

革新

THE EMERGING CLIMATE CONSENSUS

GLOBAL WARMING POLICY
IN A POST-ENVIRONMENTAL WORLD

BY TED NORDHAUS AND MICHAEL SHELLENBERGER

FOR THE JANUARY GROUP¹

革新

On the cover is the Japanese ideogram “kakushin,”
which means “radical innovation and renewal”.

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PREFACE

By Ross Gelbspan

We are living in a moment that overflows with new risks. International conflict, economic crises, and climate change offer unprecedented threats to our natural sources of food, water and climatic stability – all prerequisites for a civilized existence.

But this is also a moment of extraordinary opportunity to reboot our diplomatic and economic future.

The most obvious trigger for that renaissance is a coordinated project to address global warming – an initiative that could bring all the nations of the world together around a single, unifying common goal.

Unfortunately, most people are still thinking too small.

Today, the minimal and dismally inadequate responses to the climate crisis by the world's governments are limited to uneven and uncoordinated domestic efforts in the face of a global problem. Even at the national level, the responses show a depressing lack of imagination, creativity and intellectual honesty. The environmental movement in particular – and the world's governments in general – are still mesmerized by an outdated and severely inadequate mechanism of response – cap and trade.

Equally unfortunately, a regime of international cap and trade (emissions trading) seems to be the initial mechanism of choice for the Obama administration.

International emissions trading was initially conceived as a “market-based” mechanism to address the problem of intensifying climate change. Proponents of international carbon trading seem to assume we can negotiate this problem with nature. We can't. Nature does not care whether our solutions conform to “market-based” criteria. So, given the escalating pace of change, today “cap and trade” has come to reflect an institutionalized failure of moral courage.

That fact forms the uncompromising background of this extremely important – and extraordinarily timely – new collection of writings by Michael Shellenberger and Ted Nordhaus. As “The Emerging Climate Consensus” makes clear, there is no meaningful substitute for direct public investment in clean energy technology.

“In the past, economic or national security arguments for ecological action were ancillary at best,” Shellenberger and Nordhaus point out in the preface to the paperback edition of *Break Through*. “Today they provide the central rationalization for ecological action.”

The responses show a depressing lack of imagination, creativity and intellectual honesty. For instance, the environmental movement in particular – and the world's governments in general – are still mesmerized by an outdated and severely inadequate mechanism of response – cap and trade.

That is even truer globally than it is domestically. While President Obama has pledged to invest \$150 billion in renewable energy within the US, it is obvious that initiative must very soon

become a global – rather than a domestic – initiative.

The most obvious reason lies in a basic fact about atmospheric chemistry: even if we in the US, Europe and Japan were dramatically to reduce our emissions, those cuts would be overwhelmed by the coming pulse of carbon from India, China, Mexico, Nigeria and all the developing countries.

The proponents of an international “cap and trade” regime argue that a directly financed transition to clean energy would be far too expensive. History belies that argument. During World War II, for instance, government spending under President Franklin Roosevelt reached about 30 percent of gross domestic product. (Today government spending, by contrast, amounts to about 6 percent of GDP). At the most immediate level, that investment enabled us to emerge victorious from the war. But, from a longer perspective, that government outlay – which went initially into battleships, warplanes and tanks – provided the basis for one of the longest peacetime economic expansions in history.

The parallel is not gratuitous. If anything, the threat of runaway climate change poses a far more destructive challenge than World War II. Back then, our national sovereignty and our personal freedoms were at stake. Today accelerating changes in the climate threaten the very coherence of our civilization. The deep oceans are heating, the glaciers are melting, violent weather is increasing, the timing of the seasons is changing and all over the world, plants, insects, fish, birds and animals are migrating toward the poles in search of stable temperatures.

We are facing a new era of chaos resulting from a series of crop failures, water shortages, disease outbreaks and mass migrations of environmental refugees. Unchecked, climate change could make World War II look, in retrospect, like a relatively stable period of human history.

What we need, in short, is a global public works program to rewire the world with clean energy. And we need it yesterday.

President Obama has listed among his priorities the restoration of America’s moral leadership, the stabilization of the global economy and a far more effective strategy to neutralize international terrorism. A real solution to the climate crisis could go far toward realizing those goals.

In terms of America’s moral leadership, the Obama administration could make no stronger gesture than to reverse eight years of Bush Administration’s inaction on global warming. That negligence has infuriated much of the world, especially since the US, the world’s largest emitter, continues to increase its output of greenhouse gases even as the impacts of climate change are now affecting every portion of the world.

And in the midst of a crisis, the global economy clearly requires the kind of global public works programs initiated in the 1930s by President Franklin Roosevelt on the national level. Even if the stimulus prevents a global depression, few economists believe the current capital crisis will be our last. A substantial global public works program would provide a much-needed stabilizing ballast to counteract the wild swings of the market and the resulting instability of the global economy.

In developing countries, the relentless poverty

that afflicts about two-thirds of the world's people requires a public works project that would expand wealth and extend economic opportunity to the planet's poorest residents. Development economists tell us that every dollar invested in energy in poor countries creates far more jobs and far more wealth than the same dollar invested in any other segment of their economies. A transition to clean energy would create millions of new jobs in the developing world. That, in turn, would begin to counteract the economic desperation that creates the breeding ground for anti-Western terrorism.

Against that background, many environmentalists are still trying to figure out how to put a proper price on carbon emissions. Given the mega-historical forces in play today, this seems, at best, as an exercise in irrelevance.

That is not to say that pricing pollution or cap and trade has no value at all, as Nordhaus and Shellenberger point out. It simply has a different, far more limited value than its proponents acknowledge. Domestically, emissions trading can be a useful tool to begin to meet short-term goals within nations with relative efficiency and

At the international level, the system of “cap and trade” totally breaks down. It is not monitorable. It is not enforceable. Moreover, it is plagued by irreconcilable equity disputes between the industrial and developing countries.

minimal cost. Domestic cap and trade programs – like the U.S. trading program set up to reduce sulfur dioxide emissions – were relatively successful because they are easy to monitor and enforce. Most of the SO₂ emissions came from 2,000 smokestacks in the Midwest – a

manageable number to monitor. The program, moreover, was subject to an enforceable system of national regulation and enforcement.

Development economists tell us that every dollar invested in energy in poor countries creates far more jobs and far more wealth than the same dollar invested in any other segment of their economies. A transition to clean energy would create millions of new jobs in the developing world.

But at the international level, the system of “cap and trade” totally breaks down. It is not monitorable. It is not enforceable. Moreover, it is plagued by irreconcilable equity disputes between the industrial and developing countries. For one thing, there are far too many sources of carbon dioxide around the world to effectively monitor emissions – without turning half the world's population into carbon police.

At another level, there is a profound controversy between industrial and developing countries over how to allocate emission rights. The industrial nations want each country's emission rights based on its 1990 levels to ensure continuity of their economies. Many developing countries, by contrast, contend that only a global per capita allocation is fair and democratic. Every inhabitant of the planet, they argue, should have equal rights to pollute the atmosphere. The problem here is that the typical American is responsible for 25 times more carbon emissions than the typical resident of India. But

if the emission quota for each U.S. citizen were the same as for each citizen of India, that would decimate the U.S. economy.

A second equity issue, articulated by the late Anil Agarwal, founder of the Centre for Science and Environment in New Delhi, focuses on

provisions in the Kyoto Protocol which allow industrial nations to buy limitless amounts of cheap emission reductions in poor countries and to bank them indefinitely into the future. This means that when developing nations eventually become obligated to cut their own emissions, they will be left with only the most expensive options since the cheaper offsets will have already been bought up by industrial countries. This clearly constitutes a form of environmental colonialism.

Finally, even if all the shortcomings involving monitoring, enforcement and equity could be resolved, international carbon trading would most appropriately be used as a fine-tuning instrument – to help countries attain the final 10 to 15 percent of their obligations. It is not the workhorse vehicle we need to propel a worldwide energy transition.

We cannot finesse nature with accounting tricks.

Since 2003, when they co-founded the Apollo Alliance, and 2004, when they wrote “The Death of Environmentalism,” Nordhaus and Shellenberger have argued for a dramatic and uncompromising investment in clean energy to achieve an urgent transformation of the world’s energy systems. If we are to bequeath to future generations anything other than a combative, scarcity-ridden, degraded and wildly unstable world, this is the right approach.

But even on its own terms, the issue of carbon pricing is fraught with major problems. First, as “The Emerging Climate Consensus” makes clear, if planners overshoot and impose too high a price on carbon, that will trigger backlashes from working people who will ultimately bear the cost. In his book, *Earth Odyssey*, the environmental writer Mark Hertsgaard describes the devastating air pollution in Chinese cities.

When Hertsgaard asked officials why they didn’t begin a major clean-up operation, they explained that the temporary dislocations that would be caused by anti-pollution efforts could well trigger widespread civil unrest. As a result, the Chinese have opted to live with disastrous levels of air pollution (as well as contributions to global warming) in order to keep civil order.

A second, very different, problem with a regime of “cap and trade” is that the “cap” – the upper limit of carbon emissions – would have to be negotiated. That process opens the door for companies like ExxonMobil and Peabody Coal to use their vast political and diplomatic power to ensure that the “cap” is meaningless in terms of environmental protection. A truly meaningful cap would lead, in short order, to 80 percent reductions in the world’s output of carbon dioxide. That, in turn, would reduce big coal and big oil to boutique industries. But passing such a law is impossible politically in the U.S. and Europe because of the large price gap between fossil fuels and clean energy sources.

From another vantage point, a recent precedent underscores the failure of an international trading system in Europe. As the *New York Times* reported, some European governments initially allocated too many trading permits to polluters. That led to a near-market failure after the value of the permits fell by half. When, officials promised to revamp the system, it gave rise to “a ferocious lobbying battle” between regulators and energy companies. Stanford University’s David Victor told the *Times*: “The politics you’re seeing in Europe now are the real politics of carbon.”

Since 2003, when they co-founded the Apollo Alliance, and 2004, when they wrote “The Death of Environmentalism,” Nordhaus and Shellenberger have argued for a dramatic and uncompromising investment in clean energy to achieve an urgent transformation of the world’s energy systems. If we are to bequeath to future generations anything other than a combative, scarcity-ridden, degraded and wildly unstable world, this is the right approach.

Along the way, that same investment could also lead to the restoration of America’s moral leadership, to a new era of financial stability for the global economy and to a world far less distracted by the threat of terrorism.

In the end, “The Emerging Climate Consensus” is less about “cap and trade” than it is about the small-mindedness of the policy makers and advocates who support it. This book is a plea for the kind of transformative strategy that is needed to stabilize the climate and begin to mend many of the divisions that have plagued humanity for much of our modern history.

– Ross Gelbspan © December, 2008

Ross Gelbspan is the author of *The Heat Is On* (1997) and *Boiling Point* (2004). He maintains the website: www.heatisonline.org

INTRODUCTION

BY TED NORDHAUS AND MICHAEL SHELLENBERGER

Spring 2009

As governments struggle to deal with a worsening economic recession, policymakers, environmentalists and others who care about the rising threat of climate change are looking to new United Nations talks in Copenhagen in December of this year as the place to rejuvenate stalled efforts to reduce greenhouse gas emissions. But, as the essays in this volume argue, we cannot deal with global warming without confronting the economic and technological forces that have constrained action to date. We are publishing “The Emerging Climate Consensus” in an effort to shine a light both on these constraints and on the potential of governments to agree to a very different policy framework, one that we believe has the promise of accelerating economic growth and development while also radically reducing emissions over the next several decades.

We begin with our September 2007 cover story for *The New Republic*, “Second Life: A Manifesto for a New Environmentalism.” Adapted from *Break Through*, it argued that we will not regulate our way to a clean energy economy. The piece provoked a firestorm of criticism. Center for American Progress

Senior Fellow Joe Romm posted a five-part, six-thousand word series of posts at Climate Progress that claimed to debunk our contention that technological breakthroughs would be necessary to achieve deep reductions in carbon

emissions. NRDC attorney David Hawkins asserted that we were “wrong in claiming that a big government-funded program is the critical missing piece to make the shift to clean energy happen.”

But since then our argument has largely been vindicated. In June 2008, the International Energy Agency released a landmark analysis of the global energy economy, concluding that, “a global revolution is needed in ways that energy is supplied and used.” The report found that low carbon energy sources “face significant technical and cost barriers” to broad deployment and that “current levels of investment are very unlikely to achieve the sort of steep change in technology that is needed” concluding that “a massive

The kind of technological revolution called for by energy experts typically does not occur via regulatory fiat. We did not invent the Internet by taxing telegraphs nor the personal computer by limiting typewriters. Nor did the transition to the petroleum economy occur because we taxed, regulated, or ran out of whale oil. Those revolutions happened because we invented alternatives that were vastly superior to what they replaced and, in remarkably short order, became a good deal cheaper.

— “*Second Life: A Manifesto for a New Environmentalism*,”
The New Republic, September 24, 2007

increase [in] energy technology Research, Development and Deployment (RD&D) is needed in the coming 15 years, in the order of USD 10-100 billion per year.”

The IEA findings echoed an earlier report

by the Swedish government that argued that the policy focus should shift to government-funded technology innovation. The report authors recommended “massive investment and deployment of climate friendly technologies” and said that “any sensible climate policy will have technological development as a main focus” and that “more attention should be given to efforts to secure breakthroughs in technology development, if necessary at the expense of short term emission reductions.”²

And in February 2009, President Barack Obama’s energy secretary, Stephen Chu, told the *New York Times* that Nobel-caliber “breakthroughs” would be necessary in at least three critical technologies, solar power, batteries, and biofuels, in order to solve the world’s energy and environmental problems. Later that month, the Brookings Institution released a report calling for federal investments in energy research and development to rise to \$20 to \$30 billion per year in order to achieve these technology breakthroughs.

Global Warming’s Gordian Knot

In January 2008, the *Harvard Law and Policy Review* published “Fast, Clean and Cheap.” In it we argued that the vast price gap between fossil fuels and clean energy sources combines with public resistance to higher energy prices to create a fundamental constraint on the efficacy of carbon pricing to drive emissions reductions everywhere in the world. This dynamic creates a “Gordian Knot” for policymakers focused on pollution regulation. If they price pollution too low, firms will just pass the higher energy prices along to consumers and invest little to nothing in clean energy, efficiency, or conservation. But if policymakers set the price too high, higher energy prices will trigger a voter backlash that

will result in the repeal or non-enforcement of regulations and a discrediting of climate policy.

Events in the U.S. and abroad in 2008 and 2009 demonstrated the scale of the energy technology gap and the Gordian Knot problem. During the summer of 2008 the price for carbon dioxide in Europe reached \$40/ton – a number that two of the most prominent American climate policy modelers had predicted would be high enough to motivate firms to switch to coal with carbon capture and storage.³ Instead Europe moved ahead with plans to build 50 new coal plants, each of which would last for 50 years.⁴ And though the price on carbon dioxide proved too low to phase out even the dirtiest source of power, it was too high for many Europeans, and a backlash against higher energy prices emerged not only in poorer countries like Italy but also in wealthy and green Germany, which has steadfastly refused speed limits on its *autobahn* or serious emissions regulations on its automakers.⁵ All this during a time that Germany has started replacing its nuclear plants with new coal plants in the name of protecting the environment.⁶

U.S. reactions to rising energy prices and efforts to pass cap and trade legislation in the U.S. Senate followed a similar path. We followed up “Fast, Clean, and Cheap” with two op-ed pieces. The first appeared in the *San Francisco Chronicle* in May of 2008 and predicted that public opposition to policies that would increase energy prices would scuttle Congressional efforts to pass cap and trade legislation. And indeed, one month later, the Lieberman-Warner cap and trade bill was pulled from the Senate floor without a vote by its Democratic sponsors when it became clear that even many of their fellow Democrats were not willing to vote for

it.

The second, appearing in the *Los Angeles Times* in September of 2008, documented the damage that candidate Obama's continuing embrace of green orthodoxy on energy policy through that summer had wrought on his election prospects. Public outrage at rising energy prices and deft maneuvering by Congressional Republicans forced Obama and his allies in Congress to not only pull Lieberman-Warner from the Senate

Environmental groups, perpetually certain that a new ecological age is about to dawn in America, have serially overestimated their strength and misread public opinion. Democrats must break once and for all from green orthodoxy that focuses primarily on making dirty energy more expensive and instead embrace a strategy to make clean energy cheap.

— *"The Green Bubble Bursts," Los Angeles Times, September 30, 2008*

floor but also abandon twenty years of opposition to off-shore drilling. Only after forsaking these policies were Obama and congressional Democrats able to get back on the offensive.

Slouching to Copenhagen

In June of 2008, the policy journal *Democracy* ran "Scrap Kyoto," our extended critique of the climate treaty and its focus on pollution limits instead of technology innovation, as its cover story. The article, which was picked up by European journals ("Vergest Kyoto!" in *Internationale Politik* and "Perché rottamare Kyoto" in *Formiche*), argued that when economic growth and environmental ends come into conflict, governments overwhelmingly choose economic growth.

The obstructionism of President George W. Bush to Kyoto obscured the reality that the mass of Kyoto-ratifying countries will not comply

with the treaty by reducing their own emissions. The European Union's program, often held up as a model, routinely takes credit for reductions in the UK and Germany. But these occurred in the early 1990s for reasons that had nothing to do with global warming. Most Kyoto-ratifying countries will meet their targets by purchasing dubious (and in some cases outright fraudulent) carbon off-sets. Indeed, this is how Germany's Environment Minister recently justified his country's transition from nuclear to coal plants.

"You can build 100 coal-fired power plants and don't have to have higher CO2 emissions," he insisted, pointing to the E.U.'s off-sets policy.⁷

Kyoto failed because it was based on a misreading of past successes in dealing with environmental problems. The Kyoto framework was modeled after the 1989 Montreal Treaty, which phases out the global use of ozone-depleting CFC chemicals. What few remember is that earlier efforts to negotiate the treaty repeatedly failed until DuPont finally invented a low cost alternative to CFCs. Pollution regulation did not precede but rather followed technology innovation. What greens misunderstand is that past political breakthroughs were made possible by technological breakthroughs.

