# A Strategy to Reduce U.S. Greenhouse Gas Emissions

## A Message to the Nation

The American Response
To Climate Change Conference

The Wild Center
Tupper Lake, New York

June 25 & 26, 2008

By Carter F. Bales and Richard D. Duke

# EXECUTIVE SUMMARY

The need to sharply reduce greenhouse-gas (GHG) emissions in the United States is becoming increasingly apparent and is broadly understood among America's opinion leaders. Accordingly, support is growing for an effective program of federal action to address the issue.

Urgent action is essential, as U.S. GHG emissions are projected to grow rapidly, given an expanding population, higher per-person energy consumption, and an expanding—though temporarily derailed—economy, all of which are dependent on carbon-based energy. In addition, many of the low-cost/no-cost abatement options are perishable with the passage of time: indecision only ensures more energy-*in*efficient buildings built, appliances installed, and transport vehicles on the road—all with long economic lives and slow replacement rates. Developing new energy technologies at commercial scale and transitioning to a low-carbon energy infrastructure also involve long lead times; delays in these investments lead to more carbon buildup in the atmosphere and the need for much more costly accelerated emissions reductions in the long-run.

An acknowledged essential step is to enact a well-designed declining emissions cap that puts a price on carbon emissions (and, to the extent possible, other GHGs) to encourage a least-cost transformation to a clean-energy economy. This should take the form of a national cap-and-trade (or, what might be called a cap-and-invest) system with the goal of reducing economy-wide emissions by at least 80 percent by mid-century (the minimum U.S. abatement target advocated by climate scientists). This system, and any complementary legislation or regulations, must also provide three additional elements for an effective overall abatement strategy:

1) **Rapid adoption of effective measures to promote energy efficiency** by overcoming non-price barriers (such as lack of information about efficient technologies and split incentives between building owners who choose how much to invest in efficiency improvements and tenants who pay utility bills).

2) **Increased federal support for research, development, *and deployment* of clean-energy technologies** to ensure a strong pipeline of new low-cost solutions, despite innovation spillovers that discourage companies from investing to bring new technologies to market in the complex and slow-moving energy sector. Innovation support is needed for approximately 20 to 30 percent of year-2030 abatement solutions (plus an ever-growing share of post-2030 abatement) identified by McKinsey in their 2007 report, *Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost?*

3) **Specific measures to unlock low-cost abatement in uncapped sectors such as forestry and agriculture**. These policy measures are necessary since emissions from these sectors are dispersed across many small sources and include carbon sinks, both of which are difficult to measure and include under a cap. Thus, a cap would do nothing to incentivize the capture of the significant opportunities available from forestry and land use, most of which involve increasing the country's annual biosequestration sink and represent relatively low-cost abatement options.

All four parts of this program of federal action are essential. Simply enacting a cap-and-trade program will not, in itself, be sufficient. Relying solely on a carbon cap (or carbon tax) would require high pollution allowance prices to compensate for failing to adopt the three strategies noted above.

If a pure carbon cap approach failed to motivate *any* energy efficiency due to non-price barriers, the net economic cost of reducing 2030 emissions by 30 percent from current levels under McKinsey's high-range scenario would increase by more than $140 billion per year. If a pure carbon cap approach failed to motivate *any* cellulosic ethanol, biomass, solar power, or carbon-capture-and-storage (CCS) alternatives due to non-price innovation barriers, the year-2030 economic cost according to McKinsey's high-range scenario would increase by nearly $80 billion. Finally, failure to tap the associated low-cost abatement potential from the land-use-related abatement opportunities would increase the annual economic burden in 2030 by more than $20 billion.

In sum, failure to complement a cap with measures to scale efficiency, encourage innovation, and unlock non-fossil-fuel abatement would increase the year-2030 cost of emissions reductions by roughly $250 billion per year and would imply far greater wealth transfers among economic actors, because a higher marginal carbon price would raise energy prices throughout all sectors of the economy, from consumers to industry.

In light of the complexity of the GHG emissions issue, the Federal government should work to promote uniformity of approaches across the nation in order to promote certainty for industry and move forward as rapidly as possible. However, considering the different levels of political commitment across the United States, it should also allow states to set even-higher performance standards to "show the way" for both other states and the Federal government.

Scaling up GHG abatement solutions in the United States will require clean infrastructure investments (including low-carbon energy generation, smart grids for energy efficiency, mass transit, and the like) totaling roughly $3-5 trillion over the next two decades, including redirecting most of the $3 trillion currently planned for expanded conventional fossil-fuel infrastructure toward clean solutions (this number excludes the effect of energy subsidies). However, even under the very conservative assumption that the *average* cost of emissions reductions will range up to $50 per ton, the total U.S. economic burden for addressing GHG emissions would only reach 1 percent of GDP by 2030. The solution is affordable.

* * *

The time has come for the United States to lead the fight against global warming at home and abroad. We are the world's leading innovator, and many U.S. businesses are beginning to recognize the profit potential of clean-energy alternatives. With forceful federal legislation and global negotiations, our nation can transition to real investment in a new energy economy that restores economic growth by building a world-class domestic energy infrastructure while protecting the planet and improving energy security.

# Preface

More than 200 invited leaders in the fields of business, government, academia, and environmental advocacy gathered at The Wild Center in Tupper Lake, New York, on June 25th and 26th, 2008 to examine the issue of U.S. GHG emissions and what can be done to reduce these emissions in line with reductions being called for by climate scientists.

All GHG emissions sectors were considered, but special emphasis was given to the buildings sector, the power generation sector, and the forestry and agriculture sectors. Leadership teams produced comprehensive briefing documents in advance of the gathering which supplied participants with a framework of options and potential economic impacts.

A final plenary session was held to synthesize the group's recommendations into an integrated, workable strategy for abating U.S. GHG emissions. This document is the product of that work.

The contents of this memorandum do not necessarily represent the views of the members of the Advisory Council or conference participants or their affiliated organizations and no endorsement is implied by listing these advisors and participants at the end of this memorandum.

Presentations and other materials from the conference can be found at the conference website: www.usclimateaction.org

* * *

Carter F. Bales is Managing Partner Emeritus of The Wicks Group of Companies. Richard D. Duke is Director of the Center for Market Innovation at the Natural Resources Defense Council.

New York, NY
November 2008

# A Strategy to Reduce U.S. Greenhouse Gas Emissions

## *A Memorandum of Recommendations arising from the American Response to Climate Change Conference*[1]

The need to sharply reduce greenhouse gas (GHG) emissions in the United States is becoming increasingly apparent and broadly understood among America's opinion leaders. Support is growing for an effective program of federal action to address the issue.

The reasons for immediate U.S. action on climate emissions are well known and only summarized here:

- The head of the Intergovernmental Panel on Climate Change (IPCC) has stated that the world has until 2015 to take meaningful action before we will have committed ourselves to devastating global climate disruption. Time is running out.

- Recent data show that GHG emissions are growing at a more rapid pace than forecast by leading scientists, including the IPCC. Global emissions grew 3 percent in 2007 despite a significant slowing in the world economy.

- The United States is the largest GHG emitter on a per-capita basis and the second largest emitter on an aggregate basis.

- The United States has many low or "negative" cost opportunities for abating GHG emissions and, thus, could significantly reduce emissions at little or no net cost to its economy.

- The cost of delay is high, since emissions are growing and GHG's are building up in the atmosphere (GHGs last 100 years or more). Many abatement options are, in fact, "time perishable" (more inefficient houses/commercial buildings built, more inefficient appliances installed, more inefficient vehicles on the roads).

- Many co-benefits will accrue from addressing GHG emissions, including transitioning to a more secure and ultimately lower-cost energy infrastructure

[1] Prepared by Carter Bales and Rick Duke, with advice and input from members of the American Response to Climate Change Conference Advisory Council.

and significantly lowering emissions of other associated pollutants such as lead, mercury, and sulfur dioxide, which causes acid rain.

- Climate legislation will provide a stable incentive structure and financial flows, thereby enabling clean-energy infrastructure investments that will steadily reduce the nation's dependence on fossil fuels and associated financial and national security vulnerabilities.

- The United States is a global innovation leader and could develop many profitable new industries that address GHG emissions domestically and provide opportunities to export solutions abroad.

- U.S. leadership is essential to getting other nations to collectively commit to a "Grand Bargain on Climate Change". Most other nations will not move forward without the United States stepping up to its responsibilities. This is the ultimate "prisoners' dilemma," requiring a level of coordinated global leadership and action unprecedented in history.

- If the United States continues to fail in its leadership obligations on climate change, the nation will face much greater capital investment requirements in future years, both in the domestic "adaptation economy" and abroad through additional foreign aid.

The United States must vigorously pursue a global climate-containment regime that includes adaptation assistance for developing countries. However, serious international progress will likely prove impossible absent U.S. leadership in addressing its own emissions. This memorandum focuses on four critical and immediate actions that the U.S. must take:

1) An essential step is to enact a national cap-and-trade system that reduces economy-wide emissions at least 80 percent by mid-century (the minimum U.S. target advocated by climate scientists).

This system, and any complementary legislation, must also:

2) Overcome barriers to low or "negative-cost" energy efficiency opportunities across the economy.

3) Increase R&D and technology deployment support for emerging low-carbon technologies.

4) Take advantage of abatement opportunities in the generally "uncappable" forestry and agriculture sectors.

## Established science calls for urgent reductions in global GHG emissions

The basic science is settled: human activity has increased the average surface temperature of our planet by 0.7°C since the advent of the Industrial Age, and we are in the midst of a radical experiment that will warm the planet from 1°C to 6°C by 2100, with additional increases thereafter unless the world sharply reduces GHG emissions.

