A Way Forward on Climate Change

*Timothy E. Wirth**

I. Alarm Bells are Ringing

When the Swedish chemist Svante Arrhenius suggested in 1896 that increased levels of carbon dioxide in the atmosphere could warm the surface temperature of the Earth, the industrial revolution was in full swing.[1] Even so, Arrhenius did not foresee the exponential growth in fossil fuel use that would ensue, and in 1908 he predicted that it would take 3000 years to double atmospheric concentrations of CO_2.[2] He was off by 2800 years. Without intervention, a doubling will occur in this century.

When the American chemist Charles Keeling began measuring atmospheric CO_2 at Mauna Loa in Hawaii in 1958, the concentration had already risen from 280 parts per million (ppm) in pre-industrial times to 315 ppm, an increase of 12.5%. In 2007 that number reached 384 ppm, a third of the way toward Arrhenius's doubling, and the rate of increase has itself doubled.[3]

The results are all around us. The Arctic Ocean—engine of the Northern Hemisphere's weather—could be ice-free in summer within five years.[4] The ice sheet on Greenland, which holds enough water to raise global sea levels by twenty feet, is melting at an accelerated rate.[5] In accepting the 2007 Nobel Peace Prize, Al Gore said, "We, the human species, are confronting a planetary emergency, a threat to the survival of our civilization,"[6] and he was right.

Civilization was built around the climate we have—along coastlines that may be washed away by storms and rising sea levels, around farmland and forests that may become less productive as water supplies diminish, and away from lowlands infested with insect-borne disease. Changing the climate puts the very organization of modern civilization at risk.

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[1] Svante Arrhenius, *On the Influence of Carbonic Acid in the Air Upon the Temperature of the Ground*, 41 Phil. Mag. & J. of Sci. 237, 237–38 (1896).

[2] Svante Arrhenius, Das Werden der Welten (1908).

[3] Pieter Tans, Earth Sys. Research Lab., Nat'l Oceanic & Atmospheric Admin., Trends in Atmospheric Carbon Dioxide—Mauna Loa, http://www.esrl.noaa.gov/gmd/ccgg/trends/ (last visited Apr. 10, 2008).

[4] Jonathan Amos, *Arctic Summers Ice-Free 'by 2013,'* BBC News, Dec. 12, 2007, http://news.bbc.co.uk/2/hi/science/nature/7139797.stm.

[5] *Record Warm Summers Cause Extreme Ice Melt in Greenland*, Sci. Daily, Jan. 16, 2008, http://www.sciencedaily.com/releases/2008/01/080115102706.htm.

[6] *Gore: U.S., China Must Lead Fight Against "Planetary Emergency,"* CNN, Dec. 10, 2007, http://www.cnn.com/2007/WORLD/europe/12/10/gore.nobel/index.html.

When extreme weather, intensified by climate change, causes floods, people die. When the rains fail in Africa because of climate change, people die. The tragedy of Darfur was partly caused by climate change—as rainfall diminished, herders and farmers fought over the remaining arable land.[7] That is why Gore and the Intergovernmental Panel on Climate Change (IPCC) won the Nobel Prize for Peace, not for Chemistry or Physics.

We cannot avoid climate change altogether. The effects of our actions are already clear and for all practical purposes are irreversible. We can, however, limit the damage, and, toward that end, the world must act—urgently, dramatically, and decisively.

Because climate change confronts all the nations of the world, the engagement and leadership of the United Nations is essential. All countries must become part of the solution, not just the major emitters that have so far stood aside—China, India, and the United States—but also the poorest countries, the most vulnerable to changes in weather and rises in sea level.

Because a fundamental transformation of the world's energy systems will be required, however, climate change also creates an opportunity—an opportunity for nations that innovate and commercialize new technologies to gain substantial economic advantage. It is this opportunity that provides a hope of success.

This essay will briefly discuss prior climate agreements and offer an action plan for the next U.S. Administration—five steps that address both the risks and opportunities of climate change. As the richest country and the one most responsible for the atmospheric buildup of greenhouse gases, we have a special responsibility to reduce our emissions and alleviate the harm we have done to others. But we also have tremendous capacity for innovation and capital investment that can be mobilized to create new businesses and jobs developing clean energy technologies.

