to obtain a seasonal value. For purposes of this study, seasons were defined as follows: winter: December of the previous year, January and February; spring: March, April and May; summer: June, July, August; fall: September, October, November. The annual air temperature values resulting from the averaging of monthly values were then averaged spatially. Within the boundaries of the seven climate divisions and the entire study area, annual air temperature was averaged to produce a regional value. All of the study sites were averaged together to create a value for the study area. I performed trend analyses using all 22 stations on monthly, seasonal, and annual data from 1950–2005, and monthly and annual data from 1970–2005. Slopes for all analyses were calculated in terms of change per 50 years and 30 years, respectively, to coincide with the end of the 20th century.

4.2 Precipitation

Precipitation data were treated in a similar manner. Monthly precipitation totals were summed across all twelve months to obtain an annual precipitation total. Seasonal precipitation totals were obtained by adding the precipitation totals for the appropriate months. Annual precipitation was not studied at the regional/climate division level, because there are significantly fewer precipitation sites than temperature sites in this study. Trend analyses were performed on monthly, seasonal, and annual data using the designated 14 precipitation stations and on daily data using a subset of 9 stations for the years 1950–2005. Only annual precipitation data were analyzed for the period of 1970–2005. Similar to temperature, slopes were calculated in terms of change per 50 years and 30 years, to align with the end of the 20th century.

Raw data at the daily time step were used to examine trends in 24-hour maximum or extreme precipitation. The data were ranked from 1 to n for each year. A rank of 1 was assigned to the largest recorded 24-hour precipitation value for the time period, and n was assigned to the smallest. For lack of hourly data, and a standard method of studying and determining precipitation intensity, an analysis method derived from a study on daily minimum temperatures by Bonsal et al. (2001) was used.[58] An extreme precipitation event in this study is defined as a 24-hour precipitation total equal to or greater than the 90th percentile value of all days with measurable precipitation. An event is considered to be all measured precipitation that fell within that day. The 90th percentile value of all days with precipitation was determined separately for each station, and not as a regional value, because precipitation tends to have high spatial variability due to topography and location. All daily precipitation amounts that exceeded the 90th percentile value for each station were tallied by year and plotted, and the Mann-Kendall test for trend was applied to the results. The same raw data were ranked in a similar manner, from 1 to n, in seven eight-year increments starting with 1950 and ending with 2005. An attempt was made to categorize the data by decade, but this would have left the years 2000–2005 with half as much data as the first five categories. A procedure similar to the hydrological procedure of flow duration analysis was applied to the data. To adapt this to daily precipitation data, the ranked data in each eight-year span were assigned a percent exceedance value. Dividing the rank by the number of days of measurable precipitation in the time period and multiplying by 100 yielded the percent exceedance values. The data were plotted on a curve for each of the eight-year increments. Percent exceedance is presented on a logarithmic scale and daily precipitation amount on a normal scale. This technique was applied to daily precipitation data, to indicate the number of times a daily precipitation value was equaled or exceeded, providing a graphic representation of changes in precipitation amounts and frequencies throughout the study period.

4.3 Statistical Methods

The Mann-Kendall test for trend was applied to temperature and precipitation data.[59] This non-parametric test for temporal trend is based on and performs well on non-normal data with extremes and its use has been advocated in past regional climate studies of a similar nature in New York as it is robust.[60] A p-value of 0.10 was used to assess statistical significance, and was maintained throughout the entire study. The Sen Slope, the median of all possible pairwise slopes, was applied to the Mann-Kendall results to obtain the slope of each trend.[61] Sen Slopes were most often multiplied by 50 to get the change per 50 years in temperature and precipitation analyses. Despite having 56 years of data, this was done for comparison with studies that have evaluated the entire 20th century. In addition, anomaly plots were generated for the same parameters by comparing annual average values against the 56-year regional average to obtain the departure from normal.

5. Results

Trend results are presented for yearly, seasonal and monthly average, minimum and maximum air temperature and precipitation. To maintain consistency with previous studies for ease in comparison, trends are presented through the end of the 20th century, in terms of median change per 50 years. By understanding that changes in annual precipitation are largely driven by extreme events, analyses of sites with sufficient available daily raw precipitation data will be expressed in two forms. The first will be done by using daily data against the entire 56-year period; and the second, using daily data in seven eight-year increments. Tables 2 and 3 list the changes in temperature and precipitation over 50 years at each site, as well as for all sites in the study region.

5.1 Annual Air Temperature, 1950–2005

Changes in temperature are described by site and for the entire region both annually (Table 1) and seasonally.

Table 2—
Changes in Annual Temperature at USHCN Sites

USHCN Station	Change per 50 years (°C)		
	Min. Temp.	Avg. Temp.	Max. Temp.
Albany Airport	1.20*	0.30	-0.22
Burlington Apt (VT)	0.09	0.66*	0.78*
Canton 4SE	0.45	0.38	0.39*
Chasm Falls	-0.68*	-1.05*	-1.07*
Chazy	1.59*	1.06*	0.74*
Cornwall (VT)	0.36	0.18	0.23
Dannemora	-0.30	-0.31	-0.32
Gloversville	0.52*	0.28	0.33
Indian Lake 2SW	0.84*	0.89*	-0.23
Lake Placid 2S	0.78*	0.96*	0.83*
Lawrenceville	0.77*	0.73*	0.91*
Little Falls City Reservoir	0.66*	0.83*	0.93*
Lowville	-0.10	-0.09	-0.12
Ogdensburg 4NE	-0.45	-0.14	0.27
Plattsburgh AFB	0.73*	0.57*	0.48
Saratoga Springs	1.08*	0.91*	0.56*
Stillwater Reservoir	0.49	0.47	-0.54*
Troy Dam	0.76*	0.67*	1.29*
Tupper Lake Sunmount	-0.00	0.98*	1.00
Utica	0.74*	0.97*	0.89*
Wanakena Ranger School	0.79*	1.40*	0.85*
Watertown	-0.01	1.04*	1.15*
ALL SITES	0.76	0.42	0.39

(* denotes significant at $p \leq 0.1$)

Annual minimum temperatures cooled through the mid 1960s, rose through 1990, after which there was a slight cooling until the mid 1990s. Minimum temperatures began to rise through 2000, but there has been a cooling in the first five years of the 21st century. Spatially, the sites of largest positive trend magnitude are located on the eastern side of the study region. These sites are Troy Dam, Saratoga Springs and Chazy. The Vermont stations at the eastern most part of the study area display rising, but insignificant trends. Watertown and Lowville, the two sites that are located immediately downwind of Lake Ontario, have declining, yet insignificant trends. All of the sites south of Adirondack Park located at the southernmost part of the study area exhibit various significant increasing trends. Six of the climate divisions represented in this analysis show increasing trends, three of which are of significance. The Hudson Valley, home to two of the stations with the largest positive trend magnitude, has an overall annual minimum temperature increase of 1.03ºC per 50 years. The only decreasing trend is found in the Great Lakes, perhaps a direct result of proximity to Lake Ontario. The entire study region has an increasing, yet insignificant trend of 0.76ºC per half-century. Six of the ten years with the largest positive departure from the 1950–2005 average are found in the last 15 years of record; seven of the ten are within the last 25 years. Two of these years (2001 and 2002) are within the first five years of the twenty-first century. Similar to annual average air temperature, 1998 presents the largest positive anomaly: an annual minimum air temperature of 2.04ºC more than the 56-year average.

Annual average air temperature decreased through the mid 1960s and has mostly increased through 2005, with a slight cooling in the early 1990s. The trends of highest positive magnitude occur on the eastern side of the study area. Three of the four decreasing trends are among the northernmost sites. Six of the seven climate divisions show increasing trends, four of which are statistically significant. The Hudson Valley, containing the southernmost sites of the study region, had an increase of 0.73ºC per 50 years. All of the divisions combined provide an increasing trend of 0.42ºC per 50 years for the entire region, although this trend is not significant at the 90% confidence level. In the study area as a whole, seven of the ten years with the largest positive departure from the 1950–2005 average occurred in the last 15 years of the record. Three of these years (2001, 2002, and 2005) are found in the first part of the 21st century. In 1998, the warmest year in the observed record, the annual average temperature was 1.82ºC warmer than the 56-year regional average.