We anticipate that median expected warming of 2°C to 3°C by 2100 will commit the world to serious consequences, including a sea level rise of from 0.2 to 0.5 meters; a "very likely increase in frequency of hot extremes, heat waves, and heavy precipitation"; and a "likely increase in tropical cyclone intensity" (IPCC Fourth Assessment Report, 2007). Moreover, there is a profound downside risk, driven by compounding uncertainties over the extent of possible warming, the physical impacts of any given level of warming, and the social consequences of those physical transformations. Examples of potential extreme physical impacts include the collapse of major ecosystems such as tropical rainforests and the loss of parts of Greenland or other major ice shelves, the latter conceivably over a period of decades rather than centuries, with an attendant sea level rise of up to 7 meters.[2]

Anticipating geopolitical turmoil from such impacts, *The Age of Consequences* report, released by the Center for Strategic and International Studies in November 2007, identifies three possible scenarios:

- The expected outcome of a 1.3°C increase by 2040 implies "heightened internal and cross-border tensions caused by large-scale migrations; conflict sparked by resource scarcity…increased disease proliferation…and some geopolitical reordering..."

- Under the severe outcome of a 2.6°C increase by 2040, "massive nonlinear events in the global environment give rise to massive nonlinear societal events."

- The catastrophic outcome involves a 5.6°C rise by 2100, with social chaos evoking "Mad Max, only hotter."

Similarly, the *2007 CNA Report* by eleven retired U.S. generals calls global warming a "serious threat" to national security with "the potential to create sustained natural and humanitarian disasters on a scale far beyond those we see today [and it is likely to]

[2] See, for example, Schneider, Stephen H.; "Abrupt Non-Linear Climate Change, Irreversibility and Surprise"; ENV/EPOC/GSP (2003)13/FINAL. Also, "Amazon collapse in the next century: exploring the sensitivity to climate and model formulation uncertainties;" Global Environmental Change; GC44A-10; Booth, Ben et al.

foster political instability where societal demands exceed the capacity of governments to cope."

Measurable economic losses will also likely prove substantial. In 2006, the British government released a report prepared by Sir Nicholas Stern, former chief economist at the World Bank, which concluded that, if global warming continues unabated, per-capita economic losses worldwide could reach the equivalent of 5 to 20 percent of worldwide gross domestic product over the next 200 years—excluding national security risks.

In sum, the expected "median case" costs of global warming are severe, and the potential range of adverse impacts pose a grave threat to international economic and military security. The global community should, therefore, be prepared to invest heavily to reduce GHG emissions as insurance against these potentially catastrophic and largely irreversible outcomes.

For the purposes of this memorandum, the authors accept the widely cited target of an minimum 80 percent reduction in U.S. and EU GHG emissions below 2005 levels by the year 2050, which would allow some headroom for emissions growth in developing countries while still stabilizing global emissions at roughly 450 ppm $CO_2$e (carbon dioxide equivalent, i.e., all GHGs), with expected warming limited to approximately 2°C. Establishing a credible path toward this mid-century target suggests that reductions in the range of 30 percent from current emissions will be necessary by 2030. We assume that the United States will have to do at least its "fair share", as represented by the 80 percent target, but acknowledge that the United States and other wealthy nations may have to go beyond these targets if developing countries lag in controlling their emissions or if the scientific community's consensus becomes more alarming.

Summary of Key Findings from the 2007 McKinsey Report: *Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost?*[3]

- U.S. Government sources project annual GHG emissions will rise 35 percent by 2030 (vs. 2005 emissions levels)—in sharp contrast to reductions called for by climate scientists and legislation recently before the U.S. Congress.

- Sufficient abatement potential exists at less than $50 per ton of $CO_2$e (3.0 Gt in the “medium-range” case and 4.5 Gt in the “high-range” case - goals that would involve rapid and comprehensive legislative action) to reduce U.S. emissions 28 percent from 2005 levels by 2030. Moreover, this potential does not assume curtailing steadily improving living standards, and relies only on proven or high-potential emerging technologies.

- Abatement opportunities are distributed broadly across sectors and geographies of the United States. No single option accounts for more than 12 percent of the target, and most options account for much less. Thus, any solution must be economy-wide.

- Roughly 40 percent of identified GHG reductions that lead to energy-efficiency gains generate net savings to the U.S. economy over their lifetimes. If captured, these efficiency savings can substantially offset remaining capital, operating, and maintenance costs required to reach target abatement levels.

- Achieving reductions at lowest cost to the U.S. economy requires strong, coordinated, economy-wide action that begins in the near future, including (a) visible, sustained signals to create greater certainty about the price of carbon, (b) rapid pursuit of energy-efficiency and negative-cost options, (c) development of a low-carbon energy infrastructure, (d) strong support for research, development, and dissemination of promising low-carbon technologies, and (e) efforts to capture cost-effective emissions-reduction initiatives in the uncapped sectors of the economy.

## The United States must demonstrate leadership in controlling its emissions

While the European Union, Japan, and Australia have all taken strong steps toward controlling their GHG emissions, the participation of the United States is a necessary next step toward a global, long-term GHG reduction strategy. As the source of 20 percent of global emissions, the only remaining major wealthy nation yet to act, and an indispensable party to any decisive international climate change regime, the United

[3] *Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost*, McKinsey & Company, December 2007.

States must begin reducing its emissions now so that it will have the credibility to drive negotiations toward a comprehensive solution.

The task of controlling GHG emissions is much larger than any environmental effort ever undertaken and requires at least an order of magnitude more investment in solutions. For example, the GAO estimates year-2000 compliance costs for the 1990 Clean Air Act amendments at $19 billion per year.[4] The annual capital investment in clean solutions required to unlock even the mid-range scenario in the McKinsey Report likely exceeds $100 billion per year, considering both reallocation of most of the $3 trillion in business as usual (BAU) capital expenditures currently expected for conventional fossil-fuel infrastructure, as well as over $1 trillion in additional cumulative investment in clean solutions through 2030.

Note that excluded from this estimate are current outlays for energy subsidies by the federal and state governments of approximately $150 to $200 billion per year.[5] If subsidies were removed, much of the incremental capital could be funded from cost savings on a societal basis.

## Four market failures

There are four distinct market failures that must be addressed to ensure a least-cost, politically feasible solution:

- Absence of a price on GHG emissions.
- Non-price market barriers to energy efficiency.
- Learning-by-doing spillovers that constrain innovation in clean-energy technology.
- Lack of price incentives to pursue abatement measures outside the capped sectors (principally land-use measures in forestry and agriculture).

Relying solely on a carbon cap (or carbon tax) to drive necessary emission reductions would require high pollution allowance prices to compensate for the latter three market

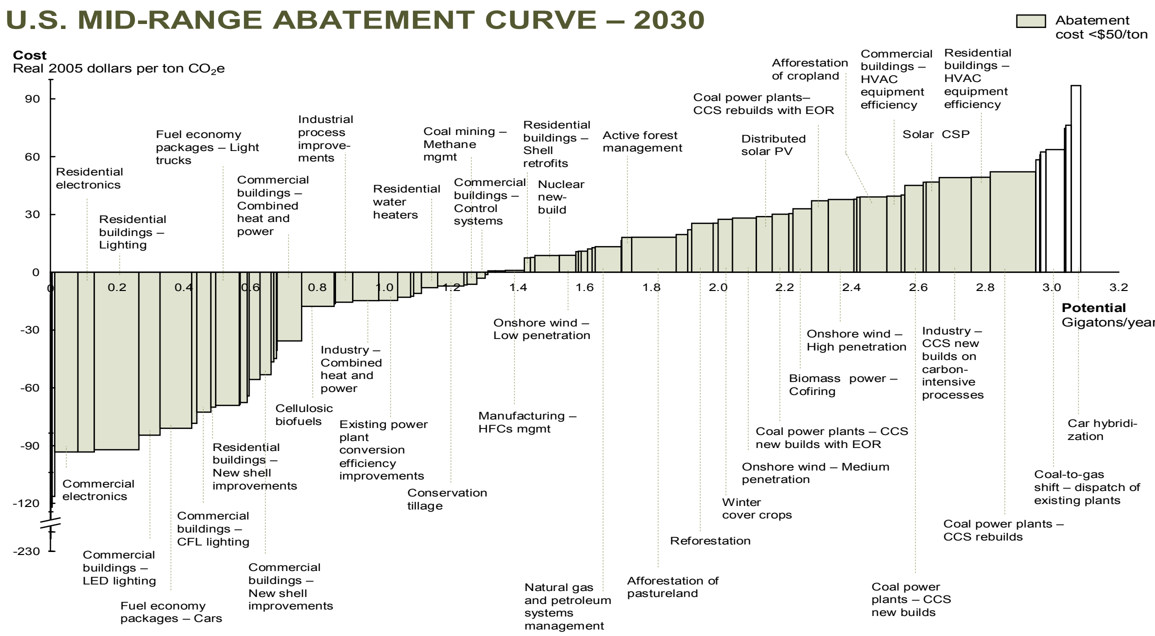
[4] "CLEAN AIR ACT: EPA Should Improve the Management of Its Air Toxics Program"; June 2006; GAO-06-669.

[5] Fossil subsidies come in many varieties: access to federal lands for energy production, low royalty payments, technical assistance, R&D assistance, maintenance of the strategic petroleum reserve, tax breaks and many other federal policies. In addition, considerable subsidies are offered by states as well as the federal government. The Presidential Climate Action Plan recommends a redirection of existing federal loan, loan guarantee, and grant programs from carbon-intensive to carbon-reducing activities and a review of federal subsidies that indirectly result in carbon emissions.

failures outlined above.  This, in turn, would raise the risk that voters would demand some form of relief, thus jeopardizing emissions reduction goals.