II. The Essential United Nations

The climate change conference in Bali in December 2007 was a reminder that if we did not have a United Nations, we would have to invent one—a global forum where rich and poor countries stand on equal footing, where small island nations can fight for their own existence. Bali may not have seemed like a triumph, but it was. It was the triumph of a process—the awkward and difficult process of working together in a global community toward a common end.

It is not often remembered that the IPCC is a creature of the United Nations. It was established twenty years ago by the cooperation of two U.N. agencies, the World Meteorological Organization and the U.N. Environment

[7] Stephan Faris, *The Real Roots of Darfur*, Atlantic Monthly, Apr. 2007, *available at* http://www.theatlantic.com/doc/200704/darfur-climate.

Programme, with the support of two foresighted conservative leaders, Margaret Thatcher and Ronald Reagan.[8]

It is also often forgotten that all the nations of the world, including an enthusiastic United States, ratified the U.N. Framework Convention on Climate Change, which was negotiated in 1992 in Rio de Janeiro and endorsed by President George H.W. Bush.[9] It is this treaty that established the essential objective of preventing "dangerous anthropogenic interference with the climate system."[10] The later Kyoto Protocol, rejected by President George W. Bush, is an implementing agreement of this Framework Convention.

In Bali, representatives of 187 countries agreed on a road map for negotiating a new implementing agreement to replace the Kyoto Protocol when it expires in 2012 and confront climate change more effectively over the long term.[11] The session was organized and brought to a conclusion by the Framework Convention's secretariat, which patiently persevered through the difficulties and obstructions that attend any such negotiation.

Ban Ki-moon, the Secretary-General of the United Nations, has become a new voice of global leadership on climate change and has made it one of his top priorities at the United Nations. In September, he convened a high-level meeting in New York that gathered world leaders—not their environment ministers—to consider the risks the planet faces. In November, Ban traveled to Spain as the IPCC released its synthesis report on the science of climate change, and then to Antarctica and other vulnerable regions to see the effects of climate change for himself. "I have always considered global warming to be a matter of utmost urgency," he said afterward in Chile. "I now believe, more than ever before, that a global calamity awaits us if we do not act."[12]

So it was appropriate that the Secretary-General went to Bali not once, but twice. As the high-level meeting began, he set the tone. "Today, we are at a crossroads," he said, "one path leading toward a comprehensive new

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[8] Janet L. Conley, *Margaret Thatcher—not Al Gore—made global warming a public policy issue*, DAILY REPORT ONLINE, Sept. 20, 2007, http://www.dailyreportonline.com (search "News Articles" for "Margaret Thatcher"; then follow "Margaret Thatcher—not Al Gore—made global warming a public policy issue" hyperlink).

[9] U.N. Framework Convention on Climate Change, *Status of Ratification*, Aug. 22, 2007, *available at* http://unfccc.int/essential_background/convention/status_of_ratification/items/2631.php.

[10] United Nations Framework Convention on Climate Change art. 2, May 9, 1992, S. TREATY DOC. NO. 102-38, 1771 U.N.T.S. 164.

[11] Press Release, U.N. Framework Convention on Climate Change, UN Breakthrough on climate change reached in Bali," (Dec. 15, 2007), *available at* http://unfccc.int/files/press/news_room/press_releases_and_advisories/application/pdf/20071215_bali_final_press_release.pdf.

[12] Press Release, Secretary-General, Secretary-General, in Statement with Chile's President, Sounds New Climate Change Warning as he Describes Vanishing Glaciers, Melting Western Ice Shelf, UNITED NATIONS DOC. SG/SM/11271 (Dec. 11, 2007), *available at* http://www.un.org/News/Press/docs/2007/sgsm11271.doc.htm.

climate agreement, and the other toward a betrayal of our planet and our children. The choice is clear."[13]

Ban then left the talks, but when they threatened to flounder, he returned to urge the negotiators on, saying, "The hour is late. It is decision time." He appealed to delegates not to "risk all that you have achieved."[14] They listened. They acted. They agreed to a two-year pathway to a new agreement.

We still have far to go. But in Bali we could see the global community, convened by the United Nations, preparing for the sweeping changes we must make to save the world we live in.

III. The Way Forward

The negotiations leading to the 1997 Kyoto agreement were prolonged and extremely difficult, and the emissions targets set then were relatively modest compared to the ones we need today. It will therefore be even more difficult and complex to reach agreement today. But since 1997 world opinion has shifted regarding the urgency of action and the scale of the threat, and common ground can be found.