Annual maximum air temperature declined from 1950 through most of the 1960s. From that point, maximum temperature increased through the late 1980s and declined into the mid 1990s, rising again into the 21st century. In the Hudson Valley climate division, annual maximum air temperature showed the smallest increases for the 56-year period of record. Spatially, patterns are not as defined as those found in average and minimum air temperature. All of the southernmost sites show an increasing trend, but Gloversville is not statistically significant. The largest significant negative trend is found at Chasm Falls, a station with a significant decreasing trend for annual average and minimum temperatures as well. The station immediately to its east, Dannemora, also exhibits a decreasing, yet statistically insignificant trend. Despite having fewer increasing trends, and a smaller magnitude than those in average and minimum air temperature, all of the climate divisions represented in the region had increases in annual maximum temperature. Four of these climate divisions had a statistically significant positive trend. The Great Lakes region, which displayed the only negative annual minimum temperature trend, has an increasing trend of 0.84ºC per 50 years. This trend is of a greater magnitude than the other three stations with a significantly positive change in

temperature over the study period. The region as a whole has an increasing, yet insignificant trend of 0.39ºC per 50 years. This magnitude is smaller than that of annual temperature increase for the entire study area, and is almost half that of the annual minimum temperature increase for the entire study area. Seven of the ten years with the largest positive departure from normal occurred in the last 15 years of record. Three of these years were in the first five years of the 21st century: 2001, 2002 and 2005. Consistent with globally averaged air temperature and trends in regional average and minimum air temperature, 1998 was the warmest year on record for the study area.

5.2 Seasonal and Monthly Air Temperature, 1950–2005

5.2.1 Winter

Most of the trends in average, maximum and minimum air temperature observed in the winter were positive, yet few were statistically significant. Changes of largest magnitude and statistical significance were found in winter maximum temperature. All six sites that increased significantly did so by more than 1ºC per 50 years. This is primarily driven by large increases in monthly maximum temperature in December. All of the stations had positive trends in December maximum temperature, yet only four were statistically significant. Positive changes in December temperature ranged from 0.19ºC per 50 years at Chasm Falls to 2.3ºC per 50 years at Plattsburgh. Declining trends were more numerous in November and January maximum temperature. Seven declining trends were noted for November, and thirteen stations exhibited negative trends for January, but overall they were all insignificant statistically. These observed temperature decreases were not numerous enough nor of a sufficient magnitude to negatively influence winter maximum air temperature trends.

More increasing than decreasing trends were noted for winter average and minimum air temperature, yet only one station in each category was significant. Little Falls showed a winter average air temperature increase of 1.29ºC per 50 years over the last half of the 20th century. This is driven by increases in the three winter months, the largest of which is a 1.61ºC increase in December average air temperature over the last 50 years. However, none of the monthly trends alone for this site are significant. Albany has experienced an increase in winter minimum air temperature of 1.59ºC over the last half-century. This is influenced strongly by the statistically significant 2.29ºC per 50 years increase in December minimum air temperature. Increases in temperature were noted at Albany for November and January, yet neither trend was significant.

5.2.2 Spring

Springtime average, maximum, and minimum air temperature generally increased over the last half of the 20th century. The largest and most significant increases were in springtime maximum air temperature. Ten of the nineteen observed temperature rises were statistically significant, and all of a magnitude greater than 1ºC per 50 years. The station experiencing the largest temperature increase is Lake Placid, with seasonal temperatures rising 1.47ºC over the last 50 years. Springtime maximum temperatures appear to be driven by increases in March maximum air temperature. Nineteen sites have increasing temperature trends, fourteen of which are statistically significant. Significant temperature increases in March range from 1.35ºC per 50 years at Dannemora to 2.35ºC per 50 years at Lake Placid. April shows weaker, yet mainly increasing trends. The only statistically significant trend for that month is found at Lake Placid, at 1.25ºC per 50 years. The majority of temperature changes in May are positive, yet again only one is statistically significant. Watertown saw an increase of 1.58ºC in the last half of the 20th century.

Few trends of statistical significance were observed in springtime average and minimum temperatures in the study area. Four sites showed statistically significant increases in average temperature, while only one site displayed a significant minimum temperature increase for the season. Most of the sites across the region had increasing average and minimum air temperatures in March. Twenty of the sites had increases in average air temperature for the month, although few were of the significance or magnitude of increases in March maximum temperature. March minimum temperature had no statistically significant increases or decreases, and the number of weak negative trends ranged from two found in March maximum and average temperature to eight in minimum temperature. In May, average and minimum air temperatures generally had fewer decreasing trends than those of May maximum air temperatures.

5.2.3 Summer

In the study region, average, maximum and minimum temperatures had larger increases in the summer than in any other season. Average temperature had the greatest number of significant increasing trends, with fifteen stations. Troy Dam had an increase of more than 2.5ºC in average air temperature for the summer through the end of the century, the greatest of any station in any season. Despite the generally increasing trend across the region, there was one declining trend in average air temperature, but it was not statistically significant. Maximum and minimum air temperature also generally increased in summer, with only a few declining trends.

The large increase in summer air temperature is primarily driven by an astounding increase in August average, maximum and minimum air temperatures across the region. August average air temperature at the Troy Dam, located in the southeastern corner of the study area, increased by 3.22ºC per 50 years. In all summer months, minimum air temperature showed strong significant

increasing trends at most stations. In the month of August, minimum air temperature at nine stations increased by more than 2ºC per 50 years, the largest increases at the greatest number of stations for any month in the record. These nine stations, with the exception of Utica, were located on the eastern side of the study area, with the northernmost site, Chazy, displaying the largest increase of 2.79ºC per 50 years.

5.2.4 Fall

Air temperatures in the fall more often than not decreased through the end of the century. Few sites had statistically significant decreasing trends, but there were a handful—and some sites had notable decreases. The majority of temperature decreases occurred in seasonal average and maximum air temperature. Seasonal minimum air temperatures across the region generally rose, but for the most part insignificantly. Despite numerous statistically significant increasing trends in September, the season was primarily driven by a majority of stations with large decreasing trends in October temperature coupled with a number of weak declining trends in November. October had more diminishing trends in monthly average, minimum and maximum air temperature than any other month. The majority of stations had more statistically significant decreasing trends in monthly maximum temperature than in minimum or average temperature. Maximum temperatures for October decreased at Chasm Falls and Stillwater Reservoir by -3.12ºC and -2.81ºC per 50 years, respectively. November trends tended to be split between increasing and decreasing, with a few statistically significant declining trends in monthly average and minimum air temperature.

5.3 Precipitation, 1950–2005

Table 3—Changes in Annual Precipitation at USHCN Sites

USHCN Station	Change in precipitation per 50 years (mm)
Albany Airport	53.5
Burlington Apt (VT)	78.4*
Dannemora	342.9*
Gloversville	74.3
Indian Lake 2SW	2.8
Lake Placid 2S	82.9
Lawrenceville	108.8*
Little Falls City Reservoir	50.6*
Ogdensburg 4NE	294.9*
Stillwater Reservoir	124.0*
Troy Dam	43.49
Tupper Lake Sunmount	216.4*
Wanakena Ranger School	47.7
Watertown	156.3*
ALL SITES	105.7*

*(*denotes significant at $p \leq 0.1$)*

Annual precipitation increased at all fourteen stations for the period 1950–2005; eight of these trends were statistically significant (Table 3). Precipitation amounts rose from 2.78 mm at Indian Lake to 342.9 mm at Dannemora over the last 50 years of the 20th century. The entire region experienced a significant increase of 105.66 mm. There is a definite spatial pattern in precipitation increases recognized in the study region. Trends of largest magnitude and significance are found at higher latitudes within the study area.

The effects of the Northeast drought are shown as 12 consecutive years with below-average precipitation, from 1959–1971. The annual totals are shown in relation to the 56-year average for all sites. The year with the largest departure from normal is 1998, also the warmest year on record globally. This year had almost 400 mm of precipitation more than the average for the entire study period. The years with positive anomalies mostly occur in the latter part of the record. The ten years with the largest positive anomalies occur after 1973, although 2001 was also the driest year for the region in the entire period of record.