Understanding the specifics of these market failures can aid in developing sustainable, cost-effective solutions.  In particular, a close assessment of the McKinsey cost curve (Fig. 1) underscores the need for an integrated strategy to hold down abatement costs.

Figure 1




Source: McKinsey analysis

## Non-price market barriers to energy efficiency

Nearly all energy-efficiency measures identified by McKinsey provide a positive economic payoff even without a carbon price in place.  As illustrated in Figure 1, the economic benefits from improved energy productivity have the potential to roughly cover the cost of cleaning up the remaining required energy supply.[6]  However, these savings are not already built into BAU forecasts precisely because non-price barriers, such as split incentives and information constraints, block their adoption.

Collectively, these barriers mean that price signals from a carbon cap would be of limited value in motivating investment in energy-efficiency opportunities, as the price signal alone would not spur the necessary changes in behavior.

[6] Assuming $59 per barrel oil and $8.60 per million BTU gas in 2030 per DOE projections.

If a pure carbon cap approach failed to motivate *any* energy efficiency, the net economic cost of reducing 2030 emissions by 30 percent from current levels would increase by more than $140 billion per year under McKinsey's high-range scenario.[7]

**Learning-by-doing spillovers that constrain innovation in clean-energy technology**

Much of the potential identified by McKinsey requires research, development, and *deployment* support or those abatement reductions that may otherwise not be available at less than $50 per ton by 2030.

For example, at current costs, distributed solar photovoltaic (PV) electricity requires a price exceeding $250 per ton of $CO_2e$ to break-even in most U.S. markets. Nonetheless, most analysts expect PV to become broadly competitive with retail power rates by 2015 - even without a price on carbon - but only if public support continues to drive rapid market expansion, associated economies of scale, and learning-by-doing over the next decade. Similarly, cellulosic biofuels and CCS technologies have not yet been "proven to scale." Many analysts expect the 2007 Energy Bill will achieve full commercialization of cellulosic technologies by 2020, but the right policy package to commercialize CCS has yet to materialize.

If a pure carbon cap approach failed to motivate *any* cellulosic ethanol, solar power, or CCS alternatives, the year-2030 economic cost of McKinsey's high-range scenario would increase by nearly $80 billion.[8]

**Lack of incentive to pursue abatement measures outside the capped sectors**

Finally, a cap-and-trade system for fossil and industrial emissions does not cover smaller and more diffuse non-$CO_2$ agricultural sector emissions, nor does it incentivize capture of the many biosequestration opportunities available from forestry and land management. Unlocking the abatement potential within these uncapped sectors thus requires specific policy measures above and beyond the cap-and-trade system.- Failure to tap the associated low-cost abatement potential from these land-use-related abatement opportunities would increase the annual economic burden in 2030 by more than $20 billion.[9]

* * *

[7] Assuming $50/ton for additional marginal abatement from retrofit carbon capture and storage to make up for the failure to unlock energy efficiency potential. Note that this figure and all figures in this report are in 2005 dollars.

[8] Assuming $80/ton for additional switching from coal to gas required to make up for the failure to unlock innovation potential.

[9] Assuming $50/ton for additional marginal abatement from retrofit CCS to make up for the failure to unlock non-fossil abatement potential.

In sum, failure to complement a cap with measures to scale efficiency, encourage innovation, and unlock non-fossil-fuel abatement in uncapped sectors would increase the year-2030 cost of emissions reductions by roughly $250 billion per year and would imply far greater wealth transfers among economic actors, since a higher marginal carbon price would raise energy prices throughout the economy.

## Four market-based solutions

To make an abatement solution affordable and politically acceptable, the United States urgently needs a "quartet" of aggressive federal policies (referred to as the "Four Policy Planks"):

1) **A well-designed declining emissions cap that puts a price on carbon** (and, to the extent possible, other GHG emissions) to encourage least-cost transformation to a clean economy.

2) **Rapid adoption of effective measures to promote energy efficiency** by compensating for non-price barriers (such as lack of information about efficient technologies and split incentives between building owners who choose how much to invest in efficiency improvements and tenants who pay utility bills).

3) **Increased federal support for research, development, *and deployment* of clean-energy technologies** to ensure a strong pipeline of new, low-cost solutions despite innovation spillovers that discourage companies from investing to bring new technologies to market in the complex and slow-moving energy sector.

4) **Specific measures to unlock low-cost abatement from the forestry and agriculture sectors** given the difficulty of including them under an emissions cap.

Scaling up GHG abatement solutions in the United States will require clean infrastructure investments (including low-carbon energy generation, smart grids for energy efficiency, mass transit, and the like) totaling roughly $5 trillion over the next two decades, including redirecting $3 trillion currently planned for conventional fossil-fuel infrastructure toward clean solutions (this number excludes the effect of energy subsidies, as noted). Given the magnitude of the investments in questions, it is critical that we get the rules right from the start, since every policy detail could translate into billions of dollars in spending.

We start with three design principles to guide our effort to translate the broad *cap-and-invest* strategy into specific recommended policies. Wherever possible, U.S. climate-abatement legislation and regulations should be:

- *Market-driven*, i.e., targeted as closely as possible to specific market failures, as well as comprehensive and stable to encourage investment in least-cost solutions.

- *Equitable* (to the extent possible) for all parties in order to achieve a standard of fairness as well as to maintain political support for action.

- *Rapidly-enacted and implemented* to ensure that we do not continue sinking capital into old polluting infrastructure while we work to scale new, clean-energy industries.[10]

Strong federal leadership is essential in order to move quickly toward a fair market-driven solution. Only federal action can rapidly establish clear economy-wide rules that unlock least-cost abatement strategies.

A swiftly adopted, strong federal cap-and-trade system should replace existing state and regional systems. However, where feasible, a federalist approach should be encouraged to allow state-level innovation, and states should remain empowered to push for tougher action going beyond what national politics supports.

One attractive idea is to move toward a program of "performance-based federalism," in which states that make substantial progress in reducing GHG emissions (through stronger building codes, smart growth development through transit-friendly land development, expanding state and local open space programs, etc.) would be rewarded through federal incentives funded by revenue from the auction of emissions allowances under the cap-and-trade program.

Pioneering states like California, which is already implementing state-wide, cap-and-trade under "AB32," would still benefit from having pushed their economies toward lower carbon infrastructure and associated clean industries. It may also make sense to allow leading states to push for faster overall reductions by purchasing and retiring federal allowances should their constituencies support such "over-compliance."

A federalist approach is equally important for complementary cost-minimization policies—e.g., the Federal government should establish minimum energy-use standards for appliances (while still allowing leading states to move ahead to set more stringent

[10] Flexibility of implementation will be essential so the Federal government can adjust to market conditions without having to go back to Congress for new legislation. Congress should provide the Administration with a range in which it is allowed to adjust the cap. Some advocate the creation of a Carbon Fed with this authority.

standards). Similarly, federal support for R&D needs to be augmented and explicitly complemented by forceful federal deployment policy. Finally, as with carbon abatement under a cap, non-fossil-fuel abatement should be encouraged through federal policies to ensure that the cheapest measures available anywhere within the United States are unlocked as early as possible; thus, specific initiatives to expand the domestic carbon sink and encourage abatement in the forestry and agricultural sectors should be included in Federal policy.

## Policy Plank #1: Cap and Trade to Motivate the Overall Transition to a Clean Economy

A carbon cap-and-trade system ensures that polluters pay for carbon emissions by requiring all major emitters to submit allowances equivalent to their emissions, usually on an annual basis.[11] A well-designed system should be:

- **Economy-wide**, including all (or practically all) $CO_2e$ emissions, all industrial gases, and all large-source agricultural/landfill sources.
- **Set to decline over time,** so the pressure on emitters to act is clear and of increasing force.
- **Unburdened by any "safety valve"** provisions to loosen the cap should carbon prices rise above a threshold level.
- **Long-term**, with inter-year banking and borrowing to minimize investor uncertainty by smoothing price signals.
- **Verifiable,** allowing "offsets" only where it is possible to confirm that emissions reductions from individual projects undertaken outside of capped sectors are real and "additional."
- **Structured to maximize public benefit** by using the value created by emissions allowances to ease the transition to a clean-energy economy through support for efficiency, innovation, and non-fossil-fuel abatement**.**

A cap-and-trade system with these elements is consistent with our recommended policy design principles and would form the cornerstone of a credible emissions-reduction program.

[11] The Presidential Climate Action Plan advocates an upstream cap-and-auction system that makes "producers," rather than "emitters," the target of emissions allowances. The Warner-Lieberman Bill contained a mixture of upstream for hard to reach sectors such as transportation, and midstream for utilities and large industries.

Cap-and-trade systems are inherently *market-driven*, in that they enable emitters to identify or develop the lowest-cost abatement strategies, including simply purchasing excess allowances from other emitters who may be better positioned to make emissions cuts. Moreover, experience from earlier cap-and-trade systems suggests that this approach unleashes considerable cost-reducing innovation. For example, under the sulfur dioxide cap-and-trade program, market innovations such as widespread shifting to low-sulfur coal substantially reduced compliance costs relative to initial expectations.

In exchange for emissions-reduction certainty, cap-and-trade systems necessarily imply emissions allowance price volatility that may pose a challenge for investors making long-term capital allocation decisions, but price uncertainty can be alleviated through careful regulatory design. In particular, caps should be set with a long time horizon, and substantial banking/borrowing of allowances across years, to ensure a relatively stable long-term price signal. Regulators should encourage the emergence of robust secondary trading markets to enable hedging strategies to deal with remaining allowance price uncertainty.