Together with the Club of Madrid—a group of sixty-six democratic former heads of state and government—the U.N. Foundation last year convened a distinguished task force, which former President Ricardo Lagos of Chile and I co-chaired. The task force was comprised of former heads of government and other leading figures from twenty countries, and it was greatly assisted by Mohamed El-Ashry, the former CEO of the Global Environment Facility. This diverse group's objective was to develop and propose a way forward: the outline of a broadly acceptable and effective global climate agreement. The resulting report, *Framework for a Post-2012 Agreement on Climate Change*,[15] was warmly received in international circles, starting with the G8 Gleneagles Dialogue in Berlin in September. The report breaks down the complex subject of climate change into four key areas or "pathways" to a new agreement: mitigation, adaptation, technology, and finance.

In the parlance of climate negotiations, "mitigation" means reducing greenhouse gas emissions, and "adaptation" means preparing for climate impacts that cannot be avoided. "Technology" refers to the need not just to develop cleaner ways of producing and using energy, but also to deploy

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[13] U.N. Sec'y-Gen. Ban Ki-moon, Press Conference in Bali, Indonesia (Dec. 12, 2007), http://www.un.org/apps/sg/offthecuff.asp?nid=1109.

[14] Press Release, Secretary-General, Secretary-General, at Bali Conference, Appeals to Delegates to "Seize the Moment," Reach Agreement for Good of Humanity, U.N. Doc. SG/SM/11336 (Dec. 17, 2007), *available at* http://www.un.org/News/Press/docs/2007/sgsm11336.doc.htm.

[15] Global Leadership for Climate Action, Framework for a Post-2012 Agreement on Climate Change (Sept. 10, 2007), *available at* http://www.unfoundation.org/files/pdf/2007/GLCA_Framework2007.pdf.

those technologies on an appropriate scale in rich and poor countries alike. "Finance" encompasses both the mechanisms and investment flows that will enable poor countries to adapt and acquire clean energy technologies. These four pathways have become the almost universally agreed-on methods of organizing climate change's many complex substantial and political issues, and they were reflected in the final road map adopted by the Conference of the Parties in Bali.[16]

Our task force worked on the premise that the agreement to be negotiated in 2008 and 2009 must be comprehensive for the world to move toward the sixty percent reduction in global emissions that scientists say will be needed by 2050.[17] A global agreement should include all countries, all sectors, all sources and sinks; it should plan for mitigation as well as adaptation, technology development and sharing, and adequate and innovative finance mechanisms. However, "comprehensive" does not mean "one size fits all." Targeted agreements—for example, agreements on industrial energy use, energy efficiency, renewable energy, and technology cooperation—should be encouraged and incorporated within a new comprehensive agreement, and these agreements should encompass a much broader array of countries than those who immediately commit to an emissions cap. Sectoral agreements developed within a global U.N. agreement should also be encouraged: automobiles, cement, steel, and utilities should be on everyone's lists.

The Framework Convention in 1992 established the principle that countries should take on the climate challenge "on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities."[18] Developed countries, and especially the United States, should take the lead, because over many years they have contributed the most to the buildup of greenhouse gases in the atmosphere. Meaningful engagement of developing countries—especially those with rapidly industrializing economies like China and India—is also needed. But requiring all countries to achieve the same percentage reduction in the same time period would be unfair, and frankly impossible. Developed countries first put carbon into the atmosphere: we were the first to use the atmosphere as our carbon garbage dump. The effects of our dumping are now being felt, and our task is to change our habits and help the world adapt to the problems we have largely created. We also must encourage others—again, China and India—to avoid our bad habits and embark over time on the same low-carbon path that we should be pursuing now.

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[16] Conference of the Parties to the United Nations Framework Convention on Climate Change, Bali, Indon., Dec. 3-14, 2007, *Bali Action Plan*, ¶ 1, U.N. Doc. Decision 1/CP.13, http://unfccc.int/files/meetings/cop_13/application/pdf/cp_bali_action.pdf.

[17] See, for example, the excellent synthesis by John P. Holdren, Global Climatic Disruption: Risks and Opportunities, Presentation at the United Nations Found. Investor Summit on Climate Risk (Feb. 14, 2008), *available at* http://www.ceres.org/NETCOMMUNITY/Document.Doc?id=282.

[18] United Nations Framework Convention on Climate Change, *supra* note 10, art. 3.1.