In misreading this history, greens continue to put the regulatory cart before the technological horse. As a result, efforts to negotiate a successor to Kyoto have repeatedly stumbled. At U.N. negotiations in Poznan, Poland in December 2008, efforts to negotiate new region-wide climate commitments foundered upon the unwillingness of Eastern Europe and other members to stop burning coal in favor of more

expensive and less secure energy sources such as Russian natural gas. Today plans to negotiate a new climate treaty in Copenhagen, Denmark, in December 2009, are plagued by the same basic challenge that has hindered climate negotiations since the start: the unwillingness of developing nations, particularly China and India, to agree to carbon limits that would slow their economic development.

Many greens believe that with Bush gone and Obama committed to action, the December 2009 U.N. meeting in Copenhagen will result in a viable new treaty. But as long as it fails to deal with technology gap between fossil fuels and clean energy, no new treaty can succeed in reducing emissions.

Green Keynesianism

In “Getting Real on Climate Change,” published by the *American Prospect* in December 2008, we argued that green leaders were long overdue

As the next president takes office, he or she will be faced with a choice: Continue with the policy agenda of the last 15 years, one that offers an unpromising mix of bad politics, poor policy outcomes, and at best very modest and incremental progress on climate change. Or strike out boldly in a new direction—one that aligns America’s economic aspirations with its ecological interests, invests directly in the energy technology we need rather than attempting to wag the energy technology dog with the pollution control tail. The choice should be clear.

— “Scrap Kyoto,” *Democracy Journal*, Summer 2008

to reconsider their obeisance to neo-classical economic orthodoxy in the form of their devotion to carbon pricing. In recent years, environmental leaders in Washington have increasingly embraced the view that private firms and investors are the primary drivers of

technological innovation. Indeed, but for the caveat that the new green market fundamentalists place their faith in *regulated* markets, green pricing advocates would make Milton Friedman proud. The result is that greens consistently conflate public regulation *of* technology with public investment *in* technology. While many conservatives imagine that technology innovation is driven by private firms identifying market opportunities, green leaders imagine that it is driven by private firms responding to regulatory or fiscal mandates.

Many reviewers of *Break Through* faulted us for challenging the view that carbon pricing and markets would drive technology innovation. “Putting a price on carbon helps phase out dirty energy and favors alternatives more equitably,” Kate Sheppard, the *American Prospect’s* reviewer claimed, despite mounting evidence to the contrary.⁸ *Grist* blogger David Roberts attacked us as opportunists who lacked sufficient faith in the power of the market to transform the energy economy.⁹ In the *New York Review of Books* Bill McKibben claimed that with pollution limits and pricing “we should see the logic of the market start to wring those carbon reductions out of the economy relatively quickly,” a prediction countered by a recent U.S. Government Accountability Office report that found no evidence of reductions due to Europe’s carbon limits.¹⁰ And in his review for the *New York Times*, Matthew Iglesias asserted that “emissions caps would effectively provide a subsidy to less polluting alternatives, one that would be harder for lobbyists to manipulate”¹¹ – a claim that was

disproven six months later as Senate leaders attempted to pass a cap and trade legislation shot through with loopholes created by lobbyists.

Contrary to the old trope that government should not “pick winners and losers,” the actual history of technology innovation suggests that governments have a remarkable record of picking technological winners that have profoundly transformed American life and the economy for over a century. The information technology revolution was driven by large and sustained public investments in microchips, the computer sciences, the Internet, and labs like Xerox PARC. The biotechnology revolution was driven by similar investments. Nuclear, solar, and wind power would not exist had governments not made large investments, not just in laboratory R&D but also real-world deployment. And against the claims made by *New York Times* columnist Thomas Friedman, Japan created hybrid-electric cars not so much through fuel economy regulations but rather through a holistic industrial policy that rewarded efficiency and invested in innovation.

Recent events give us hope that policymakers and opinion leaders in the U.S. are finally starting to reach similar conclusions. In “A New Inconvenient Truth,” published by *The New Republic* in November 2008, we highlighted an important shift in Al Gore’s policy priorities from pollution pricing to government investment in technology. In his Nobel acceptance speech in November 2007, Gore made no mention

of public investment whatsoever, focusing exclusively on carbon pricing. A year later, in the *New York Times*, Gore offered Obama five recommendations for action, the first four of which were investment and only one of which involved regulation, and even then mainly as a means to generate investment funding. It was a marked shift.

In January 2009, House Speaker Nancy Pelosi followed suit, justifying a U.S. cap and trade program not as a means to reduce carbon emissions but rather “so you can pay for some of these investments in energy independence and renewables.”¹² Shortly after taking office, President Obama made clean energy investment the centerpiece of his economic stimulus package and routinely speaks of it as the key to long-term prosperity. In March 2009, Obama’s chief climate negotiator at the State Department, Todd Stern, called for major public investments not just for emissions reductions but for “the transformation of the energy base of the global economy [so] that it can become a key driver of economic growth in the 21st century.”¹³ And Ross Gelbspan, one of the first mainstream U.S. journalists to sound the alarm about the threat

For 20 years the green climate agenda has embraced two insidious orthodoxies that are rooted in market fundamentalism: Deficit spending is always bad for the economy, and we should “let the market decide” our energy future. The result has been serial political failure, skyrocketing emissions, and stagnation of energy technology. Now is the time to let go of the pollution-pricing paradigm, along with a zero-sum deficit mentality, and embrace an agenda squarely focused on public investment, building the enabling infrastructure, and making clean energy cheap.

— “*Getting Real on Climate Change*,” *American Prospect*, December 2008.

of climate change, points out in his introduction to this collection that cap and trade is “not the workhorse vehicle we need to propel a worldwide energy transition” but rather “an institutionalized failure of moral courage.”

A New Climate and Energy Framework

No effort to achieve deep reductions in carbon emissions, domestic or international, will succeed so long as low carbon energy technologies cost vastly more than current fossil fuel based energy. *De facto or de jure*, governments, wherever they attempt to limit carbon emissions, will also contain the costs of those policies.

In light of recent events and a more careful reading of history, it is our belief that a new framework has begun to emerge among those who support swift and serious action on climate change. That framework starts with the recognition that no effort to achieve deep reductions in carbon emissions, domestic or international, will succeed so long as low-carbon energy technologies cost vastly more than current fossil fuel based energy. *De facto or de jure*, governments, wherever they attempt to limit carbon emissions, will also contain the costs of those policies. Carbon prices, where they exist, will be low not high, and, as such, carbon caps will only dictate actual emissions reductions to the degree that those emissions reductions can be achieved at costs that political economies around the world will tolerate.

Rather than focusing on emissions reduction targets and timetables, the new framework makes rapid reductions in the real, unsubsidized cost of clean energy technologies the explicit objective of climate and energy policy. Rather than attempting to establish and maintain high carbon prices globally in order to provide sufficient incentives to private interests to

invest in energy technology innovation, this new framework focuses on establishing modest and politically sustainable carbon prices in developed economies to both fund public technology innovation and provide the needed market pull once those technologies are cost-competitive. Rather than seeing private interests

and markets as the primary driver of innovation, this framework recognizes public investment as the key. Rather than insisting that developed economies “go first” by achieving symbolic but largely irrelevant emissions

reductions, the new framework sees developed economies as critical laboratories that will finance and invent the low cost technologies that will make deep global emissions reductions possible.

Embracing this framework will require that greens and governments abandon several articles of faith. The first is the view that carbon caps and the legal mechanisms that enforce them provide reasonable certainty that mandated emissions reductions will be achieved. This view discounts the role that cost will always play in constraining emissions reduction efforts. The second is the view that, like past environmental regulatory efforts, economies will find that complying with ambitious carbon caps will be much less costly than many observers, especially businesses, think. This view conflates easy technological problems, such as affixing catalytic converters to tailpipes or scrubbers to smokestacks, with the challenge of bridging the vast technology gap between fossil fuels and clean energy.

The third is the view that the establishment of regulatory requirements to reduce pollution

was the primary driver of innovations that enabled compliance with regulations. This view conveniently reshuffles the order of events. In most cases, including Montreal and acid rain, the innovations in question predated and made possible the establishment of pollution regulations, not the reverse. The fourth is the view that much, if not most, of the global emissions challenge can be addressed through the “low hanging fruit” of energy efficiency and conservation. This view simply misunderstands the scale of the challenge and the enormous growth of global energy use over the next century. Even if we use energy much more efficiently global consumption of energy will double and may triple during the same period of time we need to cut emissions in half.

The Emerging Climate Consensus

Since our very first essay on this subject almost five years ago, we have argued that the nature of the new ecological challenges would inevitably transform ecological politics. The subtitle of that 2004 essay, “The Death of Environmentalism,” was “Global Warming Politics in a Post-Environmental World” and reflected our conviction that an effective global warming politics would offer Americans, and citizens throughout the world, a vision of a future that was not only ecologically sustainable, but secure, prosperous, and free. The subtitle of this collection, “Global Warming *Policy* in a Post-Environmental World,” reflects our conviction that no effort to “reframe” ecological politics will succeed without profoundly rethinking the economic, social, legal, and policy framework that any

ecological politics purports to advance.

For those who have followed our work since *Break Through*, much of what constitutes this collection will be familiar. Yet we hope that taken as a whole, this collection offers clarity that will exceed the sum of its parts. For those who may have dismissed our critique back in 2007, we hope this collection might offer an opportunity to take a second look and reconsider the way forward in light of all that has transpired over the last several years. For those who are new to our work, we hope this collection will provide a robust context and framework through which to see and understand climate and energy policy and politics in a new and productive way. No matter how you come to this collection, we hope that its argument will be understood more as prophecy than advocacy. We use the term advisedly. By “prophecy” we mean that the changes we propose, both in understanding the problem and its solutions, are inevitable entailments of new ecological challenges that the old environmental politics is incapable of resolving.

As the old consensus collapses, a new chorus of voices has begun to articulate an alternative framework for thinking about and addressing the coming climate crisis. Some of these writers and academics such as Steve Rayner of Oxford and Gwyn Prins of the London School of Economics,

Humans didn't evolve to deal with great challenges like global warming, it is true. But neither did we evolve to overcome deprivation, create beauty, or achieve happiness. In overcoming oppression and deprivation—predators, hunger, disease—we have given birth to a new world. It is a world at once beautiful and terrible. And this world, too, we shall overcome.

— *Break Through*, 2007

McGill University economist Christopher Green, and the University of Colorado's Roger Pielke, Jr., have been long-time critics of the Kyoto approach. Others such as Columbia University economist Jeffrey Sachs and *Newsweek's* Fareed Zakaria are relative newcomers. All share the perspective that the climate crisis is better understood as an economic development and energy modernization challenge than as a pollution problem. And all, in one form or another, share the conviction that the radical transformation of the global energy economy will not primarily be accomplished through carbon pricing or pollution regulations.

As we confront the basic realities of energy, global development, and carbon, it will become ever clearer that the shift we must make does not require a transformation of our hearts, minds and lifestyles, but rather of the underlying technologies that power our civilization.

As surely as the planet warms in the coming decades, ecological politics and thought will change with it. As the coming pulse of carbon from China, India, and the rest of the developing world demonstrates once and for all that the challenge of reducing emissions is inseparable from the basic process of human development that the affluent West has long taken for granted, the idea that the crisis has anything to do with Western consumer excess will become increasingly untenable. And as we confront the basic realities of energy, global development, and carbon, it will become ever clearer that the shift we must make does not require a transformation of our hearts, minds and lifestyles, but rather of the underlying technologies that power our civilization. While this may not be the transformation that greens and others wish for, it is the one we must make if we are to deal with the global climate challenge.

SECOND LIFE

A MANIFESTO FOR A NEW ENVIRONMENTALISM

The New Republic, September 24, 2007

Rachel Carson opened *Silent Spring*, her 1962 polemic against chemical pesticides, with a terrible prophecy: “Man has lost the capacity to foresee and to forestall. He will end by destroying the earth.” She proceeded to narrate a “Fable for Tomorrow,” describing a bucolic American town “where all life seemed to live in harmony with its surroundings.” The nearby farms flourished, the foxes barked, and the birds sang in a kind of pastoral Eden. “Then a strange blight crept over the area and everything began to change. Some evil spell had settled on the community.” Cattle died. Children died. And the birds stopped singing. It was a silent spring.

The moral of the story was obvious: Apocalypse was imminent unless humankind stopped violating nature. And so it came to pass that the environmental movement’s highest priority would be to limit our contamination of the world around us. This “pollution paradigm” worked well enough—for a time. Regulatory legislation of the 1960s and ’70s cleaned up our lakes and rivers and greatly reduced smog in our cities. In the 1990s, it dealt with acid rain and phased out ozone-depleting chemicals. Given these successes, it’s not surprising that environmental leaders have seen global warming, which is caused by human greenhouse gas emissions, as, essentially, a very big pollution problem.

In the summer of 2006, Carson was resurrected in the form of Al Gore, whose documentary, *An Inconvenient Truth*, began with images

of power plants belching pollution and ended with scenes from the apocalypse: hurricanes, floods, and droughts. In case viewers missed the point, Gore observed, “It was almost like a nature hike through the Book of Revelation.” And he warned, “It’s human nature to take time. But there will also be a day of reckoning.” This narrative had dominated environmental thought for so long that few of us who grew up hearing it ever thought much about it. Nor have many of us questioned what appears to be the obvious solution to global warming: limits on pollution, especially carbon emissions.

The problem is that global warming is as different from smog in Los Angeles as nuclear war is from gang violence. The quantitative accumulation of carbon dioxide in the

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atmosphere has created something qualitatively different from the pollution problems of old: changing temperatures, which may lead to acute droughts, new disease epidemics, and even wars over resources like water. While dealing with smog and acid rain required relatively simple and inexpensive technical fixes — such as catalytic converters on cars and scrubbers on power plants — oil and coal are central to the functioning of the economy and their replacements remain far more expensive.

Nor should we want to dramatically curtail energy consumption. Increasing energy use is the primary cause of global warming, but it is also a primary cause of rising prosperity, longer life spans, better medical treatment, and greater personal and political freedom. Environmentalists can rail against consumption and counsel sacrifice all they want, but neither poor countries like China nor rich countries like the United States are going to dramatically reduce their emissions if doing so slows economic growth. Given this, the challenge we face as a species is to roughly double global energy production by mid-century while simultaneously cutting greenhouse gas emissions in half worldwide (and about 80 percent in the United States), so that we can avoid the worst consequences of climate change.

In terms of birthing a new energy economy, regulation is important — it's just not the most important thing. The highest objective of anyone concerned about global warming must be to bring down the real price of clean energy below the price of dirty energy as quickly as possible — most importantly, in places like China. And, for that to happen, we'll need a new paradigm centered on technological innovation and economic opportunity, not on nature preservation and ecological limits.

How could such a massive undertaking be achieved? Not, as environmental leaders insist, by limiting human power but rather by unleashing it. In terms of birthing a new energy economy, regulation is important – it's just not the most important thing. The highest objective of anyone concerned about global warming must be to bring down the real price of clean energy below the price of dirty energy as quickly as possible – most importantly, in places like China. And, for that to happen, we'll need a new paradigm centered on technological innovation and economic opportunity, not on

nature preservation and ecological limits.

Over the last ten years, a consensus has emerged among energy policy experts – one no less important than the consensus among climate scientists that carbon emissions are warming the earth. What's needed, they say, are disruptive clean-energy technologies that achieve non-incremental breakthroughs in both price and performance. Reflecting the consensus, New York University physicist Martin Hoffert and 16 other leading energy experts concluded a landmark 2002 analysis in the journal *Science* by observing that, “although regulation can play a role, the fossil fuel greenhouse effect is an energy problem that cannot be simply regulated away.”

Despite this consensus, environmental lobbyists in Washington today are overwhelmingly focused on addressing global warming through two overlapping strategies. First, they want to establish a cap on greenhouse gases that decreases over time. Second, they want to make clean-energy sources cost competitive by increasing the cost of dirty energy. While there is great debate about how to best implement these strategies – whether through traditional command-and-control regulatory mechanisms, market-based cap and trade approaches, or an outright tax on carbon emissions – there is little question that the solution is pollution regulation.

It is not. The challenge is simply too large. In 2007, human beings will consume roughly 15 terawatts of energy worldwide. That level of energy use will rise rapidly over the next 100 years due to population growth and increasing

living standards, especially among the global poor. By the year 2100, humankind will need to produce and consume roughly 60 terawatts of energy if every human on earth is to reach the level of prosperity enjoyed today by the world's wealthiest one billion people. Even if economies were to become much more efficient, the total terawatts needed to bring all of humankind out of poverty would still need to roughly double by 2050 and triple by century's end.

Consider China. Today, the country is rumbling with rising prosperity, rising expectations, rising demands for freedom – all fueled by cheap, dirty coal energy. This year or next, China will surpass the United States as the world's largest producer of greenhouse gas emissions. And yet, the average Chinese still consumes less than 20 percent of the energy consumed by the average American, meaning that the Chinese contribution to global warming is going to grow tremendously. After all, neither the Chinese people nor the Chinese government will accept any solution that does not allow energy consumption comparable to our own.

The only way to double global energy consumption while cutting global warming emissions in half is by developing new sources of clean energy. Thus, the problem with the proposals currently being discussed in Congress: They will, for the foreseeable future, direct private investment toward the least expensive emissions reductions (such as burning methane from landfills, purchasing forest land for carbon sequestration, or retrofitting power plants and buildings so they operate more efficiently) rather than toward breakthrough technologies (like low-cost solar energy and carbon capture and storage), which are too expensive to become widely adopted today but which are

vital for creating a new energy economy and thus drastically reducing emissions. Cap and trade schemes, for example, would achieve some inexpensive reductions but wouldn't drive investment into long-term R&D because those investments would not immediately reduce emissions. Nor can private firms invest in the public infrastructure, such as new transmission lines, both because they are public and also because they are so capital intensive.

Even if such regulations were to provide the right economic incentives, they provide the wrong political ones. The regulation-centered approach to global warming fails because it depends on doing something highly unpopular: raising the price of energy. Fears of political backlash will prevent lawmakers from raising the price of carbon (and thus the price of electricity and gasoline) high enough for clean energy to become cost-competitive. It is for this reason that virtually every congressional proposal to regulate carbon emissions gives industry an "out" if compliance with the law becomes too expensive. The regulation-centered approach is thus doomed to fail in one way or another: Price carbon too high and risk economic consequences and political backlash; price it too low, and dirty-energy sources will not cost enough to make clean energy cost-competitive.