A domestic carbon cap can be *equitable*. Under a domestic cap, the annual value of allowances will likely approach $100 to $200 billion (roughly 6 Gt of allowances initially at a minimum estimated price of $20 or more per ton of $CO_2$).[12] All allowances should be auctioned off to emitters and intermediaries in order to produce a fair market-based response. As much as possible of this value should redound to the public good, with particular attention to low-income households and other population segments particularly hard hit by the costs of transition to a clean-energy economy. Other examples of legitimate uses of allowance value include federal incentives for new super-efficient appliances; increased funding for research, development, and deployment of low-carbon technologies; and open-space acquisition plus tree-planting programs to expand carbon sinks.

An equitable approach ensures the broadest possible economy-wide response while rewarding emitters who act to reduce their emissions today in advance of regulatory clarity. The alternative is windfall profits for emitters who recover $CO_2$ cost increases twice: by passing higher marginal production costs to consumers while receiving their emission allowances free. In the EU, for example, utilities were given grandfathered $CO_2$ allowances, but they also raised power prices and earned windfall profits on the order of $20 billion per year in 2005 and 2006.

[12] This estimate excludes the possibility of benefits from removing current subsidies to fossil power generation. If removed, the net effect would be to increase the funds available for redirection to support the transition to a low carbon economy or provide additional tax relief to the public. The authors believe that federal subsidy reform should go hand-in-hand with a cap-and-trade policy.

Many have argued that the economic effect of a cap with revenue derived from allowances should be revenue neutral. Some call for an offset to employment taxes, substituting, in effect, one tax in the form of higher energy prices driven by a cap on carbon emissions for an undesirable tax on human activity, under the principle that government policy should stimulate employment and de-stimulate the use of limited natural resources, particularly polluting resources such as hydrocarbons. Others favor a "tax and dividend" approach, where the tax is given back to the public through monthly deposits of an equal amount per person (monthly dividends). These approaches have appeal, as long as the direct costs of transitioning to a low-carbon economy are paid for, which suggests that the citizen "dividend" would be phased in gradually as the transition costs are phased out.

Strong pressure from major emitters to receive allocations to cover the cost of transitioning to clean technologies will, of course, arise; however, the United States must resist these pressures since emitters will recover nearly all their transition costs simply by adjusting prices upward to pass through increased costs to their customers. In fact, recent analyses suggest that grandfathering 10 to 20 percent of allowances to electricity generators, based on past emissions, would completely compensate the sector for any loss in asset valuations from $CO_2$ regulations.[13] Moreover, the rationale for such compensation becomes increasingly unclear as carbon risk looms larger on the horizon.

Cap-and-trade systems can be *rapidly enacted* where the political will supports action. For example, the EU launched a functioning (if initially flawed) carbon cap-and-trade system in 2005, and the Regional Greenhouse Gas Initiative (RGGI) in the Northeast has recently launched. Negotiating and launching separate state-by-state initiatives would take more time than the nation can afford, so rapid enactment of a federal cap is essential.

[13] Burtraw and Palmer, Resources for the Future, DP 07-41.

**Why a Cap-and-Trade System is preferable to a Carbon Tax in light of political-economy realities and other factors**

A carbon tax is another option for creating a broad, economy-wide incentive to reduce GHG emissions. This approach has possible advantages over a cap-and-trade system, including administrative simplicity and investor certainty. On closer inspection, however, neither of these virtues is definitive. Administering a carbon tax requires careful monitoring and verification—e.g., some fossil fuels end up "sequestered" in long-lived products, so a simple upstream tax is not fair to manufacturers who produce products like petroleum-based plastics. Moreover, long-term carbon prices under a tax approach are not necessarily more predictable than under a cap, since politicians may decide to either substantially reduce or increase tax levels, depending on how closely the nation is tracking toward abatement targets.

Most importantly, a cap on carbon provides more fundamental environmental certainty than a tax, both because it is, by definition, a fixed limit on emissions and because the political process to define a cap is less likely to result in emissions loopholes. In particular, the political horse-trading involved in defining a cap centers on distributing a fixed number of total allowances—with equity and economic productivity implications but no impact on future emissions levels. In contrast, negotiations to define a carbon tax might result in exemptions for certain sectors, which would allow higher emissions levels.

In sum, both a carbon cap and a carbon tax can cost-effectively control GHG emissions when combined with regulations to overcome market barriers to efficiency and innovation. On balance, however, a carbon cap is likely to be more effective in ensuring that the nation reaches essential emissions-reduction goals.

## Policy Plank #2: Energy-Efficiency Policy to Provide Immediate Energy Productivity Benefits

Non-price market barriers block energy-efficiency investments that are highly cost-effective even absent concerns over $CO_2$ emissions, other environmental costs, or energy security. Thus, implementing policies that overcome these barriers would generate large economic benefits to the nation in addition to generating important and long-term emissions reductions.[14]

[14] Note that the Federal Environmental Protection Administration already has the authority to regulate greenhouse gas emissions, which was confirmed by the 2007 action by the Supreme Court. EPA could use the Clean Air Act as an implementing instrument in the new Administration.

Energy-efficiency measures identified by McKinsey have the potential to provide economic productivity benefits of approximately $140 billion by the year 2030. Specific policies to unlock this potential are urgently needed because the benefits are so large and because many of the opportunities disappear if we fail to construct more efficient buildings, buy more efficient vehicles, and optimize new industrial capacity at the time of development.

Efficiency policies divide into three broad categories:

- *Information measures* to help end users make more rational investment decisions, thereby strengthening the price responsiveness of efficiency investments.

- *Incentives and standards* to encourage rapid commercialization of advanced energy-efficient devices while pushing old inefficient models out of the market.

- *Direct efficiency procurement programs* to provide financial incentives to motivate utilities, energy service companies, and other businesses to deliver energy efficiency as a service to end users who otherwise might not invest due to a combination of split incentives, information shortfalls, and cognitive biases.

Information measures are inherently market-driven, while performance-based incentives and competitive programs that procure efficiency can be designed to be market-driven. Collectively, and if scaled appropriately, these measures should serve to rapidly counteract non-price market barriers to energy efficiency.

*Information measures* seek to directly overcome information shortfalls and asymmetries through initiatives such as efficiency labeling for appliances and buildings. For these measures to work, careful design and routine updating are essential. For example, the U.S. Energy Star labeling program is meant to reward top quartile performers; however, qualification thresholds are updated infrequently, and labels often apply to no more than 25 percent of appliances within a given class. Moreover, there is little incentive for manufacturers to exceed the minimum performance level required for an Energy Star label. A more effective approach would offer a range of ratings (e.g., the EU's Five Star system), including performance levels not yet achieved by any appliances and provisions for automatic updating as technical performance improves over time. Similar ratings systems are available for entire buildings, including the Leadership in Energy and Environmental Design (LEED) program and EPA's Energy Star 100-point efficiency scale; however, neither is universally applied. A key goal for information measures is a comprehensive Federal approach to minimize consumer confusion.

*Incentives and standards* seek to ensure that consumers and firms make cost-effective efficiency investments despite non-price barriers. Key measures include vehicle and appliance efficiency standards, minimum efficiency codes for building construction and retrofits, and performance-based standards for both buildings and appliances. While this approach is not fully market-driven, codes and standards should nonetheless be grounded in clear and enforceable technical criteria and should include automatic updating provisions as technologies evolve. While codes and standards raise the minimum bar and remove the worst-performing efficiency levels from the market, incentives are needed to drive the market towards the most efficient products and services.

*Efficiency procurement* programs provide direct financial incentives to encourage utilities and others to deliver energy-efficiency services, particularly to residential and small commercial consumers who are generally less sophisticated than large energy consumers in managing energy costs. Utilities have strong advantages in delivering efficiency given their access to energy consumers, brand recognition, specialized expertise, and low cost of capital. To ensure that utilities can profit from energy efficiency, three steps should be pursued using federal mandates. First, decouple utility profits from sales by allowing a guaranteed return on approved capital investments, regardless of variations from forecast load growth. Second, provide a positive incentive for utilities to deliver energy efficiency based on predetermined performance incentives. Third, impose an Energy Efficiency Resource Standard (EERS) that mandates utilities to deliver energy efficiency in a manner analogous to other quantity mandates such as renewable electricity standards. States, or the utilities they regulate, should be encouraged to directly procure efficiency from third parties such as energy service companies under competitive bids or bilateral contracts when that results in the most cost-effective approach.

The 2007 Energy Bill was a significant step forward for energy efficiency in both the buildings and transportation sectors. It has performance-based, long-term standards for both vehicle fuel economy and efficient lighting. These combined measures should deliver roughly 400 megatons (Mt) of abatement by 2030 (4 percent of projected BAU emissions) with a net payoff to the economy of roughly $30 billion per year. While a promising start, these measures still leave substantial “money on the table.”

In the buildings sector, McKinsey identified approximately 700 Mt of additional year-2030 abatement potential beyond residential lighting. We need strong federal action to unlock this potential and the associated net benefits, totaling roughly $30 billion per year, by 2030. A federal buildings sector package should start with additional performance-based standards covering all major appliances beyond just residential lighting. $CO_2$ allowance value should be used to support development and deployment of new super-efficient appliances by, for example, providing commercialization support to the very best performing appliances within each product category. Initiatives should also include a strong federal EERS to push states to enact smart regulations that allow them to achieve greater efficiency levels, for example, by allowing utilities to profit from delivering energy efficiency and amending state/local building codes to force measurable efficiency improvements.

Regarding transportation efficiency, Corporate Average Fuel Economy (CAFE) standards in the 2007 Energy Bill unlock most of the potential identified by McKinsey through 2022. It is critical, however, to push for deeper improvements through 2030; to wit, a 2008 IEA review of U.S. Energy Policies says the new U.S. CAFE standards fall far short of the cost-effective potential for improvements. The United States should also create an incentive for manufacturers to exceed CAFE to ensure that this legislation sets a performance floor rather than a ceiling.