These key questions—who has what responsibility, and when do obligations kick in—are the central issues in the climate negotiations and will be critical to the future ratification of any new climate protocol in the United States and around the world. We must be flexible enough to recognize and accept the value of diverse approaches to the climate challenge.

For example, China may not accept an immediate cap on its emissions but should be encouraged and credited with the important actions it has already taken: setting a target of improving its energy efficiency by an extraordinary four percent per year, imposing fuel economy standards that are stricter than those of the United States, and moving to double its renewable energy capacity (to sixteen percent) by the year 2020.[19] These steps will significantly reduce the growth in Chinese emissions and put China on a path toward a lower-carbon economy. Like the United States, China is learning how to cope with the looming climate crisis. Although it had made relatively little historic contribution to the level of carbon in the atmosphere until recently, it has caught up to the United States in this unfortunate category with prodigious speed. Like the United States, China is a global leader, and in dealing with the climate crisis it should become our partner, not our adversary. The United States can help to lead in many areas: technology, economic transformation, sectoral modernization. China can help to lead in others and can serve as a model in the rapidly developing world. Together we can demonstrate that the climate crisis presents opportunities to be pursued in everyone's self-interest.

India presents as much of a potential threat to the climate as China, but it is further behind in terms of the risks currently posed by its economic development, its awareness of the environmental dangers it faces, and its political responses, which are only slowly changing from finger-wagging at the West. Yet China's history of engineering excellence suggests that it could seize the opportunity that Thomas Friedman has dubbed E2K—"all the energy programming and monitoring that thousands of global companies are going to be undertaking in the early 21st century to either become carbon neutral or far more energy efficient than they are today."[20]

India will be ground zero for climate change—it is susceptible to the entire catalog of climate-related catastrophes.[21] Heavily populated coastal areas will be flooded. Refugees will stream in from low-lying Bangladesh. Diminished glaciers in the Himalayas will threaten water supplies. Monsoon patterns on which farmers depend will be disrupted. Economist William Cline estimates that India faces reductions in agricultural output ranging

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[19] Pew Center on Global Climate Change, Climate Change Mitigation Measures in the People's Republic of China (April 9, 2007), *available at* http://www.pewclimate.org/docUploads/Pew_China_Factsheet_April_07.pdf.

[20] Thomas L. Friedman, *The Dawn of E2K in India*, N.Y. Times, Nov. 7, 2007, at A29.

[21] *See, e.g.*, Greenpeace, Climate Change and its Possible Impact on India, http://www.greenpeace.org/india/campaigns/choose-positive-energy/what-is-climate-change/climate-change-its-possible (last visited Apr. 10, 2008).

from thirty percent in the south to sixty percent in the north.[22] Its willingness to face these risks and embrace the opportunities of E2K will be vital to the world's progress on climate change.

IV. U.S. Leadership[23]

For these same reasons—risk and opportunity—the United States must regain a leadership role on climate change, and it will. The impacts of climate change may not be as dramatic here as in India, but they will be real—reduced water supplies in the West, increased hurricane intensity along the Atlantic and Gulf coasts, and more severe weather events nationally. As the *Stern Review on the Economics of Climate Change* made clear, the costs of inaction on climate change are far larger than the costs of action,[24] and rapid technological change is likely to reduce those costs considerably.

Investors are responding to the inevitability of climate regulation by pouring money into clean-energy technologies, companies, and projects—nearly $150 billion worldwide in 2007.[25] Even industrial heavyweights—including Alcoa, Caterpillar, Deere, Dow, DuPont, General Electric, and all three U.S. automakers—have joined the United States Climate Action Partnership to support mandatory economy-wide emissions limits. Indeed, as the president of the Business Roundtable said recently, for businesses not to be green is no longer viable.[26]

The political momentum gathering around this issue throughout the United States is unmistakable, from climate plans issued by popular, progressive Republican governors in California, Minnesota, and Florida, to the sudden consensus among the Democratic Party leadership on the need for serious action; from the green activism bubbling on campuses nationwide to the awakening of the religious community to the significance of climate change as a moral issue.

Washington has lagged, but with all three remaining presidential candidates committed to mandatory action on climate change, that will change in 2009. The following plan of action should form the nucleus of the next President's climate strategy.

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[22] William R. Cline, Global Warming and Agriculture: Impact Estimates by Country 50 tbl.5.2 (2007), *available at* http://www.cgdev.org/content/publications/detail/14090.