The concern over higher energy prices has plagued European efforts to comply with the Kyoto treaty on global warming. EU nations issued too many emissions credits. Thus, neither the regulations themselves nor the resulting low market price for carbon has lowered emissions or raised much money for clean-energy technologies. Little surprise then that, late last year, the United Nations quietly announced that, since 2000, the emissions of the 41 wealthy,

industrialized members of Kyoto had gone up, not down, by more than 4 percent.

While pushing for a bold clean energy agenda might seem like an obvious job for the environmental lobby, the truth is that environmental groups have never prioritized those investments because they have been focused on limiting pollution. The absence of an effective lobby for clean energy explains, in part, why public investment in energy research and development in the United States dropped from an already modest \$8 billion in 1980 to \$3 billion in 2005. Given this, it's understandable that energy is the least innovative sector of the economy. Coal has been in widespread use for 150 years, and oil for 80. Our houses, cars, medicines, manufacturing, communications, and consumer technologies have all improved dramatically over the last century, but our energy sources have not. Today, clean-energy sources, such as biomass, wind, geothermal, and solar, represent just 2 percent of the world's electricity.

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The kind of technological revolution called for by energy experts typically does not occur via regulatory fiat. We did not invent the Internet by taxing telegraphs nor the personal computer by limiting typewriters. Nor did the transition to the petroleum economy occur because we taxed, regulated, or ran out of whale oil. Those revolutions happened because we invented alternatives that were vastly superior to what they replaced and, in remarkably short order, became a good deal cheaper.

And, contrary to conventional wisdom, private firms rarely initiate technological revolutions. Indeed, government has always been at the center of technological innovation, and most of America's largest industries have benefited from strategic government investments in their development. Farm land was granted to early American frontier farmers, and agriculture has been publicly subsidized since the early twentieth century. Before the Civil War, Abraham Lincoln was best known for his aggressive advocacy of publicly funded transit infrastructure: canals, roads, and railroads. During the cold war, government investment was essential to the aerospace industry's development.

Big, long-term investments in new technologies are made only by governments and are almost always motivated by concerns about national security or economic competitiveness, from the threat of the Soviet Union in the 1950s to OPEC in the '70s. The Internet (originally Arpanet) was created by the Defense Advanced Research Projects Agency, which was itself established in response to the Soviet Union's launching of the first Sputnik satellite in 1957. The invention of today's giant wind turbines was stimulated by incentives in the United States and Denmark in the '70s and '80s. The first solar photovoltaic cells were created for the space program in the '50s. And today's highly mature energy markets are the result of decades of subsidies for coal mining and oil drilling.

Our priority, then, should be a five- or ten-fold increase in investment in clean energy – broadly defined to include R&D, deployment, procurement, education, and infrastructure – from less than \$3 billion per year to \$15 to

\$30 billion. Indeed, what matters most about the global-warming legislation being considered in Congress is how much money it will raise to invest in clean energy. Auctioning emissions permits to polluting firms could generate \$15 billion or more per year. A tax on carbon could generate a similar amount. A \$300 billion investment over ten years would, according to one study, generate an additional \$200 billion in private capital.

Some of this money ought to be used to create a new military-industrial-academic complex around clean-energy sciences, similar to the one we created around computer science in the 1950s and '60s. The transformation of Silicon Valley from a sleepy collection of apple orchards and small towns to the information technology powerhouse that it is today was the result of massive investments by the federal government into a set of interlinked military, industrial, and academic institutions in the region – a fact that is largely ignored by many high-tech executives, who prefer to imagine that it all started in Bill Hewlett's garage. Concretely, this means creating undergraduate and graduate programs in new energy sciences; postgraduate fellowships for scientists, engineers, and technicians; and training for the electricians, construction workers, efficiency experts, and installers needed to make the clean-energy revolution real.

And some of it ought to be used to buy down the price of clean-energy technologies like the Defense Department did with microchips. Today, microchips are cheap and seem to be inside of everything: our cell phones, our watches, and our cars. But it wasn't always this way. Microchips used to be big, slow, and expensive. Then, in the 1960s, the Pentagon made the strategic

decision to effectively guarantee the market for microchips, allowing firms such as Intel to grow and eventually stand on their own. Some energy experts have calculated that an investment of roughly \$200 billion would bring the price of solar energy down to that of coal. Investments could also be made in carbon capture and storage, geothermal energy, and wind power, as well as toward the energy infrastructure needed so that clean-energy sources can compete on a level playing field. The goal would not be to subsidize clean energy in perpetuity but rather to make the kinds of investments that ultimately bring the real price of clean energy down to the price of dirty-energy sources like coal in places like China.

Doing all this will require a more optimistic narrative from the environmental community. Gore's "An Inconvenient Truth", like *Silent Spring*, was considered powerful because it marshaled the facts into an effective (read: apocalyptic) story. But, ironically, for more than seven years, research that environmentalists have privately conducted on attitudes toward global warming has found the opposite: Cautionary tales and narratives of eco-apocalypse tend to provoke fatalism, conservatism, and survivalism among voters—not the rational embrace of environmental policies. This research is consistent with extensive social-science research that strongly correlates fear, rising insecurity, and pessimism about the future with resistance to change.

In promoting the inconvenient truth that humans must limit their consumption and sacrifice their way of life to prevent the world from ending, environmentalists are not only promoting a solution that won't work, they've discouraged Americans from seeing the big solutions at all.

For Americans to be future-oriented, generous, and expansive in their thinking, they must feel secure, wealthy, and strong.

How might history have been different had environmentalists and their political allies 20 years ago proposed that the nations of the world make a massive, shared investment in clean energy, better and more efficient housing development, and more comfortable and efficient transportation systems? The tables would have been turned. Global warming skeptics would have had to take a position against the growth of new markets and industries.

How might history have been different had environmentalists and their political allies 20 years ago proposed that the nations of the world make a massive, shared investment in clean energy, better and more efficient housing development, and more comfortable and efficient transportation systems? The tables would have been turned. Global warming skeptics would have had to take a position against the growth of new markets and industries. Proponents of this investment agenda could have tarred their opponents as being anti-business, anti-growth, anti-investment, anti-jobs, and stuck in the past.

Thankfully, it's not too late. Today, there is quickly emerging a new political lobby and movement for clean-energy investment that is unburdened by the pollution paradigm. Increasingly, energy companies and investors are realizing that they cannot rely on the environmental lobby and must take political matters into their own hands. And, with young and grassroots environmentalists more inspired by the vision of creating a new energy economy

than regulating the old one, there's new hope that we will soon see the emergence of a more expansive, relevant, and powerful ecological movement, one grounded in possibilities, not limits.

To be sure, the effort to reduce and stabilize global greenhouse gas emissions will require a major regulatory effort to make sure that everyone is playing by the same rules, provide a stable investment environment for nations and businesses, and increase the cost of fossil fuels relative to cleaner energy sources. But the conventional wisdom today about global warming is backwards. Environmentalism is not the solution to the crisis of global warming. Instead, global warming is driving environmentalism to evolve into something else. Reflecting on the birth of a politics capable of dealing with global warming, Bill McKibben, the author of the seminal 1989 book *The End of Nature*, wrote, "If it has success, it won't be environmentalism anymore. It will be something much more important."

Environmentalism is not the solution to the crisis of global warming. Instead, global warming is driving environmentalism to evolve into something else. Reflecting on the birth of a politics capable of dealing with global warming, Bill McKibben, the author of the seminal 1989 book *The End of Nature*, wrote, "If it has success, it won't be environmentalism anymore. It will be something much more important."

FAST, CLEAN, & CHEAP

CUTTING GLOBAL WARMING'S GORDIAN KNOT

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INTRODUCTION

In the Greek legend, King Midas used a complicated knot to tie his father's ox cart to a post. An oracle prophesied that the one who untied the cart—which symbolized Apollo's father, Zeus—would rule the kingdom. For many years the knot stymied all who attempted to untie it. Then, one day, rather than trying to untie the knot, the young Alexander simply cut the rope with his sword. Alexander went on to become a brilliant military commander and, eventually, King of Macedon.

The story is traditionally interpreted to mean that one can often solve seemingly impossible problems with a single and simple bold stroke. But there are two other morals to the story. First, to find solutions, one must see old problems in a new light. Alexander saw the problem as freeing the ox cart from the post, rather than untying the knot. Alexander's new perspective—what is sometimes called a “gestalt shift”—was a prerequisite to cutting the Gordian Knot. Second, cutting the knot involved a kind of rebellion. The oracle's prophecy specified that the knot be untied. In cutting the knot Alexander had to, paradoxically and audaciously, violate the conventional meaning of the oracle's prophesy in order to realize it.

Today, there is a dilemma—a “Gordian Knot”—at the heart of any effort to deal with global warming. If policymakers limit greenhouse gases too quickly, the price of electricity and gasoline will rise abruptly, triggering a political backlash from both consumers and industry. But if policymakers limit greenhouse gases too slowly, clean energy alternatives will not become cost-competitive with fossil fuels in time to prevent catastrophic global warming.

This Essay argues that both a gestalt shift and a bold stroke are required to cut the Gordian Knot at the heart of today's energy challenge. Many policymakers view the problem of global warming as a pollution problem, similar to acid rain, smog, or the ozone

hole. But whereas addressing the ozone hole required a simple and inexpensive chemical substitute, global warming demands a totally different way of producing energy. We were able to fight smog without replacing oil. We dealt with acid rain without dismantling our power plants. And we will continue to phase out ozone-depleting chemicals without affecting any of our energy sources.

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To deal with global warming, we will need an entirely new energy infrastructure. Creating a new energy infrastructure is more comparable to the creation of the railroads, the interstate highway system, personal computers, the Internet, and the space program than it is to installing catalytic converters and scrubbers, or phasing out ozone-depleting chemicals. The latter involved mere technical fixes, not wholesale technological revolutions.

Environmentalists have been so focused on making clean energy relatively cheaper (by imposing regulations that make dirty energy expensive) that they overlook the possibility of making clean energy absolutely cheaper through major investments in technology innovation and infrastructure. The good news, however, is that the current regulation-centered approach can potentially become an investment-centered approach. For instance, the dominant proposals addressing global warming

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would auction mandatory pollution permits to U.S. companies.¹ Depending on how the auction is structured, the sale of pollution permits could generate between \$30 and \$250 billion per year for clean energy.² This money would come from higher energy prices, however, and

in order for the American public to agree to such a project, voters must be inspired by the project's potential to free the United States from oil and to create jobs through technology innovation.

In the end, it was impossible—and unnecessary—to untie the Gordian Knot. All that was needed was to free the ox cart. In the case of global warming, we must free energy production from greenhouse gas emissions.

I. THE CLIMATE CHANGE AND ENERGY CHALLENGES

A. Global Warming

Global warming threatens to trigger severe droughts, water shortages, agricultural collapses, forest fires, migration crises, and food scarcity. According to scenarios commissioned by the Pentagon, climate change could lead to wars over basic resources like food and water.³

In the face of this crisis, there is an emerging international consensus that greenhouse gas emissions (the bulk of which are carbon dioxide) must be reduced by roughly 80% in the developed world and 50% worldwide by 2050 if we are to avoid dangerous levels of global warming.⁴ Following the Industrial Revolution, total atmospheric carbon dioxide increased from roughly 280 to 430 parts per million (ppm).⁵ Unless we change today's energy trajectory, total atmospheric carbon will pass 550 ppm by 2035.⁶ Scientists believe that total atmospheric carbon dioxide must be stabilized between 450 ppm and 550 ppm if we are to avoid catastrophic global warming impacts.⁷

B. The Energy Challenge

In 2007, human beings consumed roughly fifteen terawatts (trillion watts) of energy.⁸ Humans will need to produce and consume roughly sixty terawatts of energy annually by 2100 if every human on earth is to reach the level of prosperity enjoyed today by the world's wealthiest one billion people.⁹ Even if economies were to become 30% more efficient, the total terawatts required to bring all of humankind out of poverty would need to roughly triple by century's end.

Meanwhile, emissions continue to increase globally. The case of China demonstrates why a regulatory approach will not eliminate the problem of greenhouse gases. In 2008, China will pass the United States as the largest emitter of greenhouse gasses.¹⁰ By 2050, estimations of the contributors of emissions in order of magnitude will be China at approximately 25%, the United States at 14%, India at 12%, and the EU at 9%.¹¹ The Energy Information Administration (EIA) predicts that, under a business as usual ("BAU") scenario, the rate of global emissions will grow 37%—about 1.8% every year—from 2004 until 2030. China's emissions will grow 3.4%—nearly double the global average.¹²

The EIA estimates that, between 2004 and 2012, China, India, and the United States will build over 850 coal power plants, which will put more than five times as much carbon dioxide into the atmosphere as the Kyoto Protocol aims to reduce. Over 550 of those plants will be in China.¹³ Coal currently provides about 70% of China's energy,¹⁴ and China builds roughly one new coal-fired power plant every week.¹⁵ China's total coal-related emissions are projected to increase by 232% between 2004 and 2030.¹⁶

C. The Goal: Cut the Link Between Energy Production and Greenhouse Gas Emissions

Energy is the lifeblood of every society. Rising energy consumption is strongly correlated with longer life spans and higher quality of life.¹⁷ But rising energy consumption has also resulted in rising greenhouse gas emissions and global warming. Moreover, America's dependence on fossil fuels has led to expensive and dangerous military entanglements. Given all of this, a top goal for humankind in the twenty-first century will be to increase energy consumption so the world's poorest people can climb out of poverty while also moving toward more secure, and cleaner, sources of energy.

II. THE PROBLEM WITH THE POLLUTION PARADIGM

A. The Regulation-Centered Approach

In 2007, the world celebrated the twentieth anniversary of the Montreal Protocol, the international treaty enacted to phase out ozone-destroying chemicals. For environmentalists, the Montreal Protocol is a model for action on global warming. In the words of David Doniger, the climate director of the Natural Resources Defense Council, "The lesson from Montreal is that curbing global warming will not be as hard as it looks."¹⁸

And indeed, when one looks back at the pollution problems of old, none of them were as hard or as expensive to solve as the affected industries claimed they would be.¹⁹ The same will be true, environmentalists say, when it comes to global warming. All the alternatives we need—efficiency, conservation, renewables, sequestration, and even nuclear energy—already exist. We just need to scale them up.²⁰ Sure, global warming is a bigger problem, environmentalists acknowledge, but it will be solved just like we solved acid rain.

The dominant regulation-centered policy approach to global warming is known as “cap and trade.” There are a number of variations on this proposal, but each of them generally consists of two elements. First, a cap and trade approach would set a nationwide cap on emissions that declines gradually each year to achieve a targeted emission reduction. For our purposes, we can assume a 2% annual reduction with the objective of reducing carbon emissions by 80% between 2010 and 2050. Private firms would then purchase or receive pollution permits in order to operate. The second element is a trading mechanism that would allow firms that reduce their emissions beyond what is required by law to sell their unused emissions credits to firms that find it cheaper to purchase these credits than reduce their own emissions. This regulatory framework is called “emissions trading” in Europe and “cap and trade” in the United States.

By capping the level of emissions each year, and auctioning or giving away a limited number of emissions permits to firms, governments effectively create a price for carbon dioxide emissions and force businesses to internalize

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some or all of the real costs of those emissions. Advocates of this approach believe that the higher prices will create an incentive to reduce emissions and that market exchanges will, over time, create enormous value for firms that reduce their emissions, while severely punishing those that do not. As dirty energy sources like coal and oil become more expensive under the cap and trade system, innovative firms will invest in and adopt clean energy technology in order to capture this value. With more private firms investing in cleaner technologies, these technologies will become cost-competitive and more widely used. Advocates of this approach believe that regulation is the most efficient way to reduce our greenhouse gases by 80% by 2050.²¹

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B. The Regulation-Centered Approach Creates a Gordian Knot

For both economic and political reasons, a regulation-centered approach to global warming cannot achieve the international consensus targets of 80% reductions in greenhouse gases in the United States, or 50% reductions globally, by 2050.

1. Economic Constraints to the Regulation-Centered Approach

Emissions trading will, by design, direct private investment towards the least expensive methods of emissions reduction—not towards more expensive, but equally important, clean energy technologies such as solar energy and carbon capture and storage. Pricing carbon dioxide at \$7–12 per ton—whether through cap and trade or carbon taxes—can help us to get part of the way towards the 80% reduction goal. Carbon dioxide at those prices will drive investments into efficiency and conservation, and will create incentives for energy providers to build gas-fired rather than coal-fired plants. These measures could result in modest emissions reductions in the United States.

Reducing carbon emissions by 50% worldwide through regulatory limits alone, however, would require setting a much higher price for carbon dioxide. For today's clean energy alternatives to become cost-competitive with coal, gas, and oil, the price of carbon dioxide would have to be set at exorbitant levels. For example, carbon dioxide would have to be set at \$37–74 per ton to make carbon-capture-and-storage technologies economically viable,²² and it would have to be set at over \$217 per ton to make photovoltaic energy cost-competitive.²³

The United Nations International Panel on Climate Change (IPCC) estimates that establishing an average global carbon dioxide price of \$50 per ton—a figure five times higher than the price currently being considered in legislation before U.S. Senate—would reduce global carbon emissions by 20–38% by 2030.²⁴ A separate, independent analysis has found that carbon dioxide would have to be priced at around \$100 per ton between 2010 and 2030, and at a whopping \$160–200 per ton between 2030 and 2050, to reduce greenhouse gases 90% by 2050 in the United States.²⁵ To gain a sense of the impact this would have on consumers, consider that carbon dioxide priced at \$190 per ton would increase the price of coal-generated electricity in the United States by two and a half times.²⁶

In order to achieve major reductions on the order of 80% in the United States, and 50% globally, we will need to replace coal and oil as energy sources almost entirely. In order to achieve the deep reductions called for by climate scientists, the per-unit cost of low-carbon energy sources and carbon-capture-and-storage technologies would need to come down dramatically. Such a price decrease will require several technology breakthroughs.

Table 1: Price Carbon Dioxide Must Reach to Make Clean Energy Alternatives Cost-Competitive with Coal in the United States.