The McKinsey study omits measures that reduce vehicle miles traveled (VMT), since these were considered lifestyle altering, but mileage reductions could yield major cost-effective abatement. Academic studies suggest consumers drive approximately 20 percent less for every doubling of fuel prices—meaning that a carbon price of $50 per ton under a carbon cap would reduce driving by roughly 5 percent.[15] Pricing and development strategies might further reduce driving demand, e.g.:

- Federal mandates to force insurers to offer pay-as-you-drive insurance might increase the variable cost per mile "experienced" by consumers by 50 to 100 percent, implying further VMT reductions of roughly 10 to 20 percent.

- Congestion pricing systems such as those already implemented in London and Singapore—and proposed for Manhattan—yield major public benefits by reducing costly transportation delays, encouraging more intensive use of public transportation, and cutting $CO_2$ emissions.

- Zoning liberalization and other "smart growth" policies to enable consumers to choose to live in more compact developments have substantially reduced VMT and public infrastructure expenditures relative to baseline projections for cities as diverse as Providence, Omaha, Portland, and Miami.[16] Moreover, the VMT reduction potential from enabling more compact development is likely to increase substantially as the share of households without children increases due to the aging of the U.S. population.

Collectively, these initiatives and policies could reduce year-2030 driving by roughly one third, yielding more than 800 Mt of additional, cost-effective carbon abatement. [17]

---

[15] A CO2 tax of $50/ton would imply a gas tax of roughly $0.50 per gallon. For $2.00 per gallon gasoline this would suggest a 25% price increase and a 5% reduction in VMT, assuming a price elasticity of demand of 0.2.

[16] See, for example, "Measuring Sprawl and Its Impact" by Reid Ewing, Rolf Pendall, and Don Chen.

[17] Note that the next opportunity to change direction of federal transportation funding will be reauthorization of the Surface Transportation Act, scheduled to come before Congress in 2009.

The industrial sector should respond reasonably well to a carbon cap and related price signals, since most major industrials have full-time staff dedicated to managing energy costs. But industrials typically demand a relatively fast payback and often ignore smaller opportunities that can, in aggregate, prove significant. Consequently, opportunities exist for targeted federal interventions such as minimum standards for industrial motors (which represents a highly cost-effective 50 Mt opportunity in 2030).

Finally, an original policy proposal by the authors would create an Energy Productivity Incentive (EPI) to reward individual states for achieving rapid improvements in overall energy productivity across multiple sectors of the economy. This "performance-based federalism" approach would allocate a disproportionate share of federal carbon allowances, or cash generated from their sale, to states that outperform on reducing their weather-adjusted energy intensity. The underlying metric would ideally be based on a cross-sector, fuel-neutral metric such as BTUs per dollar of Gross State Product; however, political or data limitations may necessitate a more narrowly defined approach such as building sector BTUs per capita and/or VMT per capita.

From a political economy perspective, this approach should appeal to states with advanced energy-efficiency programs, since they will have confidence that they can deliver results, but it should also appeal to lagging states since they have substantial "low-hanging fruit" to exploit once they put the right rules in place. The McKinsey regional breakdown of the cost curve confirms this result, in that the South, a region with relatively weak state energy-efficiency programs, has large cost-effective energy-efficiency potential relative to coastal states that have tapped into more of these programs.

Such incentives would provide a federal level "carrot" to encourage states to scale up efficiency. Ideally, the federal government would complement this approach with a federal "stick" in the form of an EERS that would require all states to procure at least 1.5 percent of their load from new energy efficiency every year (after a reasonable ramp up period), which is broadly in line with the McKinsey scenarios suggesting that aggressive energy efficiency can effectively eliminate load growth through 2030.

**Barriers to cost-effective energy efficiency**

Key barriers include split incentives, information constraints and asymmetries, and cognitive biases. Collectively, these barriers limit the value of price signals for motivating investment in energy-efficiency opportunities.

Split incentives arise when the individual making a capital investment decision is not responsible for paying the long-term operating costs associated with energy consumption. For example, homebuilders often focus on minimizing capital investment rather than minimizing long-term lifecycle costs, since they cannot generally recoup the full value of energy-efficiency investments when selling homes. Similarly, landlords typically under-invest in efficient appliances and weatherization measures when tenants pay the utility bills; conversely, tenants do not closely monitor their energy use when landlords pay utility bills.

Even in cases where incentives are fully aligned, decision makers generally lack reliable information about the range of available efficiency investments. For example, consumers facing a decision as seemingly straightforward as buying a compact fluorescent lamp (CFL) may recoil when forced to choose among light quality options, and they may doubt manufacturers' claims about efficiency savings and lamp longevity. Information requirements for more complex decisions such as selecting the most cost-effective climate-control system are even more daunting. Moreover, consumers often face information asymmetries when negotiating with better-informed vendors and installers who may be more interested in selling the most available and simplest solution rather than minimizing customer lifecycle cost.

Despite theoretical rationality in economic models, real-life end users are notoriously irrational. For example, Kahneman documents a broad range of biases that inhibit decision makers from optimizing their investments.[18] As a result of these biases, and information-related problems, the implicit homeowner discount rates used when making energy-efficiency investment decisions typically far exceed the return end users could obtain from similar low-risk investment options.

Finally, as with individuals, these same cognitive biases may imply inadequate willingness on the part of some companies to allocate capital to finance efficiency (e.g., due to a conservative bias in all capital allocation decisions). Moreover, especially in today's economy, it is sometimes difficult for firms to finance efficiency investments with debt, in part because many potential borrowers have strained balance sheets and also because there is insufficient familiarity with this investment class on the part of lenders, (due in part to lack of relevant performance data and underwriting experience).

[18] See, for example, Kahneman, D. (2003). A perspective on judgment and choice: Mapping bounded rationality. American Psychologist, 58, 697-720

## Policy Plank #3: Innovation Support to Minimize Long-Term Abatement Costs

As with policies to address barriers to energy efficiency, government support for emerging energy technologies can provide strong social returns on investment even without consideration of global warming benefits. Overall energy innovations identified by McKinsey have the potential to reduce year-2030 compliance costs by $80 billion. However, a cap-and-trade program that corrects for GHG externalities will not ensure adequate energy Research, Development and Deployment (RD&D) funding, since innovation spillovers and other barriers will continue to slow the emergence of new clean-energy technologies. Innovation support is needed for approximately 20 to 30 percent of year-2030 abatement solutions identified by McKinsey—and an ever-growing share of post-2030 abatement. Given the long lead time for developing new energy solutions, comprehensive federal innovation support is essential and should be ramped up as quickly as possible.

**Barriers to Clean-Energy Innovation**

The classic *innovation spillovers* rationale for government support of R&D also justifies *deployment* support for promising new technologies in the slow-moving energy sector. This economic rationale for RD&D support for emerging energy technologies is independent of environmental concerns.[19]

Once pilot scale technologies become available, investors face major difficulties in bringing new energy solutions from lab to market. Commercializing energy systems requires intensive learning-by-doing all along the value chain. In theory, first movers could price at a loss in order to gain the necessary production experience to drive down overall costs. Unfortunately, the benefits of learning-by-doing on the part of first movers generally spill over among competitors, making it hard to justify pioneering investments. For example, a project developer working to build a full-scale carbon capture and storage (CCS) facility must invest heavily in first-mover costs: educating the public to reduce fears about underground carbon storage, working with regulators to develop novel permitting rules, and working with suppliers and engineering firms to jointly learn to build something never before proven at full scale. There is a substantial risk of cost overruns or outright failure—and even if they succeed, competitors can follow the trail to develop the next round of facilities at far lower cost.

Accordingly, industry systematically shortchanges energy sector R&D. Since a temporary peak in 1980 driven by high oil prices, annual energy real private sector R&D expenditures plummeted from $4 billion in 1980 to $1 billion in 2005. Moreover, while high oil prices are motivating increased private investment in this sector, "U.S. energy companies could increase their R&D spending by a factor of 10 and would still be below the average R&D intensity of U.S. industry."[20] Moreover, public sector investment in energy has fallen from $8 billion to under $4 billion in 2005, and the trend shows no sign of reversing.

[19] Duke and Kammen, 1999.
[20] Kammen and Nemet, 2005.

Deployment support can quickly become expensive, often requiring billions of dollars per year in subsidies for each major technology, as opposed to millions to fund major lab research. Consequently, careful program design is essential to leverage public funds well. In particular, commercialization subsidies are too expensive to permit a completely technology-agnostic approach—but the government should not attempt to micro-manage the innovation process either. Rather, government needs to identify a suite of the most promising classes of emerging technologies based on rigorous techno-economic assessment, which is in line with the kind of analysis formerly undertaken by the Office of Technology Assessment until it was shuttered by the 104th Congress in 1995. For example, a wide range of analyses, including the McKinsey Report, indicate that CCS, solar photovoltaics, concentrating solar power, LED lighting, and cellulosic biofuels are all highly promising emerging options.

The federal government should then disburse deployment support to a broad portfolio of such technology classes in order to minimize risk associated with betting on any one option.[21] The government should then let the market choose the specific sub-technologies within each broad class that meet specified performance standards.

For example, the 2007 Energy Bill specifies that 22 billion gallons of *low-carbon* biofuels be produced by 2022, but it does not specify the production method, so a wide range of feedstocks are eligible as well as both biological and thermochemical conversion processes. The Energy Bill takes a similar broad performance standard approach in requiring ever-higher lighting efficiency levels over time without restricting manufacturer latitude to choose between enhanced incandescent, fluorescent, LED, or other technologies.