5.3.1 Seasonal/Monthly Precipitation

A majority of the increasing trends in precipitation occurred in the summer and fall. This is driven by the months of June through October. Very few decreasing trends were found at stations in any of these months, and none was significant. All stations had increased summertime precipitation, yet only three were significant. All but one of the stations, Little Falls, had an increasing precipitation trend in the fall. Eight of these twelve increasing trends were significant. In October, all of the precipitation sites being analyzed had an increasing trend through the end of the century. Four of these trends were statistically significant, and are among the northernmost sites in the study area. Of note are the eight decreasing trends in wintertime precipitation, three of which are statistically significant. However, on the northwest side of the study area, Ogdensburg displayed a statistically significant increasing trend in wintertime precipitation. This is largely due to declining trends in most stations in December and February. Springtime precipitation was divided across the study area by increasing and decreasing trend, yet no discernible spatial pattern was discovered. The spring months of March and April elicited a similar response. In May, trends were largely increasing. Only two stations (Dannemora and Ogdensburg) were statistically significant. In addition, of all thirteen stations with a sufficient precipitation record, only Ogdensburg had a statistically significant increase in precipitation in all seasons. Dannemora, the northernmost site, had the greatest increase per 50 years of all sites in spring, summer and fall precipitation.

5.3.2 Maximum Precipitation

At the nine sites with appropriate daily raw precipitation data available, 24-hour precipitation totals at or

greater than the 90th percentile event generally increased. Stations typically had a one-day 90th percentile value of around 18 mm. Of the six stations with an increasing number of days with extreme or 24-hour maximum events, four of those trends were statistically significant. The remaining three sites showed no change, positive nor negative, in precipitation amount. Using the calculated Sen Slope, the number of days with extreme precipitation increased from an additional 2.75 days per 50 years in Lawrenceville to an additional 9.2 days per 50 years in Dannemora. The three stations with the largest increase in days with extreme precipitation are located on the eastern side of the study area. Consistent with overall annual precipitation trends, the station with the largest increase, Dannemora, is at the highest latitude in the study area.

As expected, of the three sites with no discernible trend in the increase of extreme precipitation events, none had their highest values for precipitation exceedance in the latest time period of 1997–2005. The reverse holds true at the five sites that displayed increases in days with extreme precipitation, which had their largest values in the most recent time period, with the exception of Watertown. Most precipitation exceedance plots reflect the significant Northeast drought in the 1960s. The interval of years 1958–1965 almost consistently appears as the lowest values, except at Wanakena. This station also had its largest precipitation value in the period 1958–1965, and the largest precipitation value of any of the stations during that time period. On the eastern side of the study area, the time period of 1950–1957 includes some of the highest values of daily precipitation. However, at Lawrenceville, Canton, Lowville, and Wanakena, the sites on the western side of the study area, the 1950s time period had among the lowest daily precipitation values. Albany had the largest one-day precipitation event for the region, 142.24 mm, which occurred in the 1998–2005 period.

6. Discussion

This study shows that there are discernible increases in air temperature and precipitation in this region, consistent with those of other Northeast regional climate studies. Temperatures and precipitation generally increased across the region during the study period, with the largest increases occurring in annual minimum temperature. Temperatures are projected to rise through the 21st century under different scenarios of greenhouse gas emissions.[62] Studying regional climate change is important because global models do not perform at a resolution small enough to capture regional intricacies or changes in land use.[63] Large global reports such as the Intergovernmental Panel on Climate Changes 2007 report provide a glance at how the earth is changing, but do little to account for changes at the regional level. Similarities found between this study and one analyzing the Catskill Mountain region of New York.[64] show that the climate of New York State is changing differently from the globally averaged observations in the IPCC report.[65]

There are some differences in procedures and findings between this study and similar ones focusing on the Northeast. LOESS smoothed data show a cooling of annual minimum temperatures in the first part of the 21st century, while annual maximum and average temperatures continued to increase. I found that annual average temperature rose 0.42 °C per 50 years in the study area compared to 1.1 °C per 100 years across the Northeast.[66] These numbers can be compared against each other, but were obtained using different methods. My study employed a different statistical analysis technique from the Wake et al. (2005) and Trombulak and Wolfson (2004) studies by using the Mann-Kendall test in lieu of linear regression.[67] The choice to use the Mann-Kendall test was to maintain similarity with a Catskill Mountain study[68] and to account for outliers. The decision to use a timescale half that of the aforementioned Wake et al. (2005) and Trombulak and Wolfson (2004) was made to include more stations in the analysis.[69]

Frumhoff et al. (2007) and Wake et al. (2005) found that winter was the season with the greatest warming in the Northeast.[70] In the study area for this study, however, summer warmed more significantly than any other season, by almost 1°C in the last 50 years of the 20th century. August had the most statistically significant temperature trends of any month. In contrast, August also had no statistically significant trends in precipitation. The region mostly cooled in the month of October which correlates with little change in fall temperature in the region overall. This October cooling was found in the Burns et al. (2007) study of the Catskill Mountains, located to the south of the study region for this study.[71] October was also the month with all stations showing increasing trends in precipitation. This could potentially be a result of increased cloudiness as a result of increased precipitation, or perhaps a result of evaporation. The four sites with statistically significant precipitation trends in the month of October were Dannemora, Indian Lake, Lake Placid and Ogdensburg. At these sites, maximum temperature was plotted against precipitation and Spearman's rho was calculated. All sites had a statistically significant negative correlation at the 0.05 confidence level. This showed that there is an inverse relationship between October precipitation and maximum temperature; as precipitation increased, maximum temperature tended to be lower.

Despite the finding in my study that the season with the largest increase in temperature was summer, winter also warmed in the region over the last 56 years, by 0.42°C per 50 years. Winter is warming in the Northeast at a rate that is detrimental to the ecosystem.[72] Prior to 1950, there were very few years where Lake Champlain did not freeze. Recently, the lack of ice cover on the lake has been more common. A warmer lake also means lower levels of dissolved oxygen and could affect lake species.[73] Ice-out dates have come significantly earlier in New England since the 1800s. These dates changed by nine days between 1850 and 2000.[74]

Chasm Falls had anomalous cooling trends. However, when this station was examined for the last 36 years only, more increasing trends were realized or the decreasing trends were not of significance. The dominating temperatures in the early part of the record could be driving the overall downward trend. Alternatively, perhaps the cooling trend is due to a small microclimate that differs from the surrounding area or changes in land-use around the recording equipment. However, sites located nearby did not display trends similar to Chasm Falls. The reason for this uniform cooling was not examined thoroughly in this study, though it is worth mentioning that the declining trends found at this station were realized in almost every parameter.

Changes in precipitation will be harder to predict than temperature, as evidenced by what has happened over the last half-century, due to its extreme spatial and temporal variability. Wake et al. (2005) discovered an 83.8 mm rise in precipitation in the Northeast over the past century, but I found that the northern New York region has risen by 105.66 mm in 50 years.[75] Increases in precipitation were substantially greater at higher latitude. This is consistent with global findings, although the latitude range in this study is relatively small. The rise in precipitation for the months of June through October corresponds well with a similar finding of Burns et al. (2007) in the Catskill Mountain region of New York.[76] A decline in winter precipitation is worth noting, as Frumhoff et al. (2007) observed that winter temperatures were rising the fastest, and that more winter precipitation is falling as rain and not snow.[77] Therefore, a decrease in winter precipitation in this area may mean a decrease in snow. Under a higher emissions scenario, the northern part of the Northeast is projected to lose up to half of its days with snow cover.[78]

As found in my study, the observed drought in the Northeast in the 1960s and the driest year in the record, 2001, both show that precipitation changes may be extreme from year to year. Flooding events caused by rapid snowmelt and increasing rain falling on frozen ground are projected in the coming decades.[79] This is relevant for a region such as the Adirondacks, which experiences an average of 35–45 extremely cold days below -17.78°C annually[80] and has an observed springtime warming of 0.54°C per 50 years. In the 21st century, one- to three-month droughts could occur annually in the Adirondack Mountains.[81] Watershed management will be required for the successful allocation and conservation of the resource. The Tug Hill Plateau/Watertown area is prone to large lake-effect events. A study on Lake Erie observed that more lake-effect snow events may occur as lake-effect rain events, due to warmer lake conditions and warmer surface air temperatures.[82]

Changes in 24-hour maximum precipitation were noted, though their presence was not as strong as the trends in overall precipitation. There were no noted declining trends in days with precipitation events above the 90th percentile, yet there were three sites without any trend whatsoever. The threshold for extreme precipitation in this study was somewhat lower than the one used in the Karl et al. study (1998)[83] and used a procedure adapted from the Bonsal et al. (2001) study[84] for extreme temperature. The 90th percentile value in this region was often around 18 mm. This is not a significant value that would cause severe flooding unless the ground was already completely saturated. However, it does show that the amount of precipitation in individual one-day events increased during the study period. This could be examined in the future as 25.4 or 50.8 mm of precipitation falling in 24-hour period, larger values that may have more significance in terms of flooding and hydrologic changes, similar to the Karl et al. (1996) study.[85]

The effects of climate change on the Northeast are numerous. This region is rich in agriculture;[86] many of the competitive crops in the Northeast such as apples are dependent on a long cold weather season. As winters warm, these crops will be negatively impacted.[87] Dairy cattle raised in the Northeast are very sensitive to changes in temperature and perform best from about 4°C to about 24°C.[88]

Temperatures are expected to rise significantly under a higher-emissions scenario.[89] Winters could have an increase of 4.5°C to 6.7°C, and summer could have an increase of 3.4°C to 7.8°C in the 21st century.[90] These changes to climate stand to threaten plant and animal life and the infrastructure, as this study has mentioned.