Carbon Pricing Scenarios, 2010	Cents per kWh, 2010 [5]	Price above coal (cents/ kWh)	Price of CO2 necessary to compete with coal
Coal (Pulverized)	4.84	0.00	0
Solar Photovoltaic [1]	25.83	20.99	\$219.97
Wind	6.67	1.23	\$12.89
Solar Thermal [2]	14.22	8.78	\$92.01
Fuel Cell	17.96	12.52	\$131.21
Biomass [3]	5.88	0.44	\$4.61
Geothermal	6.19	0.75	\$7.86
Hydroelectric [4]	6.44	1.00	\$10.48
Conventional Nuclear	n/a	n/a	n/a
Advanced Nuclear	n/a	n/a	n/a

[1] Central Station Generator

[2] Central Station Generator

[3] Integrated Gasification Combined Cycle

[4] Conventional

[5] EIA AEO 2007 Levelized Generation costs for 2010

[6] \$100 per ton price on carbon results in price increase of \$0.026 per kWh of coal electricity

Table created by authors based on 2007 EIA data.²⁷

2. Political Constraints to the Regulation-Centered Approach in the Developed World

The price of carbon dioxide neatly illustrates the Gordian Knot created through the regulation-centered framework. If the government prices carbon dioxide high enough to make currently expensive clean energy solutions like solar and carbon capture cost competitive, then energy prices would rise dramatically and elicit a political backlash. But if the government prices carbon dioxide too low, private-sector investments will flow almost exclusively to inexpensive emissions reductions, rather than to essential technologies, such as solar and carbon capture and storage.

The regulation-centered approach depends on doing something highly unpopular with the public and the business community: raising the price of energy. New energy regulations will increase the cost of gasoline, electricity, and everything else that requires energy for its production, from food to homes to consumer products. Many industries—from building to transportation to retail to manufacturing—have genuine reason to fear and oppose price increases.

Voters, far more concerned about the immediate threat of higher energy prices than the perceived distant threat of global warming, are likely to pressure governments for low carbon dioxide prices. In an October 2006 USA Today/Gallup poll, 65% of voters said gas prices were very important to their vote for Congress, and 34% of respondents said gas prices were “extremely important.”²⁸ Voters also oppose increasing the federal gas tax. A CBS News/New York Times poll reported in

April 2007 that 58% of Americans oppose an increase in the federal gas tax.²⁹ In an April 2006 Gallup poll, 64% of Americans supported suspending all federal gas taxes.³⁰ Gallup even found that 70% favored government price controls on fuel prices.³¹ (As of this writing, the price of oil had risen to over \$90 a barrel, far higher than when the aforementioned polls were conducted.)

In addition to opposing higher prices for gasoline, Americans also say they do not want to pay more for electricity. When asked if the federal government should increase taxes on electricity or gasoline to encourage conservation, Americans overwhelmingly rejected the approach. A March 2006 ABC News/Washington Post Poll showed that 81% of voters oppose increasing taxes on electricity, and 68% oppose increasing taxes on gasoline, to encourage conservation. A year later, despite extensive national and local media attention about global warming, those numbers decreased only marginally.³²

Advocates of a higher price for carbon dioxide are building their public case around the urgency of global warming. But efforts to increase the public's concern with global warming have not been particularly successful. In 1989, Gallup asked Americans how concerned they were with global warming. 63% said they worried "a great deal" or a "fair amount" about it. By 2007, that number was virtually unchanged at 65%.³³

Public awareness reached a new high in the summer of 2006 with the publicity surrounding Al Gore's "An Inconvenient Truth". The Pew Center for People and the Press³⁴ conducted a telephone survey of 1501 adults between June 14 and June 19, 2006, a period timed to coincide with the high point of the media's interest in Gore's movie. The movie did virtually nothing to increase the saliency of global warming among voters. For Republicans, the percentage of respondents rating global warming as "very important," was the lowest out of all nineteen issues presented, and, for Democrats, thirteenth lowest.³⁵ By January 2007, the relative importance of global warming actually declined to twenty-first out of twenty-one issues for Republicans, seventeenth out of twenty-one issues for Democrats, and nineteenth out of twenty-one issues for independents.³⁶

Since voters seem to care more about the cost of energy than global warming, most policies under consideration in Congress would price carbon dioxide at around \$7–12 per ton, either directly through a safety valve or indirectly through the allocation of pollution allowances. As noted above, at that low price, private investment will mainly flow toward the least expensive options for emissions reductions and not toward the more expensive technologies.

In addition to the political obstacles posed by domestic consumers, effective carbon pricing poses free-rider and public-goods problems for domestic industries that make it difficult for policymakers to act decisively. Developed nations will likely set a low price for carbon dioxide because domestic industries, fearing disadvantage relative to competitors operating in countries that do not restrict greenhouse gas emissions, will pressure their governments for low carbon prices. Such concerns over industrial policy motivated the U.S. Senate to preemptively reject, 95-0, the Kyoto treaty on global warming in 1997.³⁷

The political restraints facing American policy had a similar constraining effect in Europe. Europe's Emissions Trading System has not achieved its goal of significantly reducing the EU's emissions because European governments issued too many permits to polluters. The price of carbon dioxide peaked at €30 per ton in April 2006, but once it became evident that countries had over-allocated permits—and that firms did not need to seriously reduce their emissions—the price fell to €0.10 per ton in September 2007.³⁸ EU officials are expected to distribute fewer permits for the 2008–10 period, but governments will remain under pressure from industry to establish a low price for carbon dioxide.

3. Political Constraints to the Regulation-Centered Approach in the Developing World

Widespread sentiment suggests that once the United States acts, so will the developing world. “If the United States leads, other nations like India and China will follow,” Senator Barbara Boxer, Chairwoman of the Senate Committee on the Environment and Public Works, told the National Press Club.³⁹ Indeed, Chinese firms earn billions of dollars selling emissions reductions to European firms, thus giving China a stake in the success of global emissions trading. Moreover, China has reason to be genuinely worried about global warming. But even if Beijing does eventually set a price for carbon dioxide, it will probably not be high enough to make building carbon-capture-and-storage facilities next to its coal power plants—or substituting wind, solar, and nuclear for coal—economically viable.

China has repeatedly maintained that it will not restrict its emissions without a strong economic reason to do so. “You cannot tell people who are struggling to earn enough to eat that they need to reduce their emissions,” a Chinese government official recently explained.⁴⁰ Part of China's reluctance to reduce its emissions stems from a sense of the developed countries' historical responsibility: “[Climate] change has been caused by the long-term historic emissions of developed countries and their high per capita emissions,” another government official noted.⁴¹ Prior to the recent United Nations negotiations in Bali, China told the European Parliament that it would oppose binding emissions caps.⁴²

High carbon dioxide prices would translate into dramatic increases in the price of energy and everything else that requires energy (which is to say, virtually everything). Given that increasing energy use and consumption are highly correlated with longer life spans and higher living standards in developing nations, a high carbon price would increase energy prices and thus represent a major obstacle to economic development for poor countries.

The only way to achieve a rapid transition to clean energy in the developing world is by addressing these countries' underlying concerns about security, stability, and economic growth. This is not to say that the Chinese government will never agree to emissions limits or a carbon tax. But any agreement to do so will need to be in China's short- and long-term economic interests.

The most plausible scenario to induce the Chinese government to substantially reduce its country's emissions is to drive down the price of clean energy, as well as carbon capture technologies.

Achieving these efficiencies may require China's manufacturing prowess. Currently, a single factory in China is estimated to produce nearly 25% of the world's solar panels.⁴³ The Chinese government may be more amenable to setting a price for carbon in the future if its domestic firms and workers benefited, as they would if investment dollars flowed into solar panel production.

C. The Proper Role of Regulation

Many environmental lobbyists, energy policy analysts, and policymakers conflate the two distinct challenges that regulation and investment address: increasing the cost of fossil fuels and decreasing the cost of clean energy. Writing for the Stern Review, Dennis Anderson noted that even many energy experts make this mistake:

[Energy experts] frequently confound the aims of innovation policies with the aims of carbon pricing, which are to encourage the use of technologies that have already passed through their RD&D and commercial trial stages By facilitating invention and reducing costs, such policies complement the pricing of carbon directly, and should pave the way to lower carbon prices in the long-term.⁴⁴

The new greenhouse regulations should instead be understood as a complement to the investments in technological innovation that will be required to address the global warming crisis. Even critics of the regulation-centered approach acknowledge that stabilizing the climate will require governments to establish a price for carbon, implement new energy regulations, and make large, long-term investments in energy-technology innovation.⁴⁵

Gradual reductions in the allowable levels of pollution by private companies will result in greater energy efficiency gains, which are likely to have economic benefits above and beyond slowing global warming. Allowing firms to freely trade pollution permits will lead to economy-wide emissions reductions. Firms most capable of making reductions will be able to sell some of their reductions to those firms least capable of making them. And most important, if the pollution allowances are auctioned, the regulatory process can generate between \$30 billion and \$250 billion annually for public investment in clean energy.⁴⁶

“[Energy experts] frequently confound the aims of innovation policies with the aims of carbon pricing, which are to encourage the use of technologies that have already passed through their RD&D and commercial trial stages.” – Stern Review

III. CUTTING THE KNOT: TOWARDS AN INVESTMENTCENTERED PARADIGM

A. The Case for Public Investment

The great technological revolutions of the past did not occur via regulatory fiat. The U.S. did not invent the Internet or the personal computer by taxing or regulating typewriters. Nor did the transition to the petroleum economy occur because we taxed, regulated, or ran out of whale oil. Those revolutions happened because we invented alternatives that were vastly superior to what they replaced, and, in remarkably short order, a good deal cheaper. The transition to the clean energy

economy will be no different and, like previous technological revolutions, will require substantial public investment to occur quickly and completely.

1. Obstacles to Innovation in the Energy Sector

Energy is arguably the least innovative sector of the economy. Coal and oil have been in widespread use for the last 200 and 100 years respectively. While alternatives to fossil fuels exist, they represent a tiny fraction of our current energy mix because they are relatively more expensive and difficult to use on a mass scale.

Several reasons account for the relative lack of innovation in the energy sector. The first is that national electricity grids are tailored for large, centralized plants. Energy companies and investors are often reluctant to expend their revenue on risky, innovative, and costly ventures without government regulation or measures designed to reduce their risks.⁴⁷

There are additional obstacles to a transition to renewable energy sources. Solar and wind energy depend on the vagaries of the weather, and most electricity systems are not capable of taking advantage of such intermittent production. Many renewable electricity sources, such as wind, are located far from current power lines, and their integration faces regulatory and technical challenges.⁴⁸ Just as the electrical grid was created to support coal and natural gas, the transportation infrastructure is geared to oil. Alternatives like biofuels and hydrogen depend on massive public investments in public infrastructure.⁴⁹ As a result, fossil fuels remain “locked in” as energy sources.

Old energy sources are also locked in politically. As the Stern Review makes clear, the annual investment of \$33 billion in clean energy technologies (which includes nuclear energy) is “dwarfed by the existing subsidies for fossil fuels worldwide that are estimated at \$150 billion to \$250 billion each year.”⁵⁰

Because consumers perceive energy as a homogenous commodity, there is little to no product differentiation for newer, cleaner, and more technologically advanced energy sources like solar and wind. Whereas pharmaceutical and high-tech companies have an incentive to invest heavily in research and development to invent new products that consumer might switch to or pay more for (such as new cell phones and personal computers), the energy sector will sell the same product—electrons—in 2100 that it sold in 1900. While there has been some very modest success selling “green power” to consumers, no serious expert believes that demand for green power will be anything more than negligible in determining future energy sources.⁵¹

Another obstacle to firms making large investments in technology innovation is that energy companies cannot easily capture all of the future returns on these investments. Pharmaceutical companies can invest roughly 15% of their revenue on research and development in order to develop new drugs because they can patent specific drugs and benefit from a monopoly on that patent for a certain number of years.⁵² By contrast, notes one analyst, “it is far harder to define engineering patents in ways that cannot be circumvented over time.”⁵³ Firms are often unable to capture the

value of their investments because the knowledge and learning from research and development “spills over” to benefit other firms, creating a free-rider problem that discourages private firms from investing capital in research and development.⁵⁴

Given the lack of incentives for private investment, public investments in energy R&D are vitally important. Yet public investment remains low and has actually declined over the last twenty years. Public investment in energy research and development in the United States dropped from an already modest \$8 billion in 1980 to \$3 billion in 2005 (in 2002 dollars). Private venture capital during the same period dropped from \$4 billion in 1980 to a paltry \$1 billion in 2005.⁵⁵ This lack of investment can be attributed to the declining cost of oil in the 1980s and 1990s, and the absence of an effective national lobby for clean energy.

2. A High Price for Carbon Dioxide Is Not Enough

Even if governments did set a very high price for carbon dioxide, doing so would not be enough to dramatically reduce emissions. “[T]he presence of a range of other market failures and barriers mean [sic] that carbon pricing alone is not sufficient,” the Stern Review concluded.⁵⁶ “Technology policy, the second element of a climate change strategy, is vital to bring forward the range of low-carbon and high-efficiency technologies that will be needed to make deep emissions cuts.”⁵⁷

Technological breakthroughs are needed to boost the performance of current clean energy technologies and to decrease the cost of deploying them. Without these breakthroughs, the costs of these technologies are too high, and their performance and return on investment too low, to justify private sector investment in their widespread deployment. This will likely be the case even with the higher carbon prices that the many proposals currently being considered in the U.S. Congress would establish.

“Getting those new technologies on line will require more than price signals because no company on its own will invest in the necessary speculative and costly research and development concepts,” wrote Stanford’s David Victor and Danny Cullenward in *Scientific American*.⁵⁸ “Ultimately, the belief that prices alone will solve the climate problem is rooted in the fiction that investors in large-scale and long-lived energy infrastructures sit on a fence waiting for higher carbon prices to tip their decisions. In fact, many factors stifle the implementation of novel low-carbon policies.”⁵⁹

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Relying only on a high price for carbon without also making large public investments in strategic

deployment, others warn, “is likely to result in distortions in other economic sectors and to increase the total costs of climate policy to society.”⁶⁰ The way to avoid these distortions and other detrimental effects to the economy is by investing in innovation. In assessing various approaches to climate policy, one influential study concluded that “investments in climate friendly technologies can reduce GDP losses to the U.S. by a factor of two or more.”⁶¹

Finally, in order to be deployed at levels that might allow them to displace conventional energy sources on a large scale, clean energy alternatives like solar and wind will require significant improvement in the cost and performance of battery and other energy storage technologies, as well as the development of a new electricity grid. These are investments that the private sector either cannot or will not be able to make.

3. Expert Consensus Supports a Massive Increase in Public Investment

Over the last ten years, a consensus has emerged among energy policy experts that “disruptive” clean energy technologies that achieve “non-incremental” breakthroughs in price and performance are needed to solve the problem of global warming.⁶² Although the media coverage of the Spring 2007 IPCC focused on the U.N.’s reiteration of the long-standing consensus that global warming exists and is caused by humans, the report went much further, calling not just for regulation but also for large public investments into clean energy. “Public benefits of RD&D investments are bigger than the benefits captured by the private sector,” the IPCC report concluded, “justifying government support of RD&D.”⁶³ Similarly, the Stern Review recommends that governments boost their clean-energy investments from current global levels of \$34 billion (an amount that includes nuclear) to between \$68 billion and \$170 billion annually.⁶⁴

Indeed, whether it is the recommendations presented by the IPCC, the Stern Review, *Scientific American*, or top energy innovation experts, investment in technology is universally seen as a central element in overcoming ecological crisis. “Funding for energy research,” *Scientific American* said in its lead editorial in a special issue dedicated to clean energy, “must be accorded the privileged status usually reserved for health care and defense.”⁶⁵ In a 2002 article, New York University physicist Martin Hoffert and sixteen other leading energy experts argued that “although regulation can play a role, the fossil fuel greenhouse effect is an energy problem that cannot be simply regulated away.”⁶⁶ It is a conclusion broadly echoed by other leading analysts.⁶⁷

Clean energy alternatives exist, have been demonstrated in laboratory settings, and in the case of things like solar panels, have been deployed over a number of years at a relatively small scale. Other technologies, such as carbon capture and storage, are at an even earlier stage of development.

That these technologies exist, however, does not mean that the market will adopt them without further improvements:

[I]t will require substantial effort and investment by both the public and private sectors for them to be adopted by the market Urgent action is needed to stimulate R&D,

to demonstrate and deploy promising technologies, and to provide clear and predictable incentives for low carbon options and diverse energy sources.⁶⁸

In fact, high levels of initial public investment can help encourage later private investment. MIT's John Deutsch writes, "Government support of innovation—both technology creation and technology demonstration—is desirable to encourage private investors to adopt new technology."⁶⁹

There is a key difference between what government does well in terms of promoting technological innovation and what the private sector does well. The standard distinction is that government is the appropriate entity to fund basic research while the private sector is better and more efficient at commercializing new technologies. However, a vast chasm lies between the research stage and the commercialization stage where many promising energy technologies die—the so-called "technology valley of death." It represents critical early-stage production and deployment stages of commercialization. At these stages, the private energy sector has not fared well.

4. Lack of Public Investment Is a Primary Barrier to Innovation

Most energy experts view the lack of public investment in clean energy as the primary barrier to achieving price reductions through innovation. "Probably the most significant barrier to ETI [Energy Technology Innovation] is inadequacy of funds, especially for R&D, in relation to the challenges that are faced by [the] energy system."⁷⁰

John Holdren, the current chairman of the American Association for the Advancement of Science, wrote:

Around the world, the energy sector's ratio of RD&D investments to total revenues is well below that for any other high-tech sector of the economy These investments will need to be boosted at least 2–3-fold if the world is to meet the energy challenges it faces in the decades immediately ahead.⁷¹

Others say the level of investment should be much higher. "Using emissions scenarios from the Intergovernmental Panel on Climate Change and a previous framework for estimating the climate-related savings from energy R&D programs, we calculate that U.S. energy R&D spending of \$15–30 billion per year would be sufficient to stabilize CO₂ at double pre-industrial levels [550 ppm.]"⁷²

B. Lessons from Past Public Investment in Technology and Infrastructure

The efficacy of this kind of public investment is well-documented. For instance, in the roughly five years that the federal government guaranteed the market for microchips in the 1960s, the price of a microchip came down from \$1000 per chip to between \$20 and \$30 per chip.⁷³ According to Stern and the IPCC, "extensive and prolonged public support and private markets were both instrumental in the development of all generating technologies. Military R&D, the US space programme and learning from other markets have also been crucial to the process of innovation in the energy sector."⁷⁴ The IPCC further explains that "government support through financial contributions, tax

credits, standard setting and market creation is important for effective technology development, innovation and deployment.”⁷⁵

The dramatic price and performance improvements in wind technology occurred because Denmark guaranteed its market for wind energy in the 1980s and 1990s. “Development of the Danish wind and Brazilian biofuels industries each required sustained government support over decades. The Danish subsidies totaled \$1.3 billion, and Danish wind companies now earn more than that each year. At current oil prices, Brazil may soon similarly recoup its investment in biofuel technology.”⁷⁶ Similarly, the Japanese government saw breakthroughs in the price of solar panels as a result of its intervention in the solar market in the 1990s.⁷⁷

Large public investments in technology innovation and infrastructure are not new. Most of America’s largest industries have benefited from strategic public investment in their development: agriculture,

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aerospace, transport, biotechnology, and energy. Farm land was granted to early American frontier farmers, and agriculture has been publicly subsidized since the early twentieth century. Before the Civil War, Abraham Lincoln was best known for his aggressive advocacy of publicly funded transit projects intended to modernize industry: canals, roads, and later, famously, railroads. The U.S. government created computer science, aerospace, and the modern highway system through investments that were designed to compete with the Soviets and were justified by national security concerns. And today’s highly mature energy markets are the result of decades of subsidies for coal mining and oil drilling.