Similarly, the federal government should follow the lead of more than thirty states in mandating that utilities source a gradually increasing share of their energy supplies from renewables—allowing firms with a comparative advantage to develop and sell renewable electricity credits (RECs) to firms that lag behind.[22] Portfolio standards are effective at providing industry with clear sales volume forecasts, which enable efficient capital investment decisions. They also help ensure downward pressure on subsidies as production costs come down and suppliers begin accepting lower REC prices.

As with tradable carbon allowances, RECs are subject to price volatility, which can pose challenges for project developers, particularly for modular small-scale technologies such as solar. As a result, other mechanisms such as direct $/kWh "feed-in" subsidies or tax breaks may help to minimize deal transaction costs and enable more rapid industry scale-up but at the risk of excessively subsidizing some projects. The German PV feed-

---

[21] In the case of renewables, direct federal subsidies are likely needed in electrical transmission and distribution to support expansion of wind and solar energy, which are often located away from existing transmission facilities.

[22] http://www.dsireusa.org/

law illustrates both the pros and cons of this approach, driving a nearly 50 percent yearly expansion of the global PV market in recent years but at a high cost in public funds.

Finally, commercialization support mechanisms should attempt to ensure fairness on two levels. First, different emerging technologies should be allowed to compete for support based on transparent and reasonably objective techno-economic criteria. Second, commercialization subsidies should be channeled to benefit lower-income consumers wherever feasible.

## Policy Plank #4: Forestry and Agricultural Measures to Unlock Abatement Opportunities beyond the Capped Energy Economy

Comprehensive global-warming regulations should also encourage the capture of forestry and agriculture-related abatement opportunities (including afforestation, improved forest management, open-space protection programs, tree planting, conservation tillage, and manure management methane capture), which could constitute more than 500 Mt of incremental abatement per year, according to the McKinsey study (and even more once conservation efforts not analyzed in that study are taken into account). Forestry and agriculture measures in the United States, most of which involve increasing the country's annual biosequestration sink, are relatively low-cost abatement options and have the potential to reduce year-2030 compliance costs by roughly $20 billion.

Despite the attractiveness of these options, however, these emissions cannot readily be included under an emissions cap. Indeed, these abatement opportunities (such as generating electricity off of the methane produced from livestock manure) are highly fragmented and diffuse, making capture through capping difficult. Moreover, a cap would do nothing to incentivize the capture of the significant *offset* opportunities available from forestry and land use. Additional government action above-and-beyond a cap-and-trade system is, therefore, necessary.

Such government action to capture opportunities outside of the capped sectors can be divided into two broad categories:

1. *Direct government action* to capture opportunities

2. *Indirect government action* to incentivize capture of offset opportunities

*Direct government action* can be taken in one of two ways. First, the government can enact regulations to expand protected land, such as national parks and forests. The government can also regulate environmentally friendly land-use and development practices through the creation of binding land-use plans, zoning ordinances, and natural resource protection laws. In addition, public funding can be used to capture abatement opportunities. Federal, state, and local governments can base development funding decisions on conservation principles, for instance, or fund land conservation, ecosystem restoration, and tree-planting grant-based challenge programs. These direct actions have the advantage of allowing opportunities to be captured at a large scale. The government could also provide incentive programs to compensate private landowners who are maintaining the forest carbon sink, and have been doing so for some time, yet may not qualify as "additional" carbon storage.

*Indirect government action* involves incentivizing, through either public or private finance, the capture of offset opportunities. Of these options, foremost among them is the creation of an offset mechanism as part of a potential cap-and-trade system. Such an offset system would do much to provide the estimated $6 billion per year it would take to capture the 320 to 452 Mt of annual offset opportunities the McKinsey study found could be captured.[23] It would also allow businesses to achieve cost reductions at lower compliance costs than they would otherwise be able to achieve with current technology, reducing the overall cost of abatement.

An offset mechanism will not be successful without a number of key provisions. Most importantly, any offset mechanism must ensure "additionality" and account for the possibility of "leakage" and impermanence (possible strategies to accomplish this include insurance programs or discount factors applied to the value of the offset opportunity where a certain percentage of credits is held in escrow in case of sequestration reversal). Strong monitoring, reporting, and verification programs (MRV programs) are essential to protect the integrity of these programs. Finally, an offset mechanism must ensure private enterprise investment in offsets does not come at the expense of investments in technologies to abate emissions more cost-effectively, which can be achieved by limiting offsets as a portion of the overall emissions cap or as a percentage of economy-wide abatement under the cap.[24]

Independent of the offsets market, the government may also provide incentives to encourage the adoption of pre-specified practices that abate GHGs (e.g., for conservation set asides or potentially for certain agricultural or forestry practices) and for forest certification programs. Accessing these payments would likely be more straightforward than getting approval for an offsets project, but compensation would likely be at a lower cost per ton than the market clearing price for offsets.

Additional principles to be built into a forest carbon-sequestration program include provisions that forest carbon credits be fully fungible with credits from emission reductions activities in other sectors; ensuring early action credits for qualifying

[23] Assumes 100 million acres either afforested or better managed to improve carbon stocks, $50/acre rental and establishment levelized cost (in-line with the current value of marginal land in the U.S. Conservation Reserve Program) and $13/acre annual maintenance costs.
[24] Both the EU Emissions Trading Scheme (ETS) and RGGI have instituted offset "caps."

activities taken prior to the start date for a cap-and-trade program are admissible; and encouraging forest carbon activities to produce broad co-benefits for the environment and promote sustainable development objectives to the maximum extent possible.

## A Cap and Invest Strategy for Reducing U.S. GHG Emissions Would Yield Strong Net Benefits

Under all reasonable assumptions, rapid action to cap U.S. GHG emissions would yield strong net economic benefits. The *cost* of imposing a carbon cap on the U.S. economy will depend largely on the nation's success in scaling efficiency and commercializing clean-energy technologies. With strong complementary policies, a carbon cap does not have to impose a significant overall economic burden—i.e., the *average* cost of abatement would be roughly $0 per ton of $CO_2$e in 2030. Moreover, even under the very conservative assumption that the *average* cost of emission reductions were to range up to $50/ton, the total U.S. economic burden for addressing GHG emissions would only reach 1 percent of GDP by 2030.[25]

The primary *benefit* of imposing a carbon cap in the United States is the prospect of starting down the path toward containing the adverse impact of global warming. Assessments by prominent researchers suggest quantifiable negative GDP impacts ranging from 5 to 20 percent from unchecked climate change. Moreover, while it is clear that we are radically transforming our atmosphere and that the basic physics of global warming are well-established, profound discomfiting uncertainties remain about the probability of catastrophic impacts.

If the United States acts to cap domestic emissions, this action will provide the credibility needed to negotiate an international accord and thus begin controlling the problem on a global scale. Even if such an accord proves elusive, by moving early, the United States would still reduce the risk of extreme global-warming outcomes while developing the technological edge needed to roll out solutions quickly once a serious global emissions-containment regime is negotiated.

In the interim, it may prove possible to achieve significant GHG reductions in emerging economies through other measures, such as investing a share of the revenue from the sale of carbon allowances in the US market to reduce tropical deforestation.

* * *

Capping carbon is fundamental to a workable global warming solution for the United States, and that cap should be legislated as soon as possible to pick up the many time-

[25] Assumes 5 billion tons of emissions reduction required in 2030 at $50 per ton, or $250 billion in annual economic burden vs. U.S. GDP of $24 trillion based on 2.6% growth in real GDP (AEO 2008).

perishable opportunities and kick start the innovation process. However, the authors believe that a cap-and-trade system by itself will lead to higher long-term abatement costs than necessary.

Like it or not, a system of regulatory standards and government subsidies will be essential to addressing the issue with force and in a timely way. Many of these regulatory standards should take the form of Federal Performance Floors, overriding the patchwork of state and locals standards on a minimum-performance basis (but not limiting states' ability to establish stronger standards) and include quantity mandates to drive emerging clean solutions to market, or performance-based incentives that provide financial rewards to states that act strongly to improve efficiency and reduce GHG emissions.

In light of the complexity of the GHG emissions issue, the Federal government should work to promote uniformity of approaches across the nation in order to promote certainty for industry and move progress forward as rapidly as possible. However, considering the different levels of political commitment throughout the United States, it should also allow states to set even-higher performance standards to "show the way" for both other states and the Federal government.

The time has come for the United States to lead the fight against global warming at home and abroad. We are the world's leading innovator, and many U.S. businesses are beginning to recognize the profit potential of clean-energy alternatives. With forceful federal legislation and global negotiations, our nation can transition to real investment in a new energy economy that protects the planet, improves energy security, and restores economic growth by building a world-class domestic energy infrastructure.