[23] The author notes with appreciation the contributions to this section of United Nations Found. Senior Fellow Nigel Purvis.

[24] Nicholas Stern, Stern Review: The Economics of Climate Change (2007), *available at* http://www.occ.gov.uk/activities/stern.htm.

[25] New Energy Finance, http://www.newenergyfinance.com (last visited Mar. 13, 2008).

[26] John Castellani, President, Bus. Roundtable, Remarks at Climate RESOLVE Workshop (Nov. 8, 2007) (notes on file with author).

1. Reduce U.S. Emissions

Given our role in the world, our historical responsibility for the climate problem, and our current contributions to it, the United States must act decisively to reduce its emissions. Not only is this the right thing to do, but it is also a precondition for U.S. credibility and global leadership. Until we reduce our own emissions, other nations will hide behind our inaction.

To move the world onto a path to avoid catastrophic change, the United States should cut its emissions to thirty percent below 1990 levels by 2020. A very aggressive program will be needed to reach that target and put us on a glide path to an eighty percent reduction by 2050. The first number would bring us into line with the goals of the European Union, and the second is consistent with the cuts needed in industrialized nations to reach a global sixty percent reduction. Key elements of the U.S. program will be: increased efficiency and a modernized electric power grid, the transformation of the transportation sector through advanced biofuels and plug-in hybrids, and the phase-out of conventional coal-fired power generation.

The first and most important step, however, is to put a price on carbon, either through a cap and trade system or a carbon tax. The purpose of such a step, it is important to note, is not to drive down energy consumption through higher prices—i.e., to force conservation through deprivation. The impact of carbon legislation on most consumers is likely to be modest, and, in any case, energy use is notoriously inelastic, especially in transportation. Rather, the reason to put a price on carbon is to send a new economic signal and to set the rules of the game so that clean technologies can compete with dirty ones and indeed, over time, can out-compete them. This will lead to a great wave of innovation, investment, economic development, and job creation, of a type which the United States has historically been better at generating than anyone in the world.

In both the House and the Senate, Congress is actively developing legislation that would cap U.S. emissions. The leading bill, introduced by Senators Joseph Lieberman and John Warner, cleared the Senate Committee on Environment and Public Works in December 2007.[27] It includes an economy-wide emissions cap, trading flexibility to contain compliance costs, and financial incentives for demonstrating and deploying advanced technologies. A joint analysis by the Natural Resources Defense Council and the World Resources Institute found that the bill would lead to an eighteen to twenty-five percent reduction in total U.S. emissions by 2020.[28] Passage of the bill in 2008 would be a major accomplishment. But even if the clock runs out on the legislation in 2008, its failure will pave the way for action by the next Congress.

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[27] America's Climate Security Act of 2007, S. 2191, 110th Cong. (reported favorably as amended by S. Comm. on Env't & Pub. Works, Dec. 5, 2007).

[28] Nat'l Res. Def. Council, Lieberman-Warner Climate Security Act (2007), *available at* http://www.nrdc.org/legislation/factsheets/leg_07121101A.pdf.

2. Negotiate and Ratify a Strong New U.N. Climate Agreement

The Bali road map approved at the U.N. climate talks in December 2007 provides a strong basis for future negotiations. On the topic of mitigation—i.e., emissions reductions—the Bush Administration has refused to consider legally binding targets, and so Europe and most of the rest of the world are now waiting for political change in the United States. In the meantime, however, progress is possible on other topics, including adaptation, deforestation, technology cooperation, and financial mechanisms for North-South assistance. The European Union has pressed for rapidly industrializing countries such as China and India to commit to concrete policies on energy efficiency, power generation, deforestation, and the like—measures that could reasonably be considered as first steps appropriate to their level of development.

Because the Kyoto Protocol runs only until 2012, and because the next agreement will need to be ratified (and implementing legislation passed) before it goes into effect, it must be negotiated well in advance, preferably in 2009. The next President therefore will face a very short timeline for action and intense international pressure for U.S. leadership. Whoever is elected will have to hit the ground running. The same goes for the U.S. Senate, which will have to ratify the next agreement, as it failed to do with the Kyoto Protocol. It is imperative, therefore, that both branches of government develop open lines of communication and effective means of cooperation. Formation of a bipartisan Senate observer group to the negotiations—as was done for the U.N. Framework Convention on Climate Change in 1992—would be extremely helpful to the long-term success of the climate talks. These negotiations are going to be very hard and very complex. If they are successful, the Senate will have to take up a difficult set of issues charged with political overtones. Engagement by the Administration of a group of well-respected representatives from both parties would help determine the limits of what can be ratified and empower a peer group to explain the terms to Senate members. Going into Kyoto, this essential communication was lacking between the Administration, the negotiating team, and the Senate. The result was a 95-0 vote on the Byrd-Hagel resolution, demanding emissions commitments by developing countries.[29] That breakdown in communication was a very, very big mistake and led directly to the failure of the Kyoto protocol, which the Clinton Administration never dared to submit to the Senate for ratification.