It has become evident that increases in precipitation are partly the result of increased greenhouse gas emissions.[91] Although species may not be harmed directly by the changing climate, they will unquestionably suffer indirectly. The area is heavily forested, and the loss of the sugar maple will not only affect the maple syrup industry, but also nitrogen retention in the surrounding forested watershed.[92]

7. Conclusions

Experts are calling for a significant reduction in greenhouse gas emissions. Without a significant change in energy policy and the reversal of the trend of excessive human consumption, the only solution will be merely to adapt and survive the changing climate. The data presented in this study show with certainty that temperatures have increased between 1950 and 2005, along with precipitation. Annual temperature has risen about .42ºC in the last 50 years of the 20th century, summers are significantly warmer and longer, mostly due to a significant increase in August temperature. The months of June through October are considerably wetter. However, February, a month in which precipitation typically falls as snow, is drier. Although precipitation has increased overall, the wettest year (1998) and the driest year (2001) fall in the last ten years of study period. It is reasonable to assume that this region will experience more years with similar wet and

dry extremes, leading to flooding and droughts. Increases in minimum temperature were observed, and of a higher magnitude and significance than average and maximum temperatures. Changes in temperature and precipitation often varied from month to month. In October, there seems to be an inverse relationship between maximum temperature and precipitation amount.

The Northeast studies had many similar results to global studies overall, but the subtle differences make an even more through examination worthwhile. This study not only advocates for the continued examination of how climate is changing worldwide, but also how it is affecting smaller localities. Studying climate change at the local level is imperative, particularly in this topographically diverse area of the country. Not all of the effects of climate change will be experienced in the entire Northeast. Potential sea level rise is a serious problem, but it will affect mostly coastal areas. The Adirondack area is ecologically different from areas that are adjacent to the ocean. It is heavily forested and home to many plant, animal and insect species. A shifting climate will force these species to adapt or shift their ranges to a more comfortable climate. Studies on benthic macroinvertebrate communities in streams and how they are impacted by the changes in climate are being performed by federal and state agencies. Benthic macroinvertebrates are a good indicator of overall water quality. Certain indicator taxa are highly sensitive to temperature.

In the Northeast, precipitation type and snowpack amounts are historically highly variable. As discussed in this study, the changes in precipitation are a little bit harder to discern than temperature, but flooding and drought will have the greatest immediate impact on society and the economy. The maintenance of the spatially diverse United States Historical Climatology Network is also extremely important. It allows for a continued accurate analysis of regional climate change. Additionally, it allows for other entities to attempt to correlate changes in climate to those that they are observing in streamflow, algal blooms, and species mortality, to name a few. The Northeast region, along with others, should continue to be studied so that appropriate and specific actions can be taken to adapt to, mitigate and perhaps reverse the projected temperature and precipitation increases that the earth faces in the next century.

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AMERICAN BAR ASSOCIATION
ADOPTED BY THE HOUSE DELEGATES
FEBRUARY 11, 2008

RECOMMENDATION

RESOLVED, That the American Bar Association urges the United States government to take a leadership role in addressing the issue of climate change through legal, policy, financial, and educational mechanisms.

FURTHER RESOLVED, That the American Bar Association urges Congress to enact and the President to sign legislation that would:

1. Cap and reduce United States greenhouse gas emissions to help prevent the rise of worldwide atmospheric greenhouse gas concentrations to dangerous levels;
2. Utilize market mechanisms designed to minimize compliance costs, such as cap and trade, carbon taxation, or emissions trading;
3. Recognize and incorporate sustainable development principles;
4. Increase fuel economy and energy efficiency standards, promote greater use of renewable energy, promote fuel diversity through the use of carbon neutral or low carbon technologies, and encourage development and deployment of other technologies that reduce, eliminate, or sequester emissions of greenhouse gases and minimize costs of controls or mitigation measures;
5. Provide for broad coverage of various sectors of the economy responsible for greenhouse gas emissions;
6. Enable the United States to adapt to existing and projected climate changes in a way that minimizes individual hardship, damage to its natural resources, and economic cost;
7. Coordinate and integrate state, local and territorial actions into a federal program; and

8 Require the United States government to encourage all other countries to take steps to limit their greenhouse gas emissions so that world levels of emissions will be reduced to prevent dangerous anthropogenic climate change.

FURTHER RESOLVED, That the American Bar Association urges the United States government to engage in active international discussions and to negotiate and ratify treaties or other agreements to address and reduce climate change.

REPORT

In August 2003, the American Bar Association's House of Delegates endorsed "the internationally accepted concept of sustainable development, as recognized by the United Nations Conference on Environment Development and subsequent international conferences: simultaneous achievement of environmental protection, economic development, social development, and peace, at the same time, for present and future generations." The House of Delegates also agreed to "promote the principles of sustainable development in relevant fields of law."

Climate change presents significant risks to this and future generations. Climate change presents environmental risks, to be sure, but it also presents security, economic, and social risks. At the same time, the national and international response to climate change provides major opportunities for improving environmental quality, fostering economic growth and job creation, and enhancing domestic and global security. To foster sustainable development, the United States should play a leadership role in addressing climate change.

1. Scientific Evidence and Consequences

Climate change is occurring, human activities contribute to it, and climate change will have adverse effects on the United States and the rest of the world. While there remain some uncertainties about its magnitude, the evidence of climate change easily passes the certainty tests that are used to make decisions in other relevant areas of law and policy. According to the Intergovernmental Panel on Climate Change, which synthesizes peer-reviewed scientific literature on climate change (and which shared the 2007 Nobel Peace Prize):

- "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level."
- "Eleven of the last twelve years (1995-2006) rank among the 12 warmest years in the instrumental record of global surface temperature (since 1850)."
- "The last time polar regions were significantly warmer than present for an extended period (about 125,000 years ago), reductions in polar ice volume led to 4 to 6m of sea level rise."
- "Most of the observed increase in global average temperatures since the mid-20th century is *very*

likely due to the observed increase in anthropogenic greenhouse gas concentrations."

- "There is *high confidence* that the rate of observed sea level rise increased from the 19th to the 20th century. The total 20th-centruy rise is estimated to be 0.17 [0.12 to 0.22] m."
- "Snow cover is projected to contract. Widespread increases in thaw depth are projected over most permafrost regions. . . . Sea ice is projected to shrink in both the Arctic and Antarctic. . . . In some projections, late-summer sea ice disappears almost entirely by the latter part of the 20th century . . . . It is very likely that hot extremes, heat waves, and heavy precipitation events will continue to become more frequent. . . . Based on a range of models, it is likely that future tropical cyclones (typhoons and hurricanes) will become more intense, with larger peak wind speeds and more heavy precipitation associated with ongoing increases of tropical sea surface temperatures."[1]

According to a 2001 report issued by the National Academy of Sciences/National Research Council, climate change is likely to have adverse effects on the United States. Climate change is likely to increase adversely affect agriculture;[2] will likely have a negative effect on water supplies, particularly in the west;[3] is likely to worsen water quality and increase flooding;[4] will adversely affect ecosystems;[5] will increase the risk of infectious disease and respiratory illness;[6] and could increase flooding and storm damage in coastal areas, where 53% of the U.S. population lives.[7] The report modeled these projected effects only up to 2100; more severe effects are highly likely after that time if nothing is done to curb greenhouse gas emissions.[8] "Hence national policy decisions made now, and in the longer-term future will influence the extent of any damage suffered by vulnerable human populations and ecosystems later in this century."[9]

Significantly, prominent climate scientists have expressed surprise at the speed with which the projected effects of warming are unfolding:

> As practicing scientists who study the earth's climate system, we and many in our profession have long understood that continued human caused emission of greenhouse gases—primarily carbon dioxide (CO_2), but also methane (CH_4), nitrous oxide (N_2O), and fluorocarbons—would eventually warm the earth's surface. Most were skeptical that we would see strong signs of human induced climate change in our lifetimes. But by the beginning of this decade, we observed that global temperatures are rising, plant and animal ranges are shifting, glaciers are in retreat globally, and arctic sea ice is retreating. Sea levels are rising and the oceans are becoming more acidic. To the extent that these changes result from human alteration of the atmosphere, we know that they are just the first small increment of climate change yet to come if human societies do not curb emissions of greenhouse gases.[10]

The Supreme Court's 2007 decision in *Massachusetts v. EPA* underscores the compelling nature of the science. The Court held that EPA must make a decision under the Clean Air Act on a petition to regulate greenhouse gas emissions from motor vehicles, and in so holding cited the 2001 NAS/NRC report and other scientific sources indicating the seriousness of the problem.[11]

The adverse effects of climate change are likely to be significant for the United States and the rest of the world. Most states that have taken action to address climate change have done so because of threats to ocean shorelines, key businesses and industries, water supplies, and agriculture. The seriousness of the issue is underscored by the Military Advisory Board, comprised of 11 retired admirals and generals, which concluded in April 2007 that "climate change poses a serious threat to America's national security" by adding to and exacerbating threats and tensions around the world.[12] President Bush has acknowledged that human activity is a major cause of rising surface temperatures,[13] and has described climate change as one of the "great challenges of our time."[14] Senior administration officials have described climate change as a serious problem.[15]

The United States has a history of acting to protect human health and the environment based on risk (not certainty) of harm. In a civil courtroom setting, a judge or jury makes a decision based on whether a particular harm is more likely than not caused by the defendant's activity, a probability of just over 50%. Even when risks from pollutants are relatively small (for example, a risk of cancer of 1 in 10,000 or 1 in 1,000,000), they are considered serious enough to justify regulation. For climate change, by contrast, the likelihood of many of the adverse effects described above is 90 percent or greater.[16] Even less likely risks are significant because of their potential consequences. As the late Elliot Richardson observed, it is inappropriate to treat the risks of increasing greenhouse gases differently than the risks of other environmental pollutants.[17]

The social and human health impacts of climate change are likely to be significant:

> Poor communities can be especially vulnerable, in particular those concentrated in high risk areas. They tend to have more limited adaptive capacities, and are more dependent on climate-sensitive resources such as local water and food supplies. . . . Projected climate

change-related exposures are likely to affect the health status of millions of people, particularly those with low adaptive capacity, through:

- increases in malnutrition and consequent disorders, with implications for child growth and development;
- increased deaths, disease and injury due to heat waves, floods, storms, fires and droughts;
- the increased burden of diarrheal disease
- the increased frequency of cardio-respiratory diseases due to higher concentrations of ground-level ozone related to climate change; and
- the altered spatial distribution of some infectious disease vectors.[18]

In Africa alone, by 2025, between 75 million and 250 million people are projected to be subject to increased water stress due to climate change and in some countries, rain-fed agricultural yields could be reduced by 50% by 2030. In Asia, decreased freshwater availability is projected to adversely affect more than a billion people by the 2050s.[19]

2. International Framework

The United States participated actively in the negotiations that led to United Nations Framework Convention on Climate Change[20] (Framework Convention), and played a major role in shaping it. The United States signed the Convention on June 12, 1992, at the United Nations Conference on Environment and Development in Rio de Janeiro. The Senate gave its advice and consent on October 7, 1992.[21] Less than a week later, on October 13, President George H.W. Bush signed the instrument of ratification and transmitted it to the Convention Secretariat,[22] making the U.S. the fourth country in the world to ratify the Convention.[23] The Framework Convention took effect in 1994, and now has 185 additional parties, for a total of 189.[24] In 2001, President George W. Bush specifically reaffirmed U.S. commitment to the Convention.[25]

As its name indicates, the Convention creates an international legal framework, including reporting, scientific and technological research, and annual meetings of the conference of the parties, to address climate change. The Framework Convention does not contain any binding commitments to reduce greenhouse gas emissions by a certain amount by a date certain. The Convention treats developed countries and developing countries differently. As the Framework Convention's preamble states, developed countries have contributed "the largest share of historical and current global emissions of greenhouse gases, and have higher per capita emissions levels than developing countries.[26] The developed countries' historic contribution to greenhouse gas emissions has lasting cumulative effects because of the persistence of these gases in the atmosphere. Thus, in ratifying the Framework Convention, developed countries agreed to adopt policies and measures that will demonstrate that they "are taking the lead" in addressing climate change.[27] Developed countries agreed to the "aim" of reducing their greenhouse gas emissions to 1990 levels by 2000.[28] The Convention requires all parties, both developed and developing, to establish, implement, and periodically update national programs to mitigate climate change.[29] The Convention also contains a commitment to review the adequacy of developed country commitments, including the "aim" commitment.[30]

In December 1997, at their annual meeting in Kyoto, Japan, the parties to the Convention agreed to a protocol containing binding greenhouse gas emission limits for developed countries.[31] Under the Kyoto Protocol, developed countries agreed to reduce their net greenhouse gas emissions by at least five percent from 1990 levels by 2008-2012.[32] No comparable commitment is included for developing countries. The Protocol contains somewhat different commitments for individual developed countries; the U.S. commitment is seven percent below 1990 levels.[33] Greenhouse gas emissions in the United States are now projected to be more than 25 percent higher in 2012 than they were in 1990. Thus, the Kyoto target is about 30 percent below projected "business as usual" emissions.[34]

Several months earlier, in July 1997, the Senate, by a vote of 95-0, passed a resolution sponsored by Senators Robert Byrd (D.-W.Va.) and Chuck Hagel (R.-Neb.). The Byrd-Hagel resolution expressed the sense of the Senate that the United States should not sign any protocol to the Climate Convention unless the protocol met several key conditions.[35] According to the resolution, the protocol must not "mandate new commitments to limit or reduce greenhouse gas emissions" for developed countries unless it also "mandates new specific scheduled commitments to limit or reduce greenhouse gas emissions for Developing Country Parties within the same compliance period."[36] In addition, the protocol should not "result in serious harm to the economy of the United States."[37] The resolution did not address the issue of developed country leadership, as expressed in the Convention. President Clinton did not submit the Kyoto Protocol to the Senate for its advice and consent.

On March 13, 2001, President George W. Bush, referring to the Byrd-Hagel resolution, said he opposed the Protocol "because it exempts 80 percent of the world, including major population centers such as China and India, from compliance, and would cause serious harm to the U.S. economy."[38] He also said the Administration "takes the issue of global climate change very seriously," and that he would work with "our friends and allies . . . to develop technologies, market incentives, and other creative ways to address global climate change."[39]

On February 16, 2005, following Russia's ratification, the Kyoto Protocol went into effect.[40] Among major developed countries, only the United States and Australia are not parties. By contrast, the European Union has a well developed program for reducing greenhouse gas emissions and has begun an emissions trading program that is providing countries with valuable experience in how to make such a trading program work effectively.

Parties to the Kyoto Protocol have already begun discussions for the next round of emissions cuts. The Kyoto reductions are to be achieved by 2008-12, which means that the next round of cuts under the Framework Convention would be sought for a date after that time. In the meantime, the U.S. is making an effort to secure emissions reduction commitments from major emitting countries, both developed and developing. According to President Bush, the objective is to agree on "the process by which the major economies would, by the end of 2008, agree upon a post-2012 framework that could include a long-term global goal, nationally defined mid-term goals and strategies, and sector-based approaches for improving energy security and reducing greenhouse gas emissions." The European Union, France, Germany, Italy, and the United Kingdom, Japan, China, Canada, India, Brazil, South Korea, Mexico, Russia, Australia, Indonesia, and South Africa were invited to join this effort.[41] Speakers at this meeting, which was held on Sept. 27-28, 2007, emphasized the central role of the Framework Convention in any climate change discussion, stated that developed and developing countries had common but differentiated responsibilities under the Convention, and welcomed the U.S. effort as a contribution to efforts under the Convention.[42]

3. State and Local Efforts

States and local governments are playing a leading role in addressing climate change in the United States. These efforts involve more and more states, and are becoming increasingly ambitious and regional in scope. Differences among states as well as their lack of national scale, however, mean that states are not an effective substitute for national action and leadership and an internationally effective program.