## ADVISORY COUNCIL TO THE CONFERENCE

KNOWLEDGE PARTNER: MCKINSEY & COMPANY

| | | |
|---|---|---|
| Roger Ballentine | President | Green Strategies, Inc. |
| Manish Bapna | Executive VP & Managing Director | World Resources Institute |
| Bill Becker | Executive Director | Presidential Climate Action Project |
| Frances Beinecke | President | Natural Resources Defense Council |
| Eron Bloomgarden | Country Director, United States | EcoSecurities |
| Lorraine Bolsinger | Vice President, Ecomagination | General Electric Company |
| Jeff Bortniker | CEO | Equator Environmental |
| Andrew Bowman | Director, Climate Change Initiative | The Doris Duke Charitable Foundation |
| Sandra Brown | Executive Scientist | Winrock International |
| Eileen Claussen | President | Pew Center on Global Climate Change |
| Dennis Dimick | Executive Editor | National Geographic Magazine |
| Stephen Doig | Vice President, Energy & | Rocky Mountain Institute Resources Team |
| Kim Elliman | CEO | Open Space Institute |
| Dan Esty* | Director | Yale Center for Environmental Law & Policy |
| Jesse Fink | Managing Director | MissionPoint Capital |
| Pat Foye | Downstate Chairman | Empire State Development Corporation |
| Brad Gentry* | Director | Center for Business and the Environment at Yale |
| Peter Goldmark | Program Director Air and Climate | Environmental Defense Fund |
| Pete Grannis | Commissioner | NYS DEC |
| Ashok Gupta | Air & Energy Program Director | Natural Resources Defense Council |
| John Holdren* | Director | Program in Science, Technology & Policy, Kennedy School of Government, Harvard |
| Jeff Horowitz | Founder | Avoided Deforestation Partners |
| Peter Iwanowicz | Director of Climate Change Office | NYS DEC |
| Michael Jenkins | President & CEO | Forest Trends |
| Janet Joseph | Director, R & D | NYSERDA |
| Jonathan Lash | President | World Resources Institute |
| Tony Leiserowitz | Director, Project on Climate Change | Yale School of Forestry & Environmental Studies |
| Michael Levi | Rubenstein Senior Fellow for | Council on Foreign Relations Energy and Environment |
| Tom Lovejoy | President | The Heinz Center |
| Bill Lyons | President | AES Climate Solutions |
| Ed Mathez | Curator | American Museum of Natural History |
| Bill McKibben | Author | |
| Stephanie Meeks | CEO (Acting) | The Nature Conservancy |
| Andreas Merkl | Principal | California Environmental Associates |
| Carol Murphy | Executive Director | Alliance for Clean Energy New York |
| Michael Northrop | Program Director, Sustainable Dev. | Rockefeller Brothers Fund |
| Stephen Pacala* | Director | Princeton Environmental Institute |
| Jonathan Pershing | Director, Climate | World Resources Institute |
| Tom Peterson | President & CEO | The Center for Climate Strategies |
| Diana Propper de Callejon | General Partner | Expansión Capital Partners, LLC |
| Peter Raven | President | Missouri Botanical Garden |
| Ed Reinfurt | Executive Director | NYSTAR |
| Theodore Roosevelt IV | Managing Director | Lehman Brothers |
| Jonathan Rose | President | Jonathan Rose Companies, LLC |
| Ellis Rubinstein | President | New York Academy of Sciences |
| Jeffrey Sachs | Director | Earth Institute |
| Steve Sanderson | President & CEO | Wildlife Conservation Society |

| | | |
|---|---|---|
| William Schlesinger | President | Cary Institute of Ecosystem Studies |
| Jason Scott | Managing Partner | EKO Asset Management Partners |
| Truman Semans | Principal | Green Order |
| Andrew Shapiro | President | Green Order |
| Andrew Sharpless | CEO | Oceana |
| Ted Smith | Executive Director | The Henry P. Kendall Foundation |
| Caitlin Sparks | Director, US Market | The Gold Standard Foundation |
| Rob Socolow* | Director | Carbon Mitigation Initiative, Princeton |
| Peter Stein | General Partner | The Lyme Timber Company |
| Mark Tercek | President & CEO | The Nature Conservancy |
| Laurie Wayburn | President | The Pacific Forest Trust |
| Tensie Whelan | President | Rainforest Alliance |
| David Youlen | Senior Vice President | North American Generation Development, Brookfield Renewable Power |

* - Denotes a member of the Scientific Advisory Team to the Conference.

## APPENDIX

### Conference participants

| | |
|---|---|
| Kevin K. Albert<br>Managing Director | Elevation Partners |
| Jennifer Thorne Amann<br>Senior Associate | ACEEE |
| Marc Andraca<br>Director | Johnson Controls |
| Kent Anson<br>Vice President Global Energy | Honeywell Building Solutions |
| Evan Ard<br>Director, Marketing & Communications | Evolution Markets |
| Matt Arnold<br>Director | Sustainable Finance Ltd. |
| Atul Arya<br>Head, Policy & Long Term Strategy | BP |
| Ralph Ashton<br>Chair, Terrestrial Carbon Group | Wentworth Group of Concerned Scientists |
| Carter Bales<br>Managing Partner Emeritus | The Wicks Group of Companies, LLC |
| Roger S. Ballentine<br>President | Green Strategies, Inc |
| Manish Bapna<br>Executive Vice President & Managing Director | World Resources Institute |
| Wayne Barfield<br>General Manager, US Commercial Operations | ArborGen, LLC |
| Emily M. Bateson<br>Associate Director | Hubbard Brook Research Foundation |
| William S. Becker<br>Executive Director | Presidential Climate Action Project |
| Frances Beinecke<br>President | Natural Resources Defense Council |
| Elle Berdy<br>Press & Public Affairs Officer | Consulate General of Monaco |

| | |
|---|---|
| Greg Bergtold<br>Director of Building Codes and Standards | Dow Building Solutions |
| Nate Berry<br>Project Manager | Open Space Institute |
| Eron Bloomgarden<br>Country Director, United States | Ecosecurities Group |
| Alexandra Borders<br>Project Manager | Span560 |
| Jeffrey Bortniker<br>CEO | Equator Environmental |
| Andrew Bowman<br>Director, Climate Change Initiative | Doris Duke Charitable Foundation |
| Steve Boyd<br>Executive Director | Renewable Energy for America Political Action |
| Katherine Brass<br>Ecomagination Manager | GE Energy |
| Corey Brinkema<br>President | Forest Stewardship Council |
| Dirk Brinkman<br>President & CEO | Brinkman & Associates Reforestation Ltd |
| Bill Britton<br>Editor | Edit-Text |
| Stuart Brodsky<br>Sustainability Leader, North America | GE Real Estate |
| Mike Burnett<br>Executive Director | The Climate Trust |
| Michael T. Carr<br>Executive Director | Adirondack Chapter, The Nature Conservancy and Land Trust |
| Juan Carlos Castilla-Rubio<br>Managing Director, Global Climate Change Practice | Cisco Strategy & Innovation Group |
| Orlando Castro<br>Lead Project Manager | Kaiser Permanente Information Technology |
| Christopher Robert Chafe<br>Executive Director | Change to Win |
| Matthew Cheney<br>CEO | MMA Renewable Ventures LLC |
| Albert Cho<br>Engagement Manager | McKinsey & Company |

| | |
|---|---|
| Aimee Christensen<br>CEO | Christensen Global Strategies, LLC |
| John Claybrooks<br>Senior Global Brand Leader, Sustainability & DBS | Dow Chemical Company |
| Lisa Cleckner<br>Assistant Director of Operations | Syracuse Center of Excellence in Environmental and Energy Systems |
| Obie Clifford<br>President of the Board of Directors | The Wild Center |
| Neil Cohn<br>Senior Vice President | Macquarie |
| Jon Creyts<br>Principal | McKinsey & Company |
| John Crosson<br>Director, Climate Initiatives | AES Corporation |
| Andrew Dasinger<br>Sustainable Strategies Leader | United Technologies Corporation Power |
| R. Andrew de Pass<br>Managing Director | Citi Alternative Investments |
| Stephen Doig<br>Vice President, Energy & Resources Team | Rocky Mountain Institute |
| Edward M. Dreyfus<br>Managing Director | Clinton Climate Initiative-Forestry, Clinton Foundation |
| Charles Driscoll<br>Professor | Syracuse University |
| Rick Duke<br>Director, Center for Market Innovation | Natural Resources Defense Council |
| Seth Dunn<br>Director America's Policy | GE |
| Christopher Elliman<br>CEO | Open Space Institute |
| Sally Ericsson<br>National Policy Representative | The Pacific Forest Trust |
| Daniel Esty<br>Director | Yale Center for Environmental Law & Policy |
| Paul Ezekiel<br>Managing Director | Credit Suisse Capital Markets |
| Mark Fabry<br>Managing Partner | Philanthropic Capital Group |

| | |
|---|---|
| Tim Fahey<br>Lead Scientist | Hubbard Brook Research Foundation |
| Jesse Fink<br>Managing Director | MissionPoint Capital Partners |
| Howard Fish<br>President | Points North Communications |
| Kate Fish<br>President | Span560 |
| George Frampton<br>Partner | Boies, Schiller & Flexner LLP |
| Peter Frumhoff<br>Director, Science and Policy | Union of Concerned Scientists |
| Norman E. Gaut<br>Chairman | SuperWater Systems |
| Brad Gentry<br>Director | Yale Center for Business & the Environment |
| William J. Ginn<br>Director, Forestry Initiative | The Nature Conservancy |
| Diana Glassman<br>Head Environmental Business Group Americas | Credit Suisse |
| Joseph Gleberman<br>Chair, NYS Board of Trustees | The Nature Conservancy |
| David Goodman<br>Principal | e-Solar Properties LLC |
| Mike Gordon<br>Founder & Chief Strategy Officer | ConsumerPowerline |
| Larry Gotlieb<br>Vice President, Government and Public Affairs | KB Home |
| Hannah Granade<br>Associate Principal | McKinsey & Company |
| Alexander B. Grannis<br>Commissioner | New York State Department of Environmental Conservation |
| Gina Green<br>Director | Jamaica Tree Growers Association/Isla Botanica |
| Joshua Green<br>CEO | Verdeo Group |
| Paul Growald<br>Trustee | Rockefeller Family Fund |