Government investments come in a variety of forms, from outright subsidization to various tax deductions, credits, and other mechanisms aimed at starting, financing, and otherwise supporting industries deemed important either to national wealth creation, national security, or both. The U.S. government invested directly in computer science scholarships and fellowships, prizes, research and development, and microchips. The private sector did not create, and could not have created, these high-tech markets.

Many successful new technologies cannot become commercially viable without public investment in the form of government procurement. The Defense Department’s procurement of microchips facilitated the technology’s market penetration and helped decrease its cost. It is not just microchip companies like Intel that benefited from these public investments. All high tech firms that depend on microchips, the Internet, and computer science exist thanks to these “tech-push” strategies.

In thinking about the history of U.S. technology policy, we need to draw conclusions about policy design, in part, from the political preconditions. The first lesson is that public investments succeed

when they have strong support from both elites and the public. Cold War military leaders, for instance, supported the expansion of airplane technology for security reasons, which also helped establish elite support for the space program. By the time President John F. Kennedy announced his intention to put a man on the moon and bring him safely back home, which cost over \$135 billion in 2006 numbers, widespread public support for the aerospace industries already existed, with both job creation and national security driving that support.

The second lesson is that these investment-centered policies succeeded politically because they spoke to core American values, such as ingenuity, creativity, perseverance, and competition. They were also urgent: the Manhattan project was a race against the Nazis, and fear of the Soviets motivated the development of aerospace, computers, and the Internet.

In the case of the Cold War space program, the United States was literally in a “space race” with the Soviets. The speed with which the United States built the railroads and the interstate highway system, invested in microchips, put a man on the moon, and built the Internet helped overcome bureaucratic obstacles to success. National security and economic development became justifications for policymakers and administrators to tunnel through various bureaucratic obstacles to success.

Today, Americans overwhelmingly view energy independence with equal urgency, and see political instability in the Middle East and the high price of oil as reasons to accelerate our transition to a clean energy future.⁷⁸ The investment-centered framework for action on energy independence and global warming should speak to both existing fear and to feelings of confidence and optimism.

The third lesson is that revolutionary new technologies generate multiple benefits. ARPANET was created primarily for communication during the Cold War, but eventually developed into the Internet. Similarly, successful public investment into clean energy has the potential to create widespread, unanticipated benefits: it can create jobs, increase national security through energy independence, reduce and stabilize energy prices by diversifying energy supplies, secure America’s place in global innovation by taking part in the fast-growing clean energy technology market, and help to mitigate the effects of global warming by reducing greenhouse gas emissions.

America’s national culture today remains far more supportive of a political and policy agenda grounded in accelerating the transition to a clean energy economy than one grounded in reducing pollution emissions. Poll data demonstrate strong public support for government research programs

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specifically. Though Americans do not support higher gasoline or electricity prices to change behavior, wide majorities also say they would be willing to pay higher gasoline and electricity prices if the money was earmarked for programs designed to achieve energy independence and develop clean energy. When both the benefits and costs of the policy initiatives were listed, the support for investment far exceeded the other options in the poll.⁷⁹

The programs would benefit industry as well. In contrast to a regulation-centered approach that seeks to impose costs on businesses, the investment-centered framework defines existing industries as potential allies rather than as likely opponents. History provides a useful guide. Private firms built the railroads, but American taxpayers paid the entire bill. Historians consider the first Transcontinental Railroad, built in the 1860s, to be the greatest American technological feat of the nineteenth century. Nearly one hundred years later, Congress passed and President Dwight D. Eisenhower signed the National Interstate and Defense Highways Act into law.⁸⁰

Innovation in science and technology may drive as much as 90% of overall economic growth.⁸¹ Investments in clean energy technology are particularly promising because they both drive economic growth and avoid (or reduce the cost of) the most expensive impacts of climate change. Using an economic model aimed at calculating both the economic costs of climate change and the costs of mitigation, Yale economist William Nordhaus estimates that clean energy alternatives have a net value of roughly \$17 trillion in 2005 dollars.⁸²

C. Challenges to the Investment-Centered Approach

The central objection to the investment-centered approach is that only a strong regulatory framework mandating reductions on the order of 2% per year can guarantee an 80% reduction of greenhouse gas emissions by 2050. An investment-centered approach, critics say, risks distracting attention from the central importance of regulation.

Others point out that investment in technology is no guarantee of technological innovation. Some point to failed public investments in the past. Corn-based ethanol receives tens of billions of taxpayer money annually, and although ethanol promises to reduce oil dependency, it has no net impact on greenhouse gas emissions, given the need for fossil fuel inputs into agriculture. The Synfuels program started by Truman and ended by Reagan did nothing to free the United States from oil. The Clinton Administration's partnership with United States automakers on a program to accelerate the creation of hybrid gas-electric engines in the face of the Congress's repeated unwillingness to raise fuel economy standards had no technological impact.

Some have suggested that our investment-centered approach misunderstands the workings of the free market. They say that the actual price for carbon dioxide will send a symbolic "signal" to the marketplace that is far stronger than the price itself. Indeed, the public debate over new greenhouse gas regulations has spurred a huge upsurge of private investment into firms offering energy efficiency, conservation, and clean energy.

Still others have argued that our investment-centered approach differs from the dominant regulation-centered approach in degree, not kind. While it is true that our approach embraces regulation to reduce emissions, it does so primarily to generate public investment capital. The critical distinction is that we believe investment, not regulation, should be foregrounded as the main event. This argument stands in direct contrast to regulation-centered advocates who believe that a cap and trade system will drive necessary emissions reductions with the incidental benefit of generating additional revenue for investment in clean energy.

Massive public investment is required to bring down the price of clean energy and accelerate its deployment worldwide. This investment-centered approach does not require a massive increase in the cost of dirty energy. We can get where we need to go with a lower carbon dioxide price and still achieve the emissions reductions we need as long as pollution permits are auctioned and generate the necessary \$30–80 billion annual investment. Politically speaking, such a framework is more popular, since it appeals to the American core values of economic opportunity and technological ingenuity more strongly than does the regulation-centered approach.

Critics are right to point out that public investment in technology innovation and infrastructure has failed as often as it has succeeded. But the same could be said of many past regulations as well, such as the Kyoto Protocol. The emissions of Kyoto ratifying countries went up, not down, between 2000 and 2004. Moreover, the Kyoto Protocol's failure is proof that setting regulatory limits is no guarantee of emissions reductions.

The fact that some investments in innovation fail is not an argument against public investment per se, just as the failure of Kyoto is not an argument against emissions limits per se. Indeed, in the case of technology innovation, repeated failures are widely recognized by experts and CEOs alike as preconditions to success. That some past investments and regulations failed is reason for careful examination of what has and has not worked in the past, and what needs to be done now.

IV. SPECIFIC RECOMMENDATIONS

We offer the following specific recommendations as a starting point for discussion. These recommendations are designed to drive home the scale of the problem and to initiate a dialogue about the best way to proceed. How much to invest, where to invest it, and how to structure the incentives for the private sector are complicated problems, and will take considerable additional thought. What is clear, however, is that a new approach to the energy challenge is imperative at this point in time.

1. Establish a Price for Carbon Dioxide That Is Consistent With What Present Technology Can Accomplish

Experts and stakeholders vigorously debate the level of carbon reduction Congress should mandate. The grassroots climate movement demands 80% by 2050.⁸³ Most legislative proposals in Congress undershoot that goal substantially. As noted above, carbon dioxide would need to be priced at

around \$100 per ton between 2010 and 2030, and \$160–200 per ton between 2030 and 2050, to reduce greenhouse gases 90% by 2050 in the United States—prices that would increase the cost of coal-generated electricity by two and a half times.⁸⁴ For this reason, many global warming proposals under consideration in Congress include a safety valve provision that would lift the national emissions cap if the carbon dioxide price it establishes goes above a certain price, say \$7–12 per ton. As long as there is a safety valve or other mechanism that would have the effect of keeping the price of carbon dioxide relatively low, the total emissions cap is largely irrelevant and what matters is the maximum carbon dioxide price that triggers the safety valve.

Expending political resources to establish emissions caps over forty years that will either prove unsustainable without technology breakthroughs, or irrelevant with them, does not make sense. We are better

We are better off establishing a modest carbon dioxide price in the shorter term, which can capture emissions reductions from efficiency and the shift to cleaner conventional energy sources, while pursuing a more feasible long-term strategy of reducing the price of clean energy through politically palatable public investment.

off establishing a modest carbon dioxide price in the shorter term, which can capture emissions reductions from efficiency and the shift to cleaner conventional energy sources, while pursuing a more feasible long-term strategy of reducing the price of clean energy through politically palatable public investment.

2. Establish a Dedicated Source of Public Funding for Clean Energy Investment That Can Rapidly Drive Down the Deployed Cost of Clean Energy Technologies

Given this framework, the key to achieving deep reductions is to drive down the real price and improve the performance of clean energy technology as rapidly as possible. As noted above, it is our contention that targeted public investment is the most likely path to this outcome. Carbon regulation may be one source for this revenue stream. Whether through auctioning permits or taxing carbon dioxide directly, federal carbon regulation can potentially generate tens of billions of dollars annually for public clean-energy investments. These investments should include dramatic increases in funding for basic research in the energy sciences, a ten-year commitment to buy down the price of solar technology and battery and other energy storage technologies, and a commitment to build a smarter and more efficient electricity grid that can support energy generation that is both more widely distributed and, in many cases, more remote.

3. Ramp Up: Invest \$300 Billion in Research, Development, and Deployment of Clean Energy Technologies

An emerging consensus among energy experts suggests that investment in energy research, development, and deployment should be increased to \$30–80 billion in the United States, and \$50–170 billion worldwide, per year.⁸⁵

We are proposing a ten-year, \$300 billion public investment into accelerating the transition to

a clean energy economy. The goal of the program is to bring the price of clean energy down to the price of coal and natural gas as quickly as possible. Other values also should be built into the structure of the investment, such as labor, health, and other environmental standards.

This public investment will have a significant effect in generating private investment revenue.⁸⁶ This analysis is backed by various historical investment successes. Just as past public investment efforts into railroads, the highways, microchips, the Internet, computer science, and the medical biosciences triggered billions in private investment, and paid for themselves many times over, so will these new investments into energy.

This pattern of private investment following public investment remains apparent today in both biofuels and biosciences. The econometric analysis described above found that a \$300 billion investment would pay for itself in ten years both through energy savings, economic growth, job creation, profit taking, and thus additional revenue for the U.S. Treasury.

4. Insulate Federal Clean Energy Investments From Pork-Barrel Politics

There are many models for insulating crucial policy decisions from political meddling, from the Pentagon's Defense Advanced Research Projects Agency (DARPA), to the military base closing commission, to the creation of public corporations and industry boards.

Former CIA Director John Deutsch, who also worked at the Department of Energy and now works at MIT, concludes that what is needed is both more money for commercialization and new institutions, such as a public Energy Technology Corporation. According to Deutsch,

[T]he ETC would be composed of independent individuals with experience and knowledge about future market needs, industry capability, and best use of indirect financial incentives—loans, loan guarantees, production tax credits, and guaranteed purchase—in order to run a project on as commercial a basis as possible. The ETC would not be subject to federal procurement rules, and if financed with a single appropriation, would be somewhat insulated from congressional and special interest pressure.⁸⁷

5. Buy Down the Price of Solar Technology Like We Did with Microchips

There is no silver bullet when it comes to clean energy alternatives. For that reason, we must make investments in a wide range of low- to zero-emissions technologies, including wind, geothermal, efficiency, carbon capture and storage, nuclear, solar, and advanced energy technologies.

However, this does not mean that all clean energy sources are created equal. Solar has special potential, and merits special attention. Solar panels, like microchips, have their own kind of "Moore's Law": the price of solar comes down roughly 20% every time production capacity is doubled. Just as the Department of Defense guaranteed the nascent market for silicon microchips in the 1960s, bringing the price down from \$1000 to \$20 per chip in just a few years, the Pentagon should do the same with silicon solar panels. If the price of solar photovoltaic continues to decline

20% for every doubling of capacity, it would cost just \$211 billion to bring the price of solar down to the price of current electricity costs in many countries.⁸⁸ It might be one of the best \$200 billion investments ever made by the U.S. military.

6. Play the Field: Make Strategic Investments in Key Energy Sectors and Technologies

Meeting our present and future energy needs will require greater energy diversity. Experts emphasize the need for a “silver buckshot” approach that consists of investing in innovation, including deployment, of many new energy technologies.⁸⁹

Anyone hoping to develop a new energy agenda must constantly grapple with the myriad of new technological possibilities. Delving into each specific renewable technology is beyond the scope of this essay, but targeted investments in solar, wind, geothermal, and ocean energy, as well as efficiency mechanisms, carbon capture and storage, nuclear technology, and biofuels will be important and prudent steps for the near future. Additionally, the nation desperately needs an upgraded infrastructure of batteries and transmission lines to deliver clean energy to the grid; those technologies should receive substantial public support as well.

7. Create a Framework for Global Carbon Regulation Tied to Living Standards

China, despite much criticism from environmentalists, has already done more to mitigate the environmental impacts of its development than has any developing nation in history. The establishment of nascent carbon dioxide prices in the developing world should be

The energy challenge has been framed thus far as a forced choice between poverty and environmental ruin. With a choice like that, it is no surprise that the world has failed to make real strides towards a cleaner energy future. Global warming and energy independence are new challenges that require new ways of thinking. The outmoded regulation-centered approach, which seeks to curb pollution by merely imposing costs on polluters, is inadequate to deal with this new challenge.

based upon benchmarks associated with improving living standards in those countries, the attainment of real reductions in carbon emissions in the developed world, and major progress in bringing down the costs of appropriate clean energy technologies that can be deployed in developing economies. As economic development progresses, living standards improve, and the costs of clean energy technologies come down dramatically, modest carbon prices in the developing world will become both tenable and sufficient to drive the transition to low-carbon alternatives.

V. CONCLUSION

The energy challenge has been framed thus far as a forced choice between poverty and environmental ruin. With a choice like that, it is no surprise that the world has failed to make real strides towards a cleaner energy future. Global warming and energy independence are new challenges that require new ways of thinking. The outmoded regulation-centered approach, which seeks to curb pollution by merely imposing costs on polluters, is inadequate to deal with this new challenge.

Instead, America should take a bold step and cut this Gordian Knot by pouring public funds into new technologies. Unleashing the creativity of our brightest minds on this problem is likely to produce brilliant results not only for the environment, but for our economy, national security, and status in the world.

SCRAP KYOTO

KYOTO IS DEAD – AND THAT’S A GOOD THING. IN ITS PLACE WE NEED MASSIVE GLOBAL INVESTMENT IN NEW CLEAN ENERGY TECHNOLOGY

Democracy: A Journal of Ideas, Summer 2008

The most dramatic moment during last December’s climate change talks in Bali came when delegates roundly booed U.S. negotiator Paula Dobriansky for rejecting treaty language that she said required too little of poor nations. The roar of disapproval from the delegates captured not only seven years of global frustration with the Bush Administration’s global-warming obstructionism, but also with American unilateralism more broadly.

Shortly thereafter, negotiators announced a face-saving compromise: An agreement would be negotiated in 2009, implicitly timed for a new U.S. administration, one presumably more supportive of global limits on greenhouse gas emissions. But the agreement also allowed the participants to avoid facing the painful, but true, fact that these countries had made no headway whatsoever in establishing binding emissions-reduction targets, most especially China and India, which will produce the bulk of the increase in emissions over the next century.

This last-minute arrangement also allowed those developed nations that had agreed to binding emissions targets to avoid confronting their own failures. Between 2000 and 2005, European emissions grew twice as fast as America’s. Emissions in Canada grew a whopping five times faster. Since 1990, Germany and Britain reduced their emissions, but they did so for prior reasons having nothing to do with global warming: Margaret Thatcher broke the coal miners’ union in the early 1980s, moving Britain to cleaner-burning natural gas, and the

East German economy collapsed after the fall of communism, reducing a reunified Germany’s reliance on dirty coal plants. When you remove these two from the calculation, European emissions rose almost 12 percent between 1990 and 2005.

Many Kyoto signers will, by 2012, meet their emissions reduction targets (5.2 percent under 1990 levels) on paper. But most will do so not through reducing their own carbon emissions, but rather by buying emissions reductions from poorer, developing nations through Kyoto’s Clean Development Mechanism (CDM). The CDM allows developed nations to pay for equivalent reductions of greenhouse gas emissions in developing countries when doing so is less expensive than reducing their own emissions. But because many of these are of questionable authenticity, the CDM is a poor substitute for reducing developed-world emissions.

Indeed, even if the world’s wealthiest nations were making substantial progress reducing their own emissions, emissions increases from developing countries like China, India, and Brazil would negate them. China’s emissions alone will grow more than 10 percent annually between 2000 and 2010—that’s more than the 2004 emissions of Britain, Canada, Australia, Japan, and Germany combined. From an ecological perspective, even if Europe dramatically reduced its emissions, it wouldn’t matter much.