Many states are employing a planning process that involves a greenhouse gas reduction goal and implementation of a suite of legal and policy measures to achieve that goal. Others are acting without quantifiable reduction goals, but are nonetheless employing a suite of tools. These tools include, but are not limited to, renewable electricity portfolio standards, energy efficiency portfolio standards, net metering, carbon dioxide limits on new power plants, energy efficiency provisions in building codes, public funding or benefit programs for efficiency and renewable energy, tax credits, and registries for early greenhouse gas reductions. In addition to reducing greenhouse gas emissions, these tools reduce negative external costs of energy generation, require energy conservation activities with benefits exceed their costs, and use markets that reduce net emissions. They also limit and even lower energy costs for the poor, and create employment and economic growth. These tools encourage technological innovations that can lead to even greater greenhouse gas reductions in the future. Many of them also provide greater public understanding of greenhouse gas sources and ways of limiting emissions. Use of these tools can also reduce emissions of other air pollutants, including sulfur dioxide, nitrogen oxides, fine particulates, ozone, and mercury.[43]

A growing number of states are acting on a regional basis. Ten northeastern states (Connecticut, Delaware, Maine, New Hampshire, New Jersey, New York, Vermont, Massachusetts, Rhode Island and Maryland) are participating in the Regional Greenhouse Gas Initiative to develop a regional emissions cap and trade program. RGGI has developed a model rule to establish a cap and trade program for electric utilities.[44] Most of the RGGI states have already proposed individual state rules to implement the model rule. Six western States (Arizona, California, New Mexico, Oregon, Utah, and Washington) and two Canadian provinces (British Columbia and Manitoba) participate in the Western Climate Initiative to adopt a regional emissions cap for multiple economic sectors and a cap-and-trade system.[45] Finally, 39 states, two Canadian provinces, and three Indian tribes are members of The Climate Registry, which is developing a common set of criteria for registering measures to reduce emissions and a cap-and-trade program.[46] At the local level, more than 500 U.S. municipalities have signed the Mayors Climate Protection Agreement, under which they agree to strive to meet or exceed the Kyoto Protocol goal of a seven percent reduction in greenhouse gas emissions from 1990 levels by 2012.[47] In addition, more than 150 U.S. cities and local governments have joined the Cities for Climate Protection of ICLEI-Local Governments for Sustainability. As members, they seek to reduce greenhouse gas emissions while improving community livability.[48]

Many observers see state and local activity as a next-best approach in the absence of federal legislation and effective international agreements. State and local governments provide an important laboratory for working out many of the difficult questions involved in the development of national climate legislation, and states have shown that legal and policy measures to address energy and climate policy can create economic and other opportunities. In addition, Congress will need to effectively engage states in any future national legislation if it expects that legislation to be fully effective.[49] Yet differences among state laws and the lack of a unified national strategy for addressing climate change handicap even the most advanced and most regional efforts at the present time.

4. National Efforts

The United States has no overall goal for reducing the total amount of greenhouse gas emissions, and no legal structure in place to achieve that result. On the other hand, the United States does have a goal of reducing the greenhouse gas intensity of the U.S. economy by 18% by 2012, which is projected to prevent the emission of 500 million metric tons of emissions over the decade. Greenhouse gas intensity measures the relationship between GDP and greenhouse gas emissions; it is not an absolute measure of greenhouse gas emissions.[50] The United States has several kinds of laws in place that have the indirect effect of reducing greenhouse gas emissions, but also other laws that in all likelihood tend to increase emissions (e.g., subsidies for fossil fuels). In spite of, or perhaps partly because of, these laws, U.S. greenhouse gas emissions continue to increase. Net greenhouse gas emissions were 16.3 percent higher in 2005 than they were in 1990.[51]

The United States has had laws for several decades that support energy efficiency and conservation. The primary laws fostering efficiency and conservation are 1) efficiency standards for appliances and other equipment under the National Appliance Energy Conservation Act of 1987;[52] 2) state energy efficiency standards for buildings, which are prompted to some degree by a requirement in the Energy Policy Act of 1992 that each state review and consider upgrading the energy efficiency provisions of its residential and commercial building codes;[53] and 3) corporate average fuel economy (CAFE) standards for motor vehicles, which are established under the Energy Policy and Conservation Act.[54]

The U.S. also has laws fostering the use of renewable energy. These include the production tax credit for wind turbines. In addition, the Energy Policy Act of 2005 requires EPA to establish regulations requiring the volume of renewable fuel sold or introduced into commerce in the U.S. annually to increase from 4.0 billion gallons in 2006 to 7.5 billion gallons in 2012.[55] The United States also has a variety of other voluntary programs, many of them international partnerships that are intended to in various ways to reduce greenhouse gas emissions and develop new and alternative technologies to address climate change.[56]

By reducing energy use, and increasing the use of renewable energy, each of these has the effect of ensuring that U.S. greenhouse gas emissions are lower than they would otherwise be. These laws and programs have not, however, stopped the growth in greenhouse emissions.

Nor does the United States appear to be prepared to adapt to the consequences of climate change. The two most certain effects of climate change, increased surface temperatures and rising sea levels, are already occurring and are likely to continue even if serious efforts are made to mitigate climate change. Accordingly, adaptation is a necessary part of any national effort to address climate change. Rising sea levels, for example, raise a variety of legal issues that have yet to be fully addressed.[57]

The U.S. business community is disadvantaged by the absence of a comprehensive federal program and the consequent proliferation of inconsistent state and regional regulations, as well as litigation that is intended to force (or substitute for) federal regulation. The lack of a federal program also makes capital expenditure planning very difficult, inhibits research and development, robs businesses of economies of scale and of markets for climate-friendly technologies and products, and puts them at a disadvantage compared to companies in countries that have ratified the Kyoto Protocol. U.S. companies would also have greater opportunities to engage in carbon trading if the U.S. was part of an international cap-and-trade system.

There is growing Congressional interest in comprehensive climate change legislation. Seven bills were pending in late 2007. These bills apply to most or all sectors of the economy, not just, for example, electrical generation or transportation.

5. Conclusion: Need for U.S. Leadership

The United States has a history of leadership on key international issues, including many issues involving international environmental law. The United States played an instrumental role in designing and carrying out the post World War II international legal architecture, including the United Nations, the Bretton Woods institutions, and the post war reconstruction of Europe. Many U.S. environmental laws, including the National Environmental Policy Act of 1969, have been modeled throughout the world. The United States helped lead the international effort for Montreal Protocol, under which both developed and developing countries have agreed to reduce or phase out production of certain substances that deplete the stratospheric ozone layer. It now appears that the reduction in those substances has also had a large and positive effect in mitigating climate change. The U.S. sulfur dioxide emissions trading program in the Clean Air Act served as a model for the Kyoto Protocol trading programs. In addition, the United States has led recent international efforts to protect high seas fisheries, prevent lead poisoning, integrate environmental considerations into trade agreements, and incorporate environmental impact reviews and public participation in World Bank projects.

As in many other areas of law and policy, U.S. ability to influence other countries to reduce greenhouse gas emissions is directly dependent on what we do at home. This is particularly true because the historic contribution of developed countries to greenhouse gas emissions, and their superior financial and technological resources, are acknowledged by the Framework Convention to which the U.S. is a party. Moreover, it is widely acknowledged that negative climate change effects will occur dispropor-

tionately in developing countries that are most vulnerable to climate change and that lack the resources to adapt effectively. The many strengths of the United States—including its technological capacity, economic strength, educational system, commitment to innovation, and legal institutions—give this country a unique and unparalleled opportunity to play a significant and constructive role in addressing climate change.

Respectfully Submitted,
Lee A. DeHihns, III, Chair
Section of Environment, Energy, and Resources
February 2008

GENERAL INFORMATION FORM

Submitting Entities: Section of Environment, Energy, and Resources

Submitted By: Lee A. DeHihns, III, Chair, Section of Environment, Energy, and Resources

1. **Summary of Recommendation(s).**
The American Bar Association urges the United States Government to take a leadership role in addressing the issue of climate change through legal, policy, financial, and educational mechanisms; urges Congress to enact and the President to sign appropriate climate change legislation; and urges the United States Government to engage in active international discussions to address climate change.

2. **Approval by Submitting Entity.**
Approved by the Section of Environment, Energy, and Resources Council on November 9, 2007.

3. **Has this or a similar recommendation been submitted to the ABA House of Delegates or Board of Governors previously?**
In 2003 the ABA adopted a resolution reaffirming the ABA's 1991 commitment to sustainable development, and further encouraging governments, businesses and nongovernmental entities to promote sustainable development and recognizing that good governance and the rule of law are essential to achieving sustainable development. In August 2007, the ABA adopted a resolution urging governments, businesses, nongovernmental organizations and other organizations to integrate and consider Rule of Law Initiatives with global environmental issues.