3. Change the Rules to Favor Energy Efficiency

As important as a price on carbon is, and as important as an international agreement is, waiting for them to take effect while our emissions continue to rise is simply unacceptable. Fortunately, it is also unnecessary. As

[29] S. Res. 98, 105th Cong. (1997) (enacted).

numerous studies by McKinsey and others have shown, a substantial number of energy efficiency measures make economic sense even under current circumstances. The United States could cap its energy demand and greenhouse gas emissions at today's levels using only existing technologies with an internal rate of return on investment of ten percent or more.[30] Globally, growth in energy demand could be cut in half through 2020 by means of investments that would yield an average internal rate of return of seventeen percent. Annual global investments of $170 billion would yield energy savings that would total $900 billion a year by 2020.[31]

According to a distinguished expert group convened by the U.N. Foundation, if developed countries doubled their average historic rates of energy efficiency improvement to 2.5% annually, by 2030 they would avoid greenhouse gas emissions equivalent to those produced by 2000 power plants, and they would dramatically deflect the growth of global emissions downward.[32] The United States should promote that goal and the development of international energy efficiency programs and standards to achieve it, supported by technical assistance for poor nations. The cheapest and cleanest energy, after all, is the energy that is never generated.

To capture the vast supply of wasted energy—energy that is not required to perform the services we need—we need to change the rules. States must rethink their regulation of utilities to make investment in efficiency more attractive than investment in new supply. In most states, the reverse is true today: utilities make more money as their customers use more energy.[33] We should flip those incentives. In California, utility companies are compensated by their ratepayers for helping customers to install better insulation and use more energy-efficient products—not for selling more electrons. Less energy consumption means less expensive energy production and fewer costly new power plants, leaving both the consumers and the utilities better off. Rules that allow utilities to make more money helping people save rather than use energy are a smart set of rules.

Today, new windows have three times the insulation value of old ones, and new air conditioners use thirty to forty percent less energy than models that are just ten years old. But these "extras" are rarely installed in new homes, because in most cases the principal objective of both the builder and buyer is to keep the purchase price as low as possible. For utilities, however, a new building is a fifty-year energy obligation, and permanently reducing

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[30] McKinsey Global Inst., Wasted Energy: How the U.S. Can Reach Its Energy Productivity Potential (2007), http://www.mckinsey.com/mgi/publications/wasted_energy/index.asp.

[31] McKinsey Global Inst., The Case for Investing in Energy Productivity 7–8 (2008), *available at* http://www.mckinsey.com/mgi/publications/Investing_Energy_Productivity.

[32] United Nations Found., Realizing the Potential of Energy Efficiency (2007), *available at* http://www.unfoundation.org/energyefficiency/.

[33] Leadership Group of the U.S. Dep't of Def. & U.S. Envtl. Prot. Agency, National Action Plan on Energy Efficiency ES-7 (2006), *available at* http://www.epa.gov/solar/documents/napee/napee_report.pdf.

its energy use should be treated as a fifty-year asset. It should be in their interest—and the interest of their customers—to pay for efficiency "extras" and to earn a return on structural investments in energy efficiency just as they do in a new power plant. Providing that incentive to utilities would release a transformational torrent of investment that would benefit consumers and reduce energy use at a scale much larger than possible through government funding alone.

4. Spur U.S. Innovation and Global Deployment of Clean Energy Technologies

Solving the climate crisis will require nothing less than a fundamental transformation of global energy systems. In the United States, transportation and electricity generation are the two largest sources of emissions.[34] In rapidly industrializing nations like China and India, power generation, manufacturing, and transportation are the fastest-growing sources.[35] A new generation of climate-friendly technologies will be needed to reduce emissions quickly and at low cost.