| | |
|---|---|
| Bill Hallisey<br>Managing Director | GSC Group |
| Eric Hangen<br>Principal | I Squared, Inc. |
| Jason Hartke<br>Director, Advocacy and Public Policy | U.S. Green Building Council |
| Ellen Hawes<br>Forestry Policy Analyst | Environment Northeast |
| Jeffrey Hayward<br>Verification Services Manager | Rainforest Alliance |
| Stefan Heck<br>Director | McKinsey & Company |
| Jack Hidary<br>Chairman | smarrtransportation.org |
| Cheryl Holdren<br>Consultant | Woods Hole Research Institute |
| John Holdren<br>Theresa & John Heinze Professor of Environmental Policy & Director | Harvard University, Kennedy School of Government, Program in Science, Technology & Policy |
| Thomas Holland<br>President | SouthEastern Carbon Solutions, LLC |
| Jeff Horowitz<br>Founding Partner | Avoided Deforestation Partners |
| Anne Hoskins<br>Vice President, Federal Affairs and Policy | PSE&G |
| Brian Houseal<br>Executive Director | Adirondack Council |
| Janet Joseph<br>Program Manager | NYSERDA |
| Bruce M. Kahn<br>Director and Senior Analyst | Deutsche Asset Management |
| Donald Kanak<br>Chairman | Prudential Corporation Asia/ WWF's Forest Carbon Council |
| Archie Kasnet<br>Partner | Aedi Group |
| Greg Kats<br>Managing Director | Good Energies Inc. |
| Peter Keleman<br>Arthur D. Storke Professor of Geochemistry | Columbia University |

| | |
|---|---|
| Rosi Kerr<br>Energy Advisor | Juice Energy |
| Otho E. Kerr III | EKO Asset Management Partners |
| Paul A. King<br>Vice President, Sustainability | Bovis Lend Lease |
| Peter S. Knight<br>President | Generation Investment Management |
| Karen Kornbluh<br>Policy Director | U.S. Senator Barack Obama's Office |
| Ruben Kraiem<br>Partner; Co-Chair, Carbon Markets & Climate Change Practice | Covington & Burling LLP |
| Nikhil Krishnan<br>Associate | McKinsey & Company |
| Rich Kroes<br>Director, Product Strategy, Sustainability | Oracle |
| Ben Lashkari<br>Head of Emissions | Swiss Re Capital Markets Ltd. |
| Stephanie Lawrence<br>Project Coordinator | Cornerstone Parks |
| Jennifer Layke<br>Deputy Director, Climate and Energy Program | World Resources Institute |
| Mary Ann Lazarus<br>Firm-wide Director of Sustainable Design | HOK |
| Colin le Duc<br>Head of Research | Generation Investment Management |
| Susan Leeds<br>Senior Finance Fellow | Natural Resources Defense Council |
| Ilene Leff<br>President | Jafnel Advisors, Inc. |
| Peter Lehner<br>Executive Director | Natural Resources Defense Council |
| Sid Leibovich<br>Associate Director, Cornell Center for a Sustainable Future | Cornell University |
| Michael Levi<br>Rubenstein Senior Fellow for Energy and Environment | Council on Foreign Relations |
| Mark Lichtenstein<br>Director, Operations and Outreach | Syracuse Center of Excellence in Environmental and Energy Systems |

Thomas Lovejoy
President
The Heinz Center

L. Hunter Lovins
President
Natural Capitalism Solutions

Edward Lowe
General Manager, Renewable Energy & Gasification, Market Development
GE Energy

Elizabeth Lowe
Regional Director
New York State Department of Environmental Conservation

River Yun Lu
Co-Producer & Localization Director
Green Dragon Media

David Lubin
Founder & Director
Palladium Group

Adrianna Ma
Managing Partner
General Atlantic

Maguy Maccario
Vice President-US Chapter
Foundation Prince Albert II of Monaco

Bryan Magnus
Global Marketing Manager
Honeywell

David Mann
Consultant
McKinsey & Company

Donald McCloskey
Director, Environmental Strategy & Policy
PSE&G

Andrew J. McKeon
Principal
CarbonRational

John McNally
Program Officer, Environment Long Island
The Rauch Foundation

Cynthia McVay

Anish Melwani
Principal
McKinsey & Company

Bernard Mercer
Forests Philanthropy Action Network

Michelle Moore
Senior VP, Policy & Public Affairs
U.S. Green Building Council

Robert J. Moore
Executive Director
Environmental Advocates of New York

David Moulton
Director of Climate Policy
The Wilderness Society

Yerina Mugica
Research Associate, Center for Market Innovation
Natural Resources Defense Council

| | |
|---|---|
| Carol Murphy<br>Executive Director | Alliance for Clean Energy New York |
| Cornelius B. Murphy<br>President | SUNY College of Environmental Science and Forestry |
| John Nordgren<br>Program Officer | Henry P. Kendall Foundation |
| Peter Norgeot<br>VP Eastern Energy & North America East | AES Corporation |
| Michael Northrop<br>Program Director | Rockefeller Brothers Fund |
| Jeremy Oppenheim<br>Director | McKinsey & Company |
| Kenneth Ostrowski<br>Director | McKinsey & Company |
| Lisa Ott<br>President | North Shore Land Alliance |
| Jason Patrick<br>Carbon Emissions | Merrill Lynch Commodities |
| Sunil Paul<br>Founding Director | Spring Ventures |
| Karin Ezbiansky Pavese<br>Director, Innovation, Physical Sciences & Engineering | The New York Academy of Sciences |
| Roger Platt<br>Senior Vice President & Counsel | The Real Estate Roundtable |
| Eric Pooley<br>Contributor | Time Magazine |
| Josh Posner<br>CEO | Rising Tide Development |
| Karl R. Rabago<br>Managing Director, Standards and Practices | Greenhouse Gas Services, LLC/AES Wind Generation |
| Stephanie Ratcliffe<br>Executive Director | The Wild Center |
| Mark A. Redlus<br>CEO | ImageTree Corporation |
| Edward Reinfurt<br>Executive Director | New York State Foundation for Science, Technology and Innovation (NYSTAR) |
| Teresa M. Ressel<br>CEO, UBS Securities LLC | UBS Investment Bank |

| | |
|---|---|
| James Rhodes<br>President | Eco Capital LLC |
| Michael Richter<br>Founding Partner | Environmental Capital Partners |
| Allison Rockefeller<br>Founder | Cornerstone Parks |
| Timothy Roughan<br>Director, Distributed Resources | National Grid |
| James Russell<br>Senior Director | Clinton Climate Initiative |
| Richard Saines<br>Attorney | Baker & McKenzie LLP |
| Charles Samul<br>Director, Client Outreach & NYC Operations | Dormitory Authority State of New York |
| Mark Sanford<br>Manager Forecasting & Analytics | GE Energy |
| David Sassoon<br>President | Science First |
| Blake Schaefer<br>Director, Global Environmental Finance | Stark Investments |
| William H. Schlesinger<br>President | Cary Institute of Ecosystem Studies |
| Dave Schnaars<br>Director | The Business Council for Sustainable Energy |
| Gia Schneider<br>Vice President | Credit Suisse |
| Jason Scott<br>Managing Partner | EKO Asset Management Partners |
| Dave Searles<br>Marketing Executive | GE Ecomagination |
| John Seitz<br>Director, Sustainable Design | HOK |
| Truman Semans<br>Principal | Green Order |
| James Sevinsky<br>Executive Environmental Counsel | GE |
| Andrew Shapiro<br>Founder & CEO | Green Order |

| | |
|---|---|
| Dana-Lee Smirin<br>Chairwoman | CleanTech Bay |
| Ted Smith<br>Executive Director | Henry P. Kendall Foundation |
| Jodi Smits Anderson<br>Director Environmental Programs | Dormitory Authority State of New York |
| Jared Snyder<br>Assistant Commissioner | New York State Department of Environmental Conservation |
| Robert H. Socolow<br>Professor, Mechanical and Aerospace Engineering | Princeton University Carbon Mitigation Initiative |
| Daniel L. Sosland<br>Executive Director | Environment Northeast |
| Caitlin Sparks<br>United States Director | The Gold Standard Foundation |
| Bill Stanley<br>Science Lead for Carbon Strategies | The Nature Conservancy |
| William Staudt<br>Managing Director | Environmental Capital Partners |
| Cai Steger<br>Corporate Projects Manager | Natural Resources Defense Council |
| Peter R. Stein<br>General Partner | The Lyme Timber Company |
| Jack Stephenson<br>Senior Vice President, Strategy and New Ventures | PayPal |
| Andrew Stevenson<br>Efficiency Finance Specialist, Center for Market Innovation | Natural Resources Defense Council |
| Curt Stiles<br>Chairman | NYS Adirondack Park Agency |
| Marc Stuart<br>Co-Founder | Ecosecurities Group |
| Charlie Svenson<br>Partner | Brock Capital Group |
| Mark R. Tercek<br>Managing Director | Goldman Sachs Center for Environmental Markets |
| Elizabeth Thorndike<br>Founder | Center Environmental Information |
| Timothy Treadwell<br>Environmental Director | Juice Energy |

Nino Tronchetti Provera
CEO
Ambienta Sgr

Bryan Walsh
Staff Writer, Green Columnist
Time Magazine

Michael Washburn
Executive Director
Residents Committee for the Protection of the Adirondacks

Mark Watson
Program Manger, Environmental Research
NYSERDA

Christopher Wentlent
Director, Regulator & Business Development
AES Eastern Energy

Dan Whaley
CEO
Climos

Ross Whaley
President Emeritus
State University of New York, College of Environmental Science and Forestry

Martin Whittaker
Director
MissionPoint Capital Partners

Todd M. Williams
Chief Operation Officer
ENTRIX, Inc.

Adam Wolfensohn
Managing Director
Wolfensohn & Co.

Neil Woodworth
Executive Director
Adirondack Mountain Club

Scott Young
Global Portfolio Director Energy Efficiency
Dow Chemical

Dimitri Zenghelis
Chief Economist Climate Change
Cisco Systems