4. **What existing Association policies are relevant to this recommendation and how would they be affected by its adoption?**
In 1993 the Association adopted a resolution supporting NAFTA and procedures and institutions for the conduct of trade in North America. In 1995 the ABA adopted a resolution promoting meaningful and effective involvement of all affected stakeholders and interest through the public participation provisions of environmental laws, international environmental agreements and treaties. In 2003 the Association adopted a policy resolution reaffirming the ABA's 1991 commitment to sustainable development, and further encouraging governments, businesses and nongovernmental entities to promote sustainable development and recognizing that good governance and the rule of law are essential to achieving sustainable development. In August 2007, the ABA adopted a resolution urging governments, businesses, nongovernmental organizations and other organizations to integrate and consider Rule of Law Initiatives with global environmental issues.

5. **What urgency exists which requires action at this meeting of the House?**
The Association is on record supporting sustainable development and the rule of law. Few issues raise the need for sustainable development and the rule of law more squarely and urgently than climate change. As the report explains, climate change is likely to affect human quality of law in a variety of negative ways, both in the United States and in other countries. Congress, in addition, is already considering a variety of comprehensive climate change bills. Through this policy initiative the Association will be able to play a more effective role in Congress and elsewhere on climate change because it will have taken a position on the issue.

6. **Status of Legislation. (If applicable.)**
A variety of bills are now before Congress that would establish comprehensive programs to address climate change. Two proposals, companion bills in many respects, are S. 280, the Climate Stewardship and Innovation Act of 2007 (Sen. Lieberman and six cosponsors, including Sen. McCain) and H. R. 620, the Climate Stewardship Act of 2007 (Rep. Olver and 17 cosponsors). The other four are S. 1766, the Low Carbon Economy Act of 2007 (Sen. Bingaman and six cosponsors), S. 309, the Global Warming Pollution Reduction Act (Sen. Sanders and ten cosponsors), S. 485, the Global Warming Reduction Act of 2007 (Sen. Kerry and one cosponsor), and H.R. 1590, the Safe Climate Act of 2007 (Rep. Waxman and 131 cosponsors). A seventh bill, S. 2191, America's Climate Security Act, is cosponsored by Senators Joseph Lieberman and John Warner and has eight cosponsors. (Two major energy bills, H.R. 6 (passed by the Senate June 27, 2007) and H.R. 3221 (passed by the House August 3, 2007), contain renewable energy and energy efficiency provisions that would indirectly address

climate change, but do not attempt to comprehensively reduce greenhouse gas emissions.)

7. **Cost to the Association. (Both direct and indirect costs.)**
   This resolution does not impose costs on the Association beyond those already being incurred to promote Goal VIII and advance the Rule of Law.

8. **Disclosure of Interest. (If applicable.)**
   The cosponsoring entities engage in activities that address climate change, including CLE programming, providing information of ABA activities to governments, NGOs and others as well as development of policy resolutions. No individual associate with this resolution will benefit personally from adoption of the resolution.

9. **Referrals. (List entities to which the recommendation has been referred, the date of referral and the response of each entity if known.)**
   As it was being developed, this Report with Recommendations was circulated to representatives of the ABA Section of Environment, Energy, and Resources; the Standing Committee on Environmental Law; Administrative Law and Regulatory Practice; Business Law; Dispute Resolution; International Law; Law Practice Management; Litigation; Public Utility, Communications and Transportation Law; Real Property, Trust and Estate Law; State and Local Government Law; Taxation; Tort Trial and Insurance Practice; and Young Lawyers Division. Circulation to all ABA Sections is being made following this submission.

10. **Contact Person. (Prior to the meeting. Please include name, address, telephone number and email address.)**
    –Lee A. DeHihns, III, Chair, Section on Environment, Energy, and Resources, Alston & Bird LLP, 1201 West Peachtree St., Atlanta, GA 30309-3424, PH: 404-881-7151, Email: lee.dehihns@alston.com

11. **Contact Person. (Who will present the report to the House. Please include email address and cell phone number.)**
    –R. Kinnan Golemon, Section Delegate to the ABA House of Delegates, Brown McCarroll, L.L.P., Austin, TX, phone: (512) 479-9707; email: kgolemon@mailbmc.com
    –Sheila Slocum Hollis, Section Delegate to the ABA House of Delgates, Duane Morris LLP, Washington, DC, phone: (202) 776-7810; email: sshollis@duanemorris.com
    –Lee A. DeHihns, III, Chair, Section on Environment, Energy, and Resources, Alston & Bird LLP, Atlanta, GA, phone: (404) 881-7151; email: lee.dehihns@alston.com

Endnotes

1. IPCC Fourth Assessment, Working Group I, Summary for Policymakers at 5-7, 9, 10 & 15 (2007), http://ipcc-wg1.ucar.edu/wg1/Report/AR4WG1_Print_SPM.pdf. The Bush Administration participated in the development of this and the other two working group reports, and supports these findings. Office of Science and Technology Policy, Executive Office of the president, Intergovernmental Panel on Climate Change Finalizes Report, Feb. 2, 2007, http://www.whitehouse.gov/news/releases/2007/02/20070202.html.
2. National Academy of Sciences/National Research Council, Climate Change Science: An Analysis of Some Key Questions 4 (2001) ("The optimal climate for crops may change, requiring significant regional adaptations. Some models project an increased tendency toward drought over semi-arid regions, such as the U.S. Great Plains.").
3. *Id.* ("Hydrologic impacts could be significant over the western United States, where much of the water supply is dependent on the amount of snow pack and the timing of the spring runoff.").
4. *Id.*
5. *Id.* at 20.
6. *Id.*
7. *Id.* ("With higher sea level, coastal regions could be subject to increased wind and flood damage even if tropical storms do not change in intensity."). *See also id.* at 20. Hurricane Katrina occurred in 2005.
8. *Id.*
9. *Id.* at 1.
10. Brief for David Battisti et al. as Amicus Curiae Supporting Petitioners 2, Massachusetts v. EPA, 127 S.Ct. 1438 (2007) (No. 05-1120) at 2.
11. Massachusetts v. Environmental Protection Agency, 127 S. Ct. 1438, (April 2, 2007) ("A well-documented rise in global temperatures has coincided with a significant increase in the concentration of carbon dioxide in the atmosphere. Respected scientists believe the two trends are related.").
12. Military Advisory Board, National Security and the Threat of Climate Change 6-7 (2007), http://securityandclimate.cna.org/report/National%20Security%20and%20the%20Threat%20of%20Climate%20Change.pdf.
13. White House, Fact Sheet: President Bush is Addressing Climate Change, June 30, 2005 ("We know that the surface of the Earth is warmer, and that an increase in greenhouse gases caused by humans is contributing to the problem."), http://www.whitehouse.gov/news/releases/2005/06/20050630-16.html.
14. Kenneth T. Walsh, *Bush Moves on Climate Change*, U.S. News & World Report, Oct. 11, 2007, *available at* http://www.usnews.com/blogs/news-desk/2007/10/4/bush-moves-on-climate-change.html.
15. "I want to stress that the United States takes climate change very seriously, for we are both a major economy and a major emitter," Secretary of State Condoleezza Rice said. "Climate change is a global problem, and we are contributing to it; therefore, we are prepared to expand our leadership to address the challenge." Dean Scott, *Rice Says Meeting Supports Bali Talks; U.N. Official Urges Comprehensive Accord*, 38 Environment Rep. (BNA) No. 38, at 2067 (Sept. 28, 2007).
16. Climate Scientists' Amicus Brief, *supra* note 10, at 2.
17. Elliot L. Richardson, *Global Warming and the Risk of Disaster: How Much Do We Care What Happens to the World After We Are Gone?*, Looking Ahead (ABA Section of Natural Resources, Energy, and

Environmental Law, Chicago, Ill.), Jan./Feb. 1999, at 6 (remarks at section meeting in Hilton Head, South Carolina, Oct. 9, 1998) (summarizing IPCC findings). See also Massachusetts v. EPA, n. 7 ("Congress amended § 202(a)(1) in 1977 to give its approval to the decision in Ethyl Corp. v. EPA, 176 U.S. App. D.C. 373, 541 F.2d 1, 25 (CADC 1976) (en banc), which held that the Clean Air Act 'and common sense . . . demand regulatory action to prevent harm, even if the regulator is less than certain that harm is otherwise inevitable.'" The Ethyl Corp decision was based on the concept that the public health can be endangered "'both by a lesser risk of a greater harm and by a greater risk of a lesser harm.'"