Into this morass will step the next American

president. Senators John McCain, Hillary Clinton, and Barack Obama all have pledged to enact deep cuts in U.S. carbon emissions over the next four decades. All support federal legislation to cap U.S. carbon emissions. And all have pledged to return to the Kyoto process and negotiate a new international agreement with binding global emissions reduction targets.

Conventional wisdom in Washington and in Europe holds that with American leadership, international efforts to achieve deep reductions of global carbon emissions will quickly get back on track. Congress will pass, and the president will sign, "cap and trade" legislation that will mandate emissions reductions. The next president will have the moral standing to negotiate a successor to Kyoto, which will require wealthy nations to reduce their emissions not by five percent but rather 80 percent by mid-century. In the face of renewed American leadership, China and India will agree to binding reductions as well, and the world will be well on its way to reducing its combined emissions 50 percent by 2050.

But these plans are wildly optimistic – and unrealistic. The entire global framework for reducing carbon emissions, and indeed the entire conceptual and policy framework for addressing global warming, is a failure, based on an older paradigm of pollution control that won't slow global warming.

At bottom, global warming is not so much a pollution regulation challenge as it is an energy development one. To understand how different this challenge is from past pollution quandaries, consider that by 2050 global energy

consumption will more than double, even as we face the challenge of reducing greenhouse gas emissions by 50 percent. This transformation will not be accomplished by affixing scrubbers on smokestacks or catalytic converters on tailpipes—technical fixes that required little change to the underlying processes and technologies that they mitigated. Rather, it will require fundamental changes to the underlying technologies and fuel sources that power the global economy.

The problem with Kyoto, cap and trade, and most other policies aimed at enacting this transformation is that they focus primarily on the pollution problem, not the energy supply problem. As such, they attempt to enact the necessary transformation of the global energy economy through the indirect mechanism of pollution regulations and carbon markets, rather than through the direct deployment of new clean-energy technologies.

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China, Asia, and much of the developing world are at the beginning of what will be a 30-year process to build a coal-and-oil-based energy infrastructure. China grew 9 percent last year, and its emissions grew 14 percent (U.S. emissions grew 0.5 percent, while Europe's grew 1 percent). Given rapid economic and emissions growth in Asia, scientists in the spring of 2008 warned that the U.N. Intergovernmental Panel on Climate Change had underestimated

the emissions reduction challenge. In fact, given current trends in emissions growth, that challenge may be as much as two and half times larger than the U.N. predicted.

This is a time problem, not just a scale problem. Until recently, it was thought that we had until the end of the century to transition our energy sources. But the higher rate of increasing emissions will accelerate the rate of warming, making the case for energy modernization even more urgent.

Rapidly scaling up clean energy, and bringing down its price, will require that governments invest heavily in both the innovation and deployment of new energy sources. Even with stronger pollution regulations and a market for carbon emissions, the private sector cannot do this alone. Private firms cannot build transmission lines to transmit energy from windy and sunny places to big cities. Nor can they invest billions of dollars in high-risk projects whose final product will cost substantially more than coal and oil. Government action and investment are critical.

What cap and trade boosters often overlook is the fact that the acid rain cap and trade law only worked because of the availability of relatively cheap smokestack scrubbers and the availability of low-sulfur coal from the Powder River Basin in Wyoming. The cost of compliance was cheap, and thus consumers hardly noticed any increase in their electricity bills.

The good news is that a new consensus is emerging around precisely this point. Recently, influential figures, from former British Prime Minister Tony Blair to Columbia University economist Jeffrey Sachs to Duke Energy CEO (and cap and trade supporter) Jim Rogers, have all said that a price for carbon alone won't

be enough. They join a consensus of global energy experts who have been calling for far greater government investment in technology for more than six years. While not entirely rejected as the path forward, the bloom is off the carbon-regulation rose, and the need for direct government investment to deploy new clean-energy technologies is becoming increasingly apparent. A reformed carbon-trading market must be joined with an intensive green-technology investment strategy. The question now is not only how to raise the money and spend it well, but how to create a transformational politics around closing the technology gap.

Kyoto as Cautionary Tale

The Kyoto Protocol is based on U.S. legislation passed in 1990 to deal with acid rain and capped how much companies could pollute, with the cap declining each year. Companies that exceeded their required limits could purchase credits – "pollution allowances" – from companies that reduced their emissions beyond what the law required. The U.S. government thus created a national market for allowances of sulfur dioxide (the main component in acid rain).

What cap and trade boosters often overlook is the fact that the acid rain cap and trade law only worked because of the availability of relatively cheap smokestack scrubbers and the availability of low-sulfur coal from the Powder River Basin in Wyoming. The cost of compliance was cheap, and thus consumers hardly noticed any increase in their electricity bills. Moreover, because there was only one commodity that had to be measured, monitored, and traded – and because only a small number

of energy companies were doing the trading – the enterprise was remarkably easy for the Environmental Protection Agency (EPA) to enforce.

In contrast, Kyoto attempts to create and govern a global market for trading not one but six pollutants among not a few dozen but rather hundreds of thousands of companies and billions of customers. To understand the enforcement challenge, consider that in many developing countries a large percentage of energy production is already unpermitted, unregulated, and illegal. Corruption is pervasive. And there is always more domestic political pressure on politicians and government bureaucrats to maintain or accelerate economic growth than there is to cut pollution by increasing the price of energy.

Kyoto's primary mechanism for trading emissions, the CDM, has been the victim of such corruption. It allows participating countries to purchase emissions reductions made by manufacturers in poor nations. Perversely, the CDM led to the expansion, rather than reduction, of trifluoromethane (HFC-23), a by-product of manufacturing refrigerant gases, which is a greenhouse gas 12,000 times more potent than carbon dioxide. Developing-nation manufacturers, particularly in China, were paid 4.7 billion euros – two-thirds of all the payments into the CDM to 2012 – to cut HFC emissions, even though manufacturing refrigerants without HFC-23 cost manufacturers just 100 million euros, generating 4.6 billion euros in profits. In other words, the CDM gave Chinese companies an incentive to produce HFC-23, so that they could sell off cuts in its production later.

Kyoto's other structural flaw is that it is focused on future emissions reduction targets rather than immediate action. In 1997, just weeks before Vice

President Al Gore flew to Kyoto to negotiate the agreement, the Senate preemptively rejected, by a vote of 95 to zero, any treaty that would not require emissions reductions from developing nations or that would harm the U.S. economy. To give the Clinton Administration cover with Congress, Gore negotiated emissions targets that were weaker than what the European delegation and American environmentalists wanted. The modified accord, then, would reduce emissions by just 5.2 percent, instead of 15 percent, by 2012, and it would allow wealthy nations to purchase emissions reductions from developing nations. Gore and his team were so focused on establishing binding emissions targets that they ended up with the worst of both worlds: The treaty was both ecologically irrelevant and politically impossible.

The combination of low targets and a Byzantine international trading scheme meant that the global community could, for 10 years, merrily march forth under the illusion that meaningful steps were being taken to reduce carbon emissions. But during that time global emissions rose, unaffected by Kyoto. While the formal Kyoto compliance period, which runs from 2008 to 2012, has only just begun, it appears likely that almost all of the wealthy developed nations that ratified the treaty will either have failed to meet those targets altogether or will meet them by purchasing emissions reduction credits from other nations that are often of dubious legitimacy, as the deliberate production of HFC-23 showed.

Setting emissions targets and trading allowances pushes the day of reckoning into the future and does not require a nation to decommission a single coal-fired power plant or build a single wind farm today. And yet Kyoto proponents

continue to conflate agreements on emissions reduction *targets* with actual *actions* to reduce emissions. In Europe, for example, the German government calls for aggressive emissions reductions targets while, at the same time, protecting its automobile manufacturers from tougher emissions requirements. Kyoto allows governments to blithely agree to reduce emissions in the future while subsidizing fossil fuels and protecting domestic industry in the here and now.

The Energy-Technology Gap

For 20 years, environmentalists and others have insisted that addressing climate change won't be that hard or expensive. "We have the technology," insisted Al Gore last February. "If we just had one week's worth of what we spend on the Iraq war we could be well on our way to solving this challenge." But the \$2 billion we spend in one week on Iraq is actually a paltry sum – about the cost of a single new coal plant that captures and stores its emissions in a world of thousands of coal plants – and thus nowhere near enough to get started on, much less solve, the energy challenge.

When energy experts and climate scientists talk about reducing global emissions 50 percent by 2050 – or U.S. emissions 80 percent – they are referring to what they believe will be required to "stabilize" atmospheric carbon dioxide levels by 2050. The goal is to stabilize at 500 parts per million of carbon dioxide by 2050, the level that scientists believe is needed to prevent the melting of ice caps over West Antarctica and Greenland.

To help policy makers better understand how much carbon emissions must be reduced to stabilize atmospheric carbon dioxide at 500 parts per million, the IPCC creates different estimates, or scenarios, for how much emissions are expected to rise between now and 2050. In 2004, the world emitted about seven billion metric tons of carbon, and the UN's high estimate of emissions for 2050 is about double that. Thus, reducing emissions 50 percent from "business as usual" (BAU) – the baseline estimate for emissions absent action – means reducing emissions from 14 billion to seven billion metric tons. After stabilizing emissions in 2050, the world would need to keep reducing emissions until 2100, when emissions would need to be at something close to 90 percent of their BAU.

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In 2004, two Princeton professors, Rob Socolow and Steven Pacala, wrote an article for *Science* that broke down this seven-billion-ton challenge into seven "wedges" – so named because of the triangular shape those reductions have on a graph. One gigaton wedges include ending all tropical deforestation and doubling the current rate of reforestation worldwide; doubling the number of nuclear power plants in the world; increasing 50-fold the number of wind turbines; and increasing 700 times the number of solar panels. Simply meeting one of the seven would be a Herculean task. In Socolow's words, "There

is no easy wedge."

A few months after Gore stated that a week's worth of Iraq war spending would be sufficient to address the technology challenge, a spate of new analyses published in leading scientific journals revealed that the IPCC, which shared the 2007 Nobel Peace Prize with Gore, had drastically underestimated the emissions-reduction challenge: Faster-than-expected economic growth and accelerated coal-burning in Asia make the challenge of stabilizing emissions at least twice as large as predicted. The global economy, they found, is "re-carbonizing" – meaning that the amount of carbon per unit of global GDP is increasing, not decreasing.

As a consequence, all six future emissions scenarios in the IPCC report, and the scenario used in Socolow and Pacala's wedge analysis, probably greatly underestimate the challenge, as they are in part based on assumptions that the decarbonization trend over the last several decades in the United States and Europe (moving from coal and toward natural gas, nuclear, renewables, and increased efficiency) would continue globally. But developing nations like China and India, and their rapid creation of a fossil-fuel energy infrastructure, has reversed this trend.

The technology challenge is thus more than twice as large as was thought. As many as 18 stabilization wedges, not seven, may be needed, according to energy expert Marty Hoffert, a New York University physicist, who challenged Socolow and Pacala's numbers in a special issue of *Scientific American* in 2006. Against Gore's claim that "we have the technology," it's notable that Socolow and Pacala, in their famous analysis, were only able to come up with 15 ways to cut emissions enough to constitute a

one gigaton wedge. The problem is considerably more urgent than even Gore has warned.

While we do not have all the technologies or strategies we need to stabilize the climate, that does not mean we should not get started using what we have now. We should. But we must proceed from the recognition that many of the technologies we have today exist in nascent form and most are far more expensive than today's fossil fuels. Several, like solar and wind, are intermittent and far from cities and industrial centers, thus requiring costly storage and transmission lines. Others, like carbon capture and storage, appear promising but have yet to be widely demonstrated.

Advocates of Kyoto-style regulation point out that when environmental (and other) regulations are established, industries quickly and cost-effectively adapt. This was the case with automobile-tailpipe emissions, smokestack scrubbers, and seat belts. To be sure, some actions to reduce carbon dioxide emissions, such as efficiency and conservation measures, will actually save companies money. But these steps, while important, will not result in the deep reductions that scientists estimate will be necessary to stabilize the climate. Indeed, the most-often cited study on the potential of energy efficiency and conservation to reduce carbon emissions, the Department of Energy's "Five-Labs Study," found that with the perfect implementation of both strong efficiency and conservation regulations, and a \$50 per ton price for carbon (a price that far exceeds most proposals currently under consideration by the U.S. Congress), U.S. carbon emissions would be reduced at most by 22.5 percent, a far cry from the 80 percent reduction scientists say we need by 2050. Subsequent studies have

offered somewhat more optimistic estimates of the potential of efficiency and conservation policies, but few place that potential at greater than 30 percent.

To achieve deep reductions in global carbon emissions, regulatory approaches like Kyoto will need to make dirty energy sources like coal not a little bit more expensive, but a lot more expensive. Given the energy mix of most economies in the world, this means that these approaches, if they are faithfully implemented, will result in very substantial increases in overall energy prices. And therein lies the Gordian Knot created by the pollution regulation paradigm: increase energy prices too much and face a political backlash from individual consumers and industry alike as rising energy prices result in economic pain. But increase them too little and you'll make no significant impact on emissions. This is the reason EU efforts to reduce emissions have failed.

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Yet policymakers are sticking to the old pollution control paradigm. The U.S. Senate is considering legislation to cap and auction greenhouse gas permits, thereby establishing a cost for polluting carbon, but it will face a hard climb – American politicians of both parties have little stomach for policies that will result in steep increases in energy prices. It is ironic that even staunch congressional advocates of policies to require deep reductions in U.S.

carbon emissions simultaneously rail against high gasoline and energy prices.

The same conflict, albeit in even starker terms, is occurring globally. Since the early 1990s, China, India, and the rest of the developing world have made it amply clear that they will not agree to any treaty that would either increase energy prices or constrain their economic development. There is, therefore, little reason to believe that they will agree to significant steps to reduce their carbon emissions unless those actions are consistent with rapid economic development. So long as efforts to address the climate crisis continue to pit ecological action and economic development against one another, they are unlikely to succeed.

As a result of this bind, the world finds itself in a kind of prisoner's dilemma. Governments can either implement their Kyoto commitments, thereby raising domestic energy costs, putting domestic companies at a competitive disadvantage globally, slowing economic growth, and ultimately getting voted (or thrown) out of power by popular and industry resistance – or they can participate in global climate talks, exaggerate their token domestic efforts, and accuse other nations of doing too little. Most countries have chosen the latter.

Technology First

The time has come to abandon the church of Kyoto. Instead of making clean energy relatively cheaper by taxing carbon, a new, post-Kyoto agreement should focus on making clean energy absolutely cheaper through major government

investments in technology and infrastructure. This kind of green Keynesianism has been promoted in the past, including by Al Gore himself in his 1990 book, *Earth in the Balance*, by Ross Gelbspan in his 1992 *Boiling Point*, and by Mark Hertsgaard in "A Global Green Deal" in *Time* in 2002. But it was absent from Al Gore's 2006 book, *An Inconvenient Truth*, and it is routinely derided as unnecessary by leading liberal and environmental groups such as the National Resources Defense Council and the Center for American Progress.

A new, tech-centered solution should be modeled on the creation of the European Steel and Coal Commission after World War II or the government-spurred Silicon Valley explosion of the 1950s. Indeed, one of the best American precedents comes from the creation of Silicon Valley, which was largely built on government investments in R&D, procurement, and contracting. In the 1950s, the Pentagon guaranteed the market for computer microchips, driving the cost of a single microchip down from \$1,000 to \$20 in less than a decade – a potential model for buying down the price of solar panels, another silicon-based technology.

Other successes abound: The precursor to the Internet was literally invented in a Defense Department lab. And the federal government invested billions in the computer sciences, with amazing benefits worldwide.

What's needed now is a broad portfolio of governmental investments in research and development, demonstration, deployment, and procurement. At the international level, the G-8 and other wealthy

nations should together invest between \$100 billion to \$250 billion annually in technology innovation and infrastructure, both in their own countries and in rapidly industrializing nations like China and India. Together, this new clean-energy bloc could drive the commercialization of cheap clean-energy technologies throughout the global economy. The United States led a similar effort after World War II, investing heavily in the production of cheap coal and steel to rebuild Europe, effectively creating billions of consumers wealthy enough to buy U.S. products and services.

In 2005, the G-8 countries invited five big developing nations – China, India, Brazil, Mexico, and South Africa – for a "G-8+5 Dialogue on Climate Change, Clean Energy and Sustainable Development." Because neither the Bush Administration nor the EU put any serious money on the table for investment, the dialogue has resulted in little thus far. But all of that would change with a ten-year, \$1 trillion commitment by the G-8. We must stop seeing the G-8+5 discussions as a sidebar to Kyoto and start seeing them as the main event.

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The contours of a new technology-first agenda are already coming into view. The basic framework for such an approach should first of all focus on

equalizing per capita carbon emissions over the next century at levels consistent with climate stabilization, rather than negotiating national emissions caps that start from vastly different baselines and reflect greatly varied levels of economic and population growth. It should focus on jointly investing in, advancing, and deploying clean-energy technology across the globe. And it should offer economic benefits to all parties, as Western nations become the investors in and designers of new low-carbon technologies, and developing nations become the producers and, increasingly, consumers of them.

The prospect of billions of new investments to manufacture solar panels, erect wind turbines, and build pipelines to siphon off and store carbon dioxide underground might be enough for China and India to agree to some emissions limits, a cap and trade, a cap and lease program (as proposed by John Irons in the Spring 2008 issue of *Democracy*), or even a carbon tax. But in creating a workable emissions-trading mechanism, we should learn from Kyoto's failures. History shows that successful markets typically get built from the ground up, not the top down, as Kyoto attempts to do. As energy experts Steve Rayner and Gwyn Prins point out in their landmark critique of Kyoto, *The Wrong Trousers*:

Building national or regional emissions markets from the bottom up would also provide opportunities for learning from different approaches. Eventually such fragmented markets could, and would, become linked until such time as global trading is achieved. This is how all real and enduring markets have developed historically.

Establishing national and then regional markets,

and trading a single pollutant, carbon dioxide, should be the first step toward any effort to create a global market for carbon. Once functioning, well-regulated markets have been created, they can then be merged into a global market. While this approach needn't absolutely exclude other nations, focusing on creating a workable treaty, and then a global carbon market, perhaps through the auspices of the World Trade Organization (WTO), among leading emitters would be the critical first step.