18. IPCC FOURTH ASSESSMENT, WORKING GROUP II, SUMMARY FOR POLICYMAKERS 12 (2007) http://www.ipcc.ch/SPM13apr07.pdf.
19. *Id*. at 12.
20. *United Nations Framework Convention on Climate Change,* U.N. Doc. A/AC.237/18 (1992), *reprinted in* 31 I.L.M. 849 (1992).
21. 138 Cong. Rec. S17150, S17156 (daily ed. Oct. 7, 1992) (reporting Senate approval of ratification of the resolution).
22. United States Instrument of Ratification, United Nations Framework Convention on Climate Change (Oct. 13, 1992) (copy on file with author).
23. United Nations Framework Convention on Climate Change: Status of Ratification *(last modified on 24 May 2004),* http://unfccc.int/resource/conv/ratlist.pdf.
24. *Id.*
25. George W. Bush, President Bush Discusses Global Climate Change (June 11, 2001), http://www.whitehouse.gov/news/releases/2001/06/20010611-2.html (last visited June 14, 2006).
26. Framework Convention, *supra* note, preamble para. 3. In the preamble, parties also recognize the 'special difficulties" of developing countries, including their need for access to new technologies to address climate change. *Id*. paras. 20 & 22.
27. *Id.* art. 4.2(a).
28. Framework Convention, *supra* note, art. 4.2(a) & (b).
29. *Id*. art. 4.1(b).
30. *Id*. art. 4.2(d).
31. Kyoto Protocol to the United Nations Framework Convention on Climate Change, Dec. 10, 1997, U.N. Doc. FCCC/CP/197/L.7/Add. 1, art. 3.1 & Annex B, reprinted in 37 I.L.M. 22 (1998).
32. *Id.* art. 3.1. The Annex I or developed countries also agreed to make "demonstrable progress" by 2005 in meeting their commitments. *Id.* art. 3.2.
33. *Id.* Annex B.
34. NATIONAL COMMISSION ON ENERGY POLICY, ENDING THE ENERGY STALEMATE: A BIPARTISAN STRATEGY TO MEET AMERICAN'S ENERGY CHALLENGES 25 (2004).
35. S. RES. 98, 105th Cong., 1st Sess. (July 22, 1997); 143 CONG REC. S8138 (daily ed. July 25, 1997).
36. *Id.* §1(1) (A). During debate on the resolution, Senator Byrd stated several times that it did not mean developing country commitments would have to be the same as developed country commitments. 143 CONG. REC. S8117 (daily ed. July 25, 1997). "While countries have different levels of development, each must make unique and binding commitments of a pace and kind consistent with their industrialization." *Id.* at S8131.
37. S. RES. 98, *supra* note 35, § (1) (B).
38. Letter from President George W. Bush to Senators Hagel, Helms, Craig, and Roberts (March 13, 2001), http://www.whitehouse.gov/news/releases/2001/03/20010314.html.
39. *Id.*
40. The Protocol could not become effective until countries accounting for 55 percent of the carbon dioxide generated by "Annex I" industrialized nations had ratified it. Kyoto Protocol, *supra* note 31, art. 24.1. After the U.S. declined to ratify the Protocol, the Protocol could only become effective if Russia ratified it.
41. President George W. Bush, Invitation to Meeting of Major Economies on Energy Security and Climate Change, Aug. 3, 2007, http://www.whitehouse.gov/news/releases/2007/08/20070803-7.html.
42. U.S. Department of State, Final Chairman's Summary: First Major Economies Meeting On Energy Security and Climate Change, Sept. 27-28, 2007, http://www.state.gov/g/oes/climate/mem/93021.htm.
43. *See, e.g.,* John Dernbach and the Widener University Law School Seminar on Global Warming, *Moving the Climate Debate from Models to Proposed Legislation: Lessons from State Experience*, 30 ENVTL. L. REP. (Envtl. L. Inst.) 10,933 (2000).
44. Regional Greenhouse Gas Initiative, Model Rule and Amended Memorandum of Understanding, http://www.rggi.org/modelrule.htm (last visited Sept. 21, 2007).
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Professor Jason Mazzone of Brooklyn Law School in 2003, at the CAPS Supreme Court program

Committee on Attorneys in Public Service

2008 Annual Meeting Highlights

Tuesday, January 29, 2008 was the Committee on Attorneys in Public Service (CAPS) day during the 2008 NYSBA Annual Meeting week. The Committee hosted two educational programs and its annual Awards for Excellence in Public Service reception.

2008 Annual Meeting Educational Programs

The morning educational program featured distinguished Professor Susan N. Herman and Professor Jason Mazzone of Brooklyn Law School, who spoke on the topic "The Supreme Court: Past, Present, and Future." The professors discussed the Roberts' Court's first full term, and the Court's 2006 Term in historic perspective.

The afternoon program was entitled "Introducing the New Commission on Public Integrity."

On September 24, 2007 the New York State Ethics Commission and the New York Temporary State Commission on Lobbying became the New York State Commission on Public Integrity as a result of the Public Employee Reform Act of 2007 (PERA 2007). The CAPS program was intended to provide participants with an overview of the new Commission. The CAPS program featured three representatives from the Public Integrity Commission: Executive Director Herbert Teitelbaum, Counsel Ralph Miccio and Director of Training John Mancini.

Susan N. Herman, Centennial Professor of Law at Brooklyn Law School, lectures to CAPS program attendees on the recent term of the Supreme Court under Chief Judge John Roberts

John Mancini

Ralph Miccio

Herbert Teitelbaum

Public Integrity panelists John Mancini, Herbert Teitelbaum and Ralph Miccio with program chair Mary Berry at the podium

Panelists Herbert Teitelbaum and Ralph Miccio, with John Mancini at the podium

Barbara Smith and Mark Davies

NYSBA President Elect Michael Getnick, Court of Appeals Judge Eugene Pigott, Jr. and past NYSBA President Robert Witmer

Barbara Smith

Awards for Excellence in Public Service

Since 2000, the Committee on Attorneys in Public Service has honored individuals in the legal profession who have demonstrated excellence in the commitment to, and performance of, public service. For 2008, CAPS was pleased to honor two members for its annual awards. These individuals were: Mark L. Davies, Executive Director, New York City Conflicts of Interest Board, New York, NY and Barbara F. Smith, Executive Director, New York State Lawyer Assistance Trust, Albany, NY, and former CAPS chair.

CAPS chair Patricia Salkin, Raymond & Ella Smith Distinguished Professor of Law, Associate Dean and Director Government Law Center of Albany Law School served as emcee of the Event. NYSBA President Kathryn Grant Madigan presented the awards to Mr. Davies and Ms. Smith.

Mark Davies

Daniel McMahon, NYSBA Director of Publications, Sharon Stern Gerstman, former Executive Committee Member, and Timothy Taylor

NYSBA past President Kathryn Grant Madigan, Barbara Smith and CAPS Chair, Patricia Salkin

Barbara Smith, Anthony Cartusciello, CAPS Awards co-chair, Mark Davies, Patricia Salkin and Kathryn Grant Madigan

Hon. Sarah L. Krauss, NYSBA's Lawyer Assistance Committee Chair, Patricia Spataro, Director of NYSBA's Lawyer Assistance Program, Kathryn Grant Madigan, Barbara Smith, and Eileen Travis, NYC Bar's LAP Director

NYSBA Committee on Attorneys in Public Service

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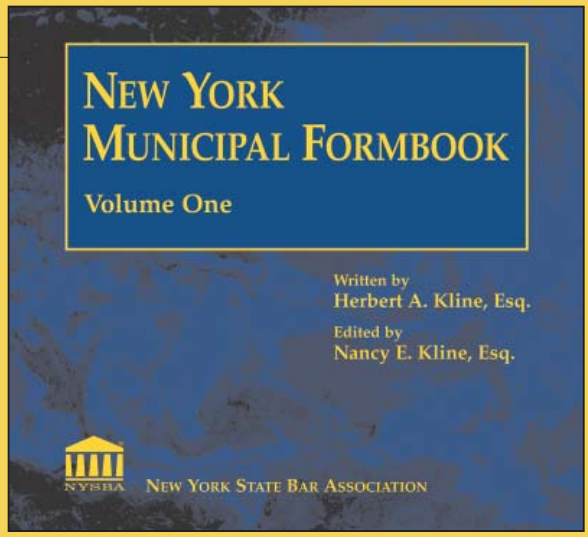

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