Just as importantly, a global carbon market must establish a price for carbon that is consistent, stable, and sustainable. A carbon price that is not high enough to drive rapid deployment of clean-energy technologies but that significantly raises energy prices and risks significant public backlash is the worst of both worlds. The price necessary to drive rapid and wholesale transition to clean-energy technologies is higher than most, if not all, democracies are likely to tolerate. Thus, rather than fighting an endless series of pitched, unsustainable political battles to increase carbon prices ever higher, we are much better served by accepting a lower price paired with very large direct public investments in technology to drive down the price of clean energy alternatives rapidly such that they are cost-competitive with a lower carbon price.

This is all the more true given that the challenge is not simply to reduce developed-world carbon emissions but to dramatically reduce global carbon emissions. As such, the explicit objective of climate policies in the developed world must not be simply to reduce our own carbon emissions but to rapidly drive down the cost of clean-energy technologies in real, deployed, unsubsidized terms such that they are cost competitive in developing economies,

where there will likely be no price for carbon any time soon.

The Next Step

What will it take domestically to achieve this transformation globally? What is our next president to do?

First and foremost, the next president must put the opportunities of building the clean energy economy at the center of any proposal to address climate change, rather than casting them as ancillary benefits. Given rising economic anxieties and the relatively low priority that global warming remains with the public, a new agenda should be justified not so much as a response to climate change but rather as a way to achieve greater energy security by lowering the price of clean energy through investments in technology and infrastructure—an extremely popular proposition for voters.

Even a modest cap and trade or cap and lease program has the potential to raise the money needed. But such efforts must be reconceptualized as a clean energy investment program, not a pollution-regulation regime. And the revenues they raise should be directed exclusively to technological advancement so that it does not spark a feeding frenzy by cash starved programs, which are better funded through other sources of revenue.

This is not to suggest that the presidential candidates should abandon cap and trade – far from it. Even a modest cap and trade or cap and lease program has the potential to raise the money needed. But such efforts must be reconceptualized as a clean energy investment program, not a pollution-regulation regime. And the revenues they raise should be directed exclusively to technological advancement so that it does not spark a feeding frenzy by cash-

starved programs, which are better funded through other sources of revenue.

If cap and trade cannot raise the \$30 to \$80 billion annually that energy experts say is needed, then the next president should seek other ways to raise the money. The presidential bully pulpit should allow the next president to win a modest carbon or electricity tax if the revenue were solely dedicated to bringing down the price of clean energy – a proposal voters say they are ready for. Moreover, in early 2008, leading energy executives privately told environmental leaders and others that they would not oppose such a tax if it were dedicated to clean-energy innovation.

Fortunately, both Democratic presidential candidates have announced ambitious clean-energy investment programs. Indeed, to the extent that either Democratic candidate has articulated a coherent theory of how to grow the economy (beyond bashing NAFTA, global trade, and Wall Street bankers), it has been through investing in clean tech and green jobs.

Internationally, the balance of power in global climate negotiations has already shifted from the Atlantic to the Pacific. Whatever shape future international action to address climate change takes will likely be determined largely by China, India, the United States, and Japan. A new American president, coming to the table with billions of dollars to push new energy technology to market, would create the opportunity to craft a very different kind of international agreement and would allow the United States to take the lead on negotiating a new technology and

investment-centered climate accord.

As the next president takes office, he or she will be faced with a choice: Continue with the policy agenda of the last 15 years, one that offers an unpromising mix of bad politics, poor policy outcomes, and at best very modest and incremental progress on climate change. Or strike out boldly in a new direction – one that aligns America’s economic aspirations with its ecological interests, invests directly in the energy technology we need rather than attempting to wag the energy technology dog with the pollution control tail. The choice should be clear.

THE GREEN BUBBLE BURSTS

AMID THE ENERGY CRISIS, DEMOCRATS ARE LOSING THE HIGH GROUND ON THE ENVIRONMENT TO A GOP THAT IS PUSHING OIL DRILLING

The Los Angeles Times, September 30, 2008

As the election enters its endgame, Democrats and their environmental allies face a political challenge they could hardly have imagined just a few months ago. America's growing dependence on fossil fuels, once viewed as a Democratic trump card held alongside the Iraq war and the deflating economy, has become a lodestone instead. Republicans stole the energy issue from Democrats by proposing expanded drilling – particularly lifting bans on offshore oil drilling – to bring down gasoline prices. Whereas Barack Obama told Americans to properly inflate their tires, Republicans at their convention gleefully chanted "Drill, baby, drill!" Obama's point on conservation and efficiency was lost on an electorate eager for a solution to what they perceive as a supply crisis.

Democrats and greens ended up in this predicament because they believed their own press clippings – or, perhaps more accurately, Al Gore's. After the release of the documentary film and book "An Inconvenient Truth," greens convinced themselves that U.S. public opinion on climate change had shifted dramatically, despite having no empirical evidence that was the case.

In fact, public concern about global warming was about the same before the movie – 65% told a Gallup poll in 2007 that global warming was a somewhat or very important concern in comparison to 63% in 1989. Global warming remains a low-priority issue, hovering near the bottom of the

Pew Center for People and the Press' top 20 priorities.

By contrast, public concern about gasoline and energy prices has shifted dramatically. While liberals and environmentalists were congratulating themselves on the triumph of climate science over fossil-fuel-funded ignorance, planning inauguration parties and writing legislation for the next Democratic president and Congress, gas prices became the second-highest concern after the economy, according to Gallup.

This summer, elite opinion ran headlong into American popular opinion. The train wreck happened in the Senate and went by the name of the Climate Security Act. That bill to cap U.S. greenhouse gas emissions would have, by all accounts (even the authors'), increased gasoline and energy prices. Despite clear evidence that energy-price anxiety was rising, Democrats brought the bill to the Senate floor in June when gas prices were well over \$4 a gallon in most of the country. Republicans were all too happy to join that fight.

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Indeed, they so relished the opportunity to accuse Democrats of raising gasoline prices in

the midst of an energy crisis, they insisted that the 500-page bill be read into the Senate record in its entirety in order to prolong the debate. Within days, Senate Democrats started jumping ship. Democratic leaders finally killed the debate to avert an embarrassing defeat, but by then they had handed Republicans a powerful political club.

Republicans have been bludgeoning Democrats with it ever since. They held dramatic "hearings," unauthorized by the Democratic leadership, on the need for expanded oil drilling to lower gas prices. Former House Speaker Newt Gingrich quickly announced a book, "Drill Here, Drill Now, Pay Less," a movie and a petition drive. And Republican presidential candidate John McCain stopped making speeches about his support for bipartisan climate action, which is how he had started his campaign, and attacked Obama and congressional Democrats for opposing drilling instead.

On June 9, three days after the emissions cap and trade bill died in the Senate, Obama led McCain by eight points, according to Gallup. By June 24, the race was in a dead heat, a shift owed in no small part to Republicans battering Democrats on energy. Seeing the writing on the wall, Obama reversed his opposition to drilling in August, and congressional Democrats quickly followed suit.

But the damage has largely been done. In following greens, Democrats allowed McCain and Republicans to cast them as the party out of touch with the pocketbook concerns of middle-class Americans and captive to special interests that prioritize remote wilderness over economic prosperity.

In a tacit acknowledgment of their defeat, some

green leaders, such as the Sierra Club's Carl Pope, have endorsed the Democrats' pro-drilling strategy. But few of them seem to realize the political implications. The most influential environmental groups in Washington – the Natural Resources Defense Council and the Environmental Defense Fund – are continuing to bet the farm on a strategy that relies on emissions limits and other regulations aimed at making fossil fuels more expensive in order to encourage conservation, efficiency and renewable energy. But with an economic recession likely, and energy prices sure to remain high for years to come thanks to expanding demand in China and other developing countries, any strategy predicated centrally on making fossil fuels more expensive is doomed to failure.

A better approach is to make clean energy cheap through technology innovation funded directly by the federal government. In contrast to raising energy prices, investing somewhere between \$30 billion and \$50 billion annually in technology R&D, infrastructure and transmission lines to bring power from windy and sunny places to cities is overwhelmingly popular with voters. Instead of embracing this big investment, greens and Democrats push instead for tiny tax credits for renewable energy – nothing approaching the national commitment that's needed.

With just six weeks before the election, the bursting of the green bubble is a wake-up call for Democrats. Environmental groups, perpetually certain that a new ecological age is about to dawn in America, have serially overestimated their strength and misread public opinion. Democrats must break once and for all from green orthodoxy that focuses primarily on making dirty energy more expensive and instead embrace a strategy to make clean energy cheap.

By continuing to hew to the green agenda, Democrats have not only put in jeopardy their chance of taking back the White House and growing their majority in Congress, they also have set back the prospects of establishing policies that might effectively address the climate and energy crises.

A NEW INCONVENIENT TRUTH

AL GORE JUST UPDATED HIS PRESCRIPTION FOR FIGHTING CLIMATE CHANGE.
NOW OTHER ENVIRONMENTALISTS HAVE TO FOLLOW HIS LEAD

The New Republic, November 17, 2008

In a New York Times op-ed published on the first Sunday after Barack Obama's presidential election, Nobel prize winner Al Gore shifted from his longstanding focus on regulating carbon pollution to advocating direct government investments in clean energy as the best way to deal with climate change. Gore is the country's most prominent spokesperson on climate change and a shift in his thinking in reaction to new economic and political circumstances is highly significant.

Of Gore's five recommendations to President-elect Obama, the first four are for investment – in solar thermal plants, energy efficiency, a new electrical grid, and in electric cars – and only the final is for regulation, establishing a price for carbon. But even on this last point, Gore was far from aggressive, suggesting merely that the United Nations meeting to replace the Kyoto treaty in Copenhagen next year should result in countries agreeing to "invest together in efficient ways."

With his op-ed, Gore has reversed the longstanding green lobby prioritization of regulation first and investment second. This reversal of priorities is crucial because cap and trade regulations, which would cap greenhouse gas emissions and allow companies to trade reductions, cannot work in the U.S. — and are not working in Europe.

This is a remarkable change from just a few months ago. In July, when he first called for 100 percent of America's electricity to be from clean sources in ten years, Gore said, "Of course, we could and should speed up this transition by

insisting that the price of carbon-based energy include the costs of the environmental damage it causes. I have long supported a sharp reduction in payroll taxes with the difference made up in CO2 taxes. We should tax what we burn, not what we earn. This is the single most important policy change we can make. "

In late 2007, when Gore accepted the Nobel Prize, he said, "Most important of all we must put a price on carbon...this is by far the most effective and simplest way to affect solutions to this crisis." And at the end of his 2006 movie, *An Inconvenient Truth*, Gore calls for fluorescent light bulbs, not new solar plants; hybrid cars, not turning Detroit into an electric car capitol of the world; and cap and trade regulations, not massive public investment in technology. In neither *An Inconvenient Truth* nor his Nobel speech did Gore make a single mention of the need for major public investments in infrastructure or technology.

With his op-ed, Gore has reversed the longstanding green lobby prioritization of regulation first and investment second. This reversal of priorities is crucial because cap and trade regulations, which would cap greenhouse gas emissions and allow companies to trade reductions, cannot work in the U.S. – and are not working in Europe. Clean energy alternatives remain prohibitively more expensive than fossil fuels. The result has been policymakers in

Europe gaming the enforcement to avoid raising energy prices by very much. While Europe has established a price on carbon dioxide pollution of \$40 per ton, that carbon price hasn't stopped the continent from planning on building 50 new coal plants over the next five years.

While he hasn't completely let go of his apocalyptic rhetoric, which polarizes rather than unifies voters, Gore should be applauded for embracing an investment-first agenda.

Gore shifted because he knows that cap and trade, and most any new regulation, would raise energy prices – a political nonstarter during a recession. Taxing one part of the economy to invest in another, as cap and trade would effectively do, is not stimulus. By contrast, even the most conservative economists today believe that, in a period of serious recession bordering on financial collapse, the U.S. government should engage in deficit spending. Martin Feldstein, President Reagan's famously supply-side economist, recently argued in a Washington Post op-ed that the federal government should invest \$300 billion as stimulus. Many other economists think that number should be close to \$500 billion a year for two years.

Thus, another important shift Gore made in his op-ed was his apparent embrace of deficit spending – rather than using money from auctioning pollution allowances – to fund these new investments. In his July speech, Gore said, "We're borrowing money from China to buy oil from the Persian Gulf to burn it in ways that destroy the planet. Every bit of that's got to change." But now Gore appears to support the view that we should borrow money from China (and other foreign investors) to invest in clean energy.

We have long argued that it has been both a

policy and political mistake for greens to place a higher emphasis on carbon prices and regulation rather than public investment in technology. The reason for this is simple: The order of investment and regulations matter. Investments aimed at making the technological innovations to reduce the price of clean energy alternatives should come first, as they are crucial to making future carbon regulations work. Moreover, these investments should not depend on being funded by the auctioning of pollution allowances. Gore's shift shows what it looks like when greens go from rhetorical support for public investment as ancillary to regulating carbon to making it their central focus. Other environmental activists would be well-served by following his lead.

While he hasn't completely let go of his apocalyptic rhetoric, which polarizes rather than unifies voters, Gore should be applauded for embracing an investment-first agenda. Some green leaders will no doubt privately accuse him of inconsistency, to which Gore could quote John Maynard Keynes, who replied to a similar charge by saying, "When the facts change I change my mind. What do you do, sir?"

GETTING REAL ON CLIMATE CHANGE

WE'LL NEVER SUCCEED IN MAKING DIRTY ENERGY TOO EXPENSIVE. LET'S MAKE
CLEAN ENERGY CHEAP

The American Prospect, December 2008

The wave of optimism that American environmentalists rode into 2008 reached its zenith sometime around April 22 – Earth Day. Green was everywhere, from the pages of Sports Illustrated to NBC's Green Week to a new cable channel, Planet Green. Armed with an Oscar and a Nobel Prize, Al Gore announced a \$300 million global-warming advertising campaign. In the Democratic presidential primary, Barack Obama and Hillary Clinton competed over who had the strongest climate and energy record, and John McCain marked his “maverick” status by his intermittent support for legislation to cap carbon emissions.

The cap and trade model of climate legislation, which many in Washington believed had achieved bipartisan consensus, remains out of reach. And all the assumptions behind cap and trade — that markets are efficient, that the federal budget deficit limits any new investment, that emission caps will be firm and free from political manipulation — have either been put to the test and failed or rendered obsolete by the economic crisis.

Since then, the environmental movement has experienced a reversal as unexpected as it has been swift. In May, when Sen. Barbara Boxer brought climate legislation to the Senate floor, Sen. Joe Lieberman, a co-sponsor, announced that he could get the 60 votes to overcome a filibuster. Green groups proclaimed that the coming Senate debate would be a show of force – a “dress rehearsal” for 2009, when a friendlier president might sign even stronger legislation.

What happened next was indeed a dress

rehearsal, just not the one the environmental movement had expected. During the debate, Senate Democrats spoke of the urgent threat to civilization and displayed pictures of melting ice. Republicans presented graphs of rising gasoline prices. Democrats held up economic models showing that cap and trade would cause only modest increases to gas and electricity prices. Republicans warned of the effect higher energy prices would have on an increasingly fragile economy. It was as though the entire Senate had not moved an inch since 1997, when it voted 95–0 to reject the Kyoto treaty.

A closer look at this episode reveals that the cap and trade model of climate legislation, which many in Washington believed had achieved bipartisan consensus, remains out of reach. And all the assumptions behind cap and trade – that markets are efficient, that the federal budget deficit limits any new investment, that emission caps will be firm and free from political manipulation – have either been put to the test and failed or rendered obsolete by the economic crisis. But this lesson and the economic crisis also open a new and more promising path to halt climate change.

The debate over cap and trade legislation in June began to turn against Democrats almost as soon as it began. As Republicans prepared to introduce amendments that would have suspended the cap if it raised gasoline prices

– which no one doubted it would – panic set in. Democrats started to flee the legislation, and senior Democratic staffers in the Senate were quoted anonymously in Roll Call: “This is what happens when the committee staff and the chairman get so deep into the weeds of the bill that they can no longer see the political realities,” said one. “Boxer is walking us off a cliff,” said another.

Senate Majority Leader Harry Reid quickly orchestrated a vote for cloture to end debate so Democrats could avoid voting on the legislation. “In the end, we got a stronger vote [for cloture] on a stronger bill than we had three years ago,” says Fred Krupp, president of the Environmental Defense Fund (EDF). But support for cap and trade has steadily eroded, not increased. In 2003, cap and trade received 43 votes. In 2005, it received 38 votes. Had the 2008 bill actually been voted on, green lobbyists and Senate staffers said, it would have received no more than 35 votes.

Emboldened by their victory, Republicans doubled down, and before long, the Republican presidential nominee who bragged of his support for cap and trade denied that he had ever supported the “cap” part and joined in the “drill here, drill now” mantra. Public opinion shifted toward lifting the ban, and by August, Obama, Reid, and House Speaker Nancy Pelosi had all reversed their opposition.

Then the global financial crisis hit. The first casualty was Stéphane Dion, Canada’s Liberal Party candidate for prime minister, who had made taxing carbon pollution a central focus of his campaign. With the global economy tipping into recession, it should have been a good year for the opposition. But instead, voters gave Conservatives 19 more seats in

Parliament. Around the same time, European governments began quietly scaling back their climate commitments. A new report revealed that Europe would only meet its Kyoto targets by purchasing highly dubious carbon offsets.

Ironically, the economic crisis that appears likely to seal the fate of cap and trade legislation in the next Congress ensured the election of Barack Obama and the largest Democratic congressional majority in a generation. But the circumstances in which the new president and Congress take power are radically different than those that greens optimistically envisioned when they planned their dress rehearsal last spring.

Obama faces the deepest recession the United States has seen in decades, a failing health system, and a crumbling infrastructure. His top priority will be to get the U.S. economy back on its feet. Yet there is little evidence that greens have come to terms with this reality. Like conservatives who see tax cuts as the solution to all problems, greens are now offering carbon auctions and energy taxes as the answer to the economic crisis. “Capping global warming pollution and auctioning off the pollution rights will inject \$150 billion into the economy each year,” Krupp of EDF told his members in an Oct. 24 e-mail.

But auctioning carbon permits does not, in fact, inject any new money into the U.S. economy. Requiring industry to purchase pollution permits functions the same as a tax. Anyone old enough to remember the beginning of the Clinton presidency will recall that greens and Democrats have tried to raise money through environmental taxes before. During the formulation of Clinton’s first budget, Gore and green groups convinced the president to propose a British thermal unit (a measurement of heat,

also known as a BTU) tax on all nonrenewable energy sources. Environmental groups had pushed similar proposals for years, seeing them as a way to encourage conservation, efficiency, and use of renewable energy sources (such as sunlight, wind, and geothermal heat). “The BTU tax creates an incentive to switch from coal to natural gas,” the Natural Resources Defense Council’s Dan Lashof told *The New York Times* in June of 1993. “If you compare the environmental benefits per dollar, a gasoline tax is just half as effective as a BTU tax.”

Clinton had decided that balancing the budget would be his top economic priority rather than stimulating the economy through increasing government spending, as he had promised during the campaign. The BTU tax promised to allow him to follow through on campaign promises without further increasing the deficit, all while enacting a policy that promised significant environmental benefits. But industries required to pay more for energy will simply pass along the cost increase to consumers. The BTU tax would have, on average, raised electricity prices for consumers by 30 percent – far more in coal-dependent states like Ohio. The fossil fuel, manufacturing, and transportation industries circulated petitions and ran ads against the proposal, and the BTU tax died in the Senate. Unfortunately, Clinton had already prevailed upon House Democrats to vote for the legislation, and many of those who lost their seats in the 1994 midterm election blamed their vote for the BTU tax. Getting “BTU’d” became Beltway slang for being hung out to dry on a difficult vote.

Green leaders are now offering President Obama the same advice they offered President Clinton: Raise energy prices. But Obama is

taking power during a very different economic moment than Clinton did in 1993. Back then, as the U.S. was slowly emerging from recession, a reasonable case could be made for reducing the budget deficit. High interest rates were constraining growth, and reducing the deficit would lower interest rates. By contrast, Obama is inheriting an economy that is entering, not exiting a recession.

The longstanding conservative arguments against large deficits and government intervention in the economy have given way to a bipartisan pragmatism. Even before the recent crisis and subsequent financial-industry bailout, deficit hawks Robert Rubin and Lawrence Summers, who served as Clinton’s treasury secretaries, publicly said that because the deficit is a smaller percentage of gross domestic product today than it was in 1992, some deficit is justified. Now Washington is under intense pressure to take a much more active role in the economy. And with a high demand for safe U.S. Treasury bonds, the cost of borrowing is low.

Deficit spending and direct government investment in the economy are in. Balanced budgets and obeisance to markets are out. Faced with a global liquidity crisis and a deep and potentially prolonged recession, government has become the investor of last resort. Congress may close tax loopholes and allow the Bush tax credits to expire, but the prospects for any kind of broad-based energy or carbon tax, or serious auctioning of pollution rights, are extremely poor. Given the recent chaos in the financial markets, Congress is unlikely to turn over the nation’s energy and transportation economies to the same Wall Street firms that brought us credit-default swaps and financial derivatives.

Greens have, by and large, missed this shift in

assumptions. While we should not be surprised if environmental leaders continue to argue for cap and trade, it will be surprising if Obama, Pelosi, and Reid choose to follow them “off a cliff” once again.

So what should greens, progressives, and Democrats do in this difficult political and economic climate? While carbon pricing and pollution trading may be dead, the prospects for serious public investment in our energy economy and infrastructure are better than they have been in a generation.

Over the last eight years the Bush administration mortgaged our future by cutting taxes and running up huge deficits. But while deficit spending during a period of robust economic growth is a waste, it is absolutely vital during a serious recession. Rather than sending checks to every household, the spending should take the productive form of major investments in our economic future. Those investments should be financed by their future returns to the Treasury, rather than through new green taxes, which would imperil not only the economic recovery but also the new Democratic majority. America has arrived at a Keynesian moment, and greens should embrace it rather than propose pollution taxes in the guise of economic stimulus.

The opportunity today is to make large and sustained federal investments to radically drive down the costs of clean energy technologies, along with investing in the enabling technologies necessary to broadly deploy them. The government should invest \$50 billion a year in building the new infrastructure and promote alternatives – including carbon capture and storage, and solar, wind, nuclear, geothermal, and tidal energy – in a competitive environment where the success of these projects can be

judged rationally.

Many greens and progressives worry that this investment approach would result in more public money going to technologies they don’t like, namely nuclear, corn ethanol, and “clean coal.” But nuclear and corn ethanol already get very large subsidies, a situation that cap and trade wouldn’t change, whereas an investment-centered approach would deliver far greater funding for renewables, the poor stepchildren of energy policy. While there is no such thing as “clean coal,” given its impact on mountains and rivers, most energy experts believe that, as the world triples its energy consumption between now and 2050, coal will remain a large component of our energy supply. Few countries will be in a hurry to dismantle coal plants, but they might retrofit them with cheap technology to capture and store carbon emissions. And that technology may help us to build inexpensive stand-alone “air capture” machines to vacuum emissions from the ambient air – prototypes of which are already up and running.

Obama has long advocated a \$150 billion clean-energy investment program, which he has proposed to pay for through carbon auctions. But on the stump and in the debates, he spent most of his time talking about his proposed investments and almost none talking about carbon auctions. Given the severity of the recession, the funds for Obama’s clean-energy plan are more likely to come from deficit spending. This will strike many greens as a flawed approach to reducing carbon emissions, because, they argue, without a carbon cap or tax, there is no certainty that investments in clean-energy technologies will actually reduce emissions.

But carbon caps and taxes hardly guarantee a decline in emissions. Despite ratifying

the Kyoto Accord, which included binding caps, few nations have actually reduced their emissions at all, and global emissions growth has substantially increased. That's because virtually every nation that has established carbon caps has also included measures, either overtly or covertly, to reduce the cost of compliance, which renders the caps largely symbolic. Carbon caps have failed to reduce emissions all over the world because fossil-fuel alternatives are still much more expensive than current polluting energy sources, and voters and policy-makers are not willing to make fossil fuels so expensive that clean-energy alternatives are economically viable. If we succeed in developing the right new technologies, it might pave the way for a future cap or carbon-pricing approach that would cause less hardship and thus actually work.

Since the early 1990s, environmentalists have argued the opposite – that once the government established caps or a price for carbon, polluting

Carbon caps and taxes hardly guarantee a decline in emissions. Despite ratifying the Kyoto Accord, which included binding caps, few nations have actually reduced their emissions at all, and global emissions growth has substantially increased. That's because virtually every nation that has established carbon caps has also included measures, either overtly or covertly, to reduce the cost of compliance, which renders the caps largely symbolic.

industries would quickly find an inexpensive way to comply, as they did in the case of acid rain and chlorofluorocarbons (CFCs). But in fact, efforts to negotiate a phase-out of CFCs failed repeatedly until the chemical company DuPont developed a low-cost alternative. Only then was an agreement achieved. And the cap-and-trade program to reduce sulfur-dioxide emissions was able to do so at costs significantly

below early estimates because low sulfur coal became widely available in the years just prior to the passage of the relevant Clean Air Act amendments in 1990.

Fortunately, some green leaders are starting to question this view. Brent Blackwelder, president of Friends of the Earth, recently called for “re-evaluating proposals that place a price on carbon such as carbon caps or taxes. For instance, a cap and trade program relies on the same markets that created the mortgage meltdown. In the aftermath of one of the largest market failures in history, do we really want to trust markets to do all the work that's needed?”

For 20 years the green climate agenda has embraced two insidious orthodoxies that are rooted in market fundamentalism: Deficit spending is always bad for the economy, and we should “let the market decide” our energy future. The result has been serial political failure, skyrocketing emissions, and stagnation of energy technology. Now is the time to let go of the pollution-pricing paradigm, along with a zero-sum deficit mentality, and embrace an agenda squarely focused on public investment, building the enabling infrastructure, and making clean energy cheap.

Endnotes

Introduction

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Fast Clean and Cheap

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 58. David Victor & Danny Cullenward, *Making Carbon Markets Work*, *Sci. Am.*, Sept. 24, 2007, at 8, available at <http://www.sciam.com/search/index.cfm?q=victor+cullenward> (follow "Making Carbon Markets Work (extended version)" hyperlink).
 59. *Id.*
 60. *Neuhoff*, supra note 48, at 103.
 61. Richard Richels Et Al., *AEI-Brookings Joint Center For Regulatory Studies, Managing The Transition To Climate Stabilization 3* (2007).
 62. *Nemet*, supra note 54, at 72.
 63. *IPCC*, supra note 4, at 20.
 64. *Stern*, supra note 4, at 347.
 65. *Cooling Our Heels*, *Sci. Am.*, Sept. 2007, available at <http://www.sciam.com/article.cfm?articleID=00035ED5-6113-14E3-A11383414B7F0000&sc=i100322>.
 66. Martin I. Hoffert et al., *Advanced Technology Paths to Global Climate Stability: Energy for a Greenhouse Planet*, *SCIENCE*, Nov. 1, 2002, at 986.
 67. See, e.g., J.A. Edmonds et al., *Global Energy Technology Strategy Program, Global Energy Technology Addressing Climate Change* (2007); *IPCC*, supra note 4; *Stern*, supra note 4; *Grubb*, supra note 47; *Nemet*, supra note 54; *Daniel Kammen, The Rise of Renewable Energy*, *Sci. Am.*, Sept. 2006.
 68. *Hoffert et al.*, supra note 66.
 69. John Deutsch, *Center for Energy and Environmental Policy Research, What should the Government do to Encourage Technical Change in the Energy Sector? 1* (2005), available at http://mit.edu/globalchange/www/MITJPSPGC_Rpt120.pdf.
 70. Kelly Sims Gallagher et al., *Energy-Technology Innovation*, 31 *Ann. Rev. of Env't & Resources* 193, 221 (2006).
 71. John P. Holdren, *The Energy Innovation Imperative*, *Innovations*, Spring 2006, at 20, available at http://www.belfercenter.org/files/innovations_the_imperative_6_06.pdf.

72. Kammen, *supra* note 67, at 4.
73. Tom Abate, Tech Titans' Radio Roots, *S.F. Chron.*, Sept. 30, 2007, at A1 (citing Paul E. Ceruzzi, *The History of Modern Computing* (2d ed. 2003)).
74. Stern, *supra* note 4, at 410.
75. IPCC, *supra* note 4, at 20.
76. Grubb, *supra* note 47, at 26–27.
77. Nemet, *supra* note 54, at 154.
78. See Jeff Navin, American Environics, Energy Attitudes: Rising Public Demand for Energy Independence even as Global Warming Remains a Low Priority for Voters 7 (2007), available at <http://www.americanenvironics.com/PDF/EnergyAttitudesSummer2007.pdf>.
79. An April 2007 CBS News/New York Times poll showed 64% of Americans would be willing “to pay higher taxes on gasoline and other fuels if the money was used for research into renewable sources like solar and wind energy.” *N.Y. Times/CBS News Poll, The New York Times/CBS Poll: Apr. 20–24, 2007*, at 11 (2007), available at http://graphics8.nytimes.com/packages/pdf/national/20070424_poll.pdf. A Gallup poll taken at the same time found that when asked a battery of questions about what the government should do to address global warming, 65% of Americans said the government should be “starting a major research effort costing up to \$30 billion per year to develop new sources of energy,” the highest scoring item in the battery. Joseph Carroll, Gallup, Americans Assess What They Can Do To Reduce Global Warming (2007), available at <http://www.gallup.com/poll/27298/AmericansAssess-What-They-Can-Reduce-Global-Warming.aspx>. An August 2006 Los Angeles Times/ Bloomberg poll asked Americans to identify the “best way for the US to reduce reliance on foreign oil.” A majority, 52%, cited “having the government invest in alternative energy sources, such as wind and solar power,” the top choice by a two-to-one margin. Anxiety About Terrorist Attacks and Conflicts in the Middle East Help to Keep Bush's Ratings Low, *L.A. Times*, Aug. 2, 2006, at 15, available at <http://www.latimes.com/media/acrobat/2006-08/24694273.pdf>. The highest levels of support in a March 2006 Gallup poll were for spending government money on the new energy sources. The public supported proposals for “spending more government money on developing solar and wind power” by 81% in 2007, up from 77% in 2006. Gallup found that “starting a major research effort costing up to \$30 billion per year to develop new sources of energy” was supported by 65% of respondents, the largest level of support of the items tested. Joseph Carroll, Gallup, Majority Of Americans Support Use Of Nuclear Energy (2006), available at <http://www.gallup.com/poll/22171/MajorityAmericans-Support-Use-Nuclear-Energy.aspx>.
80. Federal-Aid Highway Act of 1956, Pub. L. No. 84-627, 70 Stat. 374 (codified as amended at 23 U.S.C §§ 101–89 (2005)).
81. Nemet, *supra* note 54, at 30.
82. Nordhaus, *supra* note 26, at 27.
83. See, e.g., 1 Sky, 1 Sky 3 Promises to do what it takes 1 (2007), available at http://www.1sky.org/wp-content/uploads/pdfs/1sky_solutions.pdf.
84. Nordhaus, *supra* note 26, at 26.
85. While there is a strong consensus that public investment in energy research, development and deployment should increase, the amount recommended varies from a twofold to a fourfold increase. See Holdren, *supra* note 71, at 20; Nemet, *supra* note 54, at 48. Nemet argues that all of these estimates are too low, pointing out that Schock's estimate of the impacts of a fourfold increase assumes “a mean climate stabilization target of between 650 and 750 ppm CO₂, and incorporates a 35% probability that no stabilization at all will be needed. This possibility of no stabilization at all is especially concerning as it would potentially involve levels exceeding 1000 ppm CO₂ by the end of the century with higher levels

thereafter.” Nemet, *supra* note 54 at 48–49. Nemet reconfigured the Schock et al. model to reach a target of 550-ppm atmospheric level of carbon, 100 ppm below what IPCC and Stern conclude would lead to drastic and irreversible consequences, and finds that the optimal research and development investment would be between \$11 and \$32 billion annually in 2005 dollars, or roughly three to ten times more than current energy research and development. *Id.* at 54. That investment level would also act as “insurance” against electricity blackouts, oil price shocks, and air pollution. This would be a large increase, but Nemet points out that “[o]verall R&D in the US economy was 2.6% of GDP [between 1988 and 2003] and has been increasing. High tech industries such as pharmaceuticals, software and computers routinely invest between 5 and 15% of revenues in R&D”. *Id.* at 58.

In October 2007, Gwyn Prins and Steve Rayner persuasively argued that the United States should spend \$80 billion per year on clean energy. Gwyn Prins & Steve Rayner, *Time to Ditch Kyoto*, *Nature*, Oct. 25, 2007, at 973, 975, available at <http://www.nature.com/nature/journal/v449/n7165/pdf/449973a.pdf>.

86. E-mail from Ray Perryman, President, The Perryman Group, to Michael Shellenberger (Nov. 16, 2007, 11:29:57 EST) (on file with author); see also Ray Perryman, *Redifining The Prospects For Sustainable Prosperity, Employment Expansion, And Environmental Quality In The Us: An Assessment Of The Economic Impact Of The Initiatives Comprising The Apollo Project* (2003).

87. Deutsch, *supra* note 69, at 16.

88. See Bob Van der Zwaan & Ari Rabel, *The Learning Potential of Photovoltaics: Implications for Energy Policy*, 32 *Energy Pol’y* 1545, 1551 tbl.5 (2004) (stating the cost of breaking even).

89. Grubb, *supra* note 47, at 33.

BREAK THROUGH PAPERBACK MARCH 2009

“Prescient.” – *Time*

“A bracing manifesto.” – Michael Pollan

"Convincing, resonant and hopeful." – *Publishers Weekly* (Starred Review)

Greeted by controversy on its publication, *Break Through* soon became recognized – as much by those who criticized it as embraced it – as a book of historical significance. Kyoto, cap and trade, and sustainable development in the Amazon have failed. The planet is getting hotter, faster, and the old environmental solutions cannot save us.

What’s required is not that we constrain human power but rather unleash it. In opposition to regulation-focused greens and anti-government conservatives, the authors call for epic government investment in a new economy, and herald a “politics of possibility” – one of hope and renewal – to overcome global warming and allow America to become, once again, a great nation.

“To win, Nordhaus and Shellenberger persuasively argue, environmentalists must stop congratulating themselves for their own willingness to confront inconvenient truths and must focus on building a politics of shared hope rather than relying on a politics of fear.” – *New York Times*

“If heeded, Nordhaus and Shellenberger's call for an optimistic outlook – embracing economic dynamism and creative potential – will surely do more for the environment than any U.N. report or Nobel Prize.”
– *Wall Street Journal*

2008 GREEN BOOK AWARD WINNER

Ted Nordhaus and Michael Shellenberger are political strategists and opinion researchers. They have worked for every major environmental organization and foundation in America. The two are co-founders of American Enviroics, a research and strategy firm, and the Breakthrough Institute, a think tank.

WINNERS: TIME MAGAZINE “HEROES OF THE ENVIRONMENT, 2008”

“Nearly a year after *Break Through* was published, Shellenberger and Nordhaus are looking prescient. The first serious attempt by the U.S. Congress to pass cap and trade legislation – the Warner-Lieberman bill in June – met an embarrassing defeat. High gasoline prices have emerged as a defining issue of the American presidential election, and the sudden public support for offshore oil drilling has left the greens on the defensive. Far from accepting the idea that high energy prices are a fair short-term trade for averting long-term climate change, a little economic pain at the pump has seemingly been enough to undo the work of Al Gore and friends. In Europe (where even pro-Kyoto nations have struggled to reduce their carbon emissions), and in China and India (where there is zero support for environmental policies that will restrain economic growth), the story is not that different. Environmentalists have made the world care about global warming; they just haven't made us willing to do anything tangible about it.

Depressing stuff, but Shellenberger and Nordhaus – despite the title of that infamous essay – are optimists. The green movement's mistake has been to define climate change in terms of limitations: to our lifestyles, our energy use, our economy. Instead, they argue, what's needed is a shift to "the politics of possibility," fed by epic government investment in energy technology that will make renewables economically viable on their own merits against fossil fuels. That will be a tough battle with the global economy entering choppy waters, but at least Shellenberger and Nordhaus have injected a vital strain of realism into an issue far too critical to founder on green dreams.”

— *Time Magazine*, September 17, 2008