The United States can lead this technological revolution, but we have many competitors in a global race. If we snooze, we lose. Whether the analogy is to the Manhattan Project or the Apollo Project, the United States should make a national commitment to developing low- and zero-carbon technologies. Private investment in energy research declined by more than half between 1991 and 2003, and public investment fell by eleven percent just in 2005, even as oil prices have risen to historic highs.[36] The United States could increase federal energy R&D five- to ten-fold, or up to $15 to $30 billion per year, commensurate with prior funding for those major national endeavors, and partner with private industry to stimulate innovation and promote rapid commercialization of new technologies.

There is also a role for international cooperation in spurring this technological transformation, encouraging rapid adoption of available solutions, and promoting R&D of future technologies. Specifically, the United States should collaborate on a new international initiative to cooperate with developing countries on low-cost clean energy technologies for the global poor. Modeled after the Consultative Group on International Agricultural Research, which helped deliver modern agricultural techniques to poor na-

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[34] U.S. Environmental Protection Agency, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2006 ES-4, tbl. ES-2 (April 2008), *available at* http://www.epa.gov/climatechange/emissions/downloads/08_ES.pdf.

[35] Center for Clean Air Policy, Greenhouse Gas Mitigation in Brazil, China & India: Scenarios and Opportunities Through 2025: China Fact Sheet, *available at* http://www.ccap.org/international/China%20Fact%20Sheet-English.pdf (last visited Apr. 21, 2008); Center for Clean Air Policy, Greenhouse Gas Mitigation in Brazil, China & India: Scenarios and Opportunities Through 2025: India Fact Sheet, *available at* http://www.ccap.org/international/India%20Fact%20Sheet-English.pdf (last visited Apr. 21, 2008).

[36] Daniel M. Kammen & Gregory F. Nemet, *Reversing the Incredible Shrinking Energy R&D Budget*, 22 Issues in Sci. & Tech. 84, 84 (2005).

tions,[37] a new Consultative Group on Clean Energy Research would adapt clean energy technologies for poor nations and help them "leapfrog" over traditional, climate-damaging businesses by using small-scale distributed energy systems instead of costly grid extensions, much as the use of cell phones avoided the need for a massive build-out of telecommunications infrastructure.

Developing countries, especially China and India, will account for the lion's share of global emissions growth over the coming years.[38] In China alone, as many as 500 million people will join the middle class, gaining access to electricity and motorized transportation, in the next two decades.[39] China now adds a new climate-damaging coal-fired power plant to its system every week.[40] Getting these countries to grow cleanly, therefore, is absolutely essential to climate stabilization. Unfortunately, climate-friendly technologies are often slightly more expensive than older, dirtier ones. Because poverty alleviation and economic growth are the top priorities for developing nations, these countries will choose clean growth only if more benign technologies are just as affordable. External intervention will be required to level the playing field.

Here the United States can do well by doing good, creating markets for U.S. products and services. The International Energy Agency estimates that the global energy sector will require some $22 trillion in investment between 2005 and 2030 to meet economic demand and human needs.[41] More than half of this investment, or about $400 billion per year, will be in developing countries. Given our role in the world, our capacity to make a difference, and our historical responsibility for climate change, the next President should commit the United States to working with other industrialized nations to help make clean technologies affordable for the developing world. The *Stern Review on the Economics of Climate Change* estimated that an incremental twenty to thirty billion dollars per year is required to ensure clean growth in poorer countries.[42] Since increased investments at this level would need to be phased in, a major first step would be to double global energy-related foreign assistance to around fifteen billion dollars per year. With an equitable division of contributions among industrialized nations, the U.S. share of this amount would be an additional $2.5 billion per year. President

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[37] Consultative Group on International Agricultural Research, Who We Are, http://www.cgiar.org/who/index.html (last visited Apr. 21, 2008).

[38] INTERNATIONAL ENERGY AGENCY, WORLD ENERGY OUTLOOK 2007: EXECUTIVE SUMMARY 11 (2007), *available at* http://www.iea.org/Textbase/npsum/WEO2007SUM.pdf.

[39] Diana Farrell, Ulrich A. Gersch, and Elizabeth Stephenson, *The Value of China's Emerging Middle Class*, MCKINSEY Q., June 2006, http://www.mckinseyquarterly.com/Economic_Studies/Productivity_Performance/The_value_of_Chinas_emerging_middle_class_1798?gp=1.

[40] Richard Lester, *China's Energy Dilemma*, TECH. R., Jan. 1, 2007, http://www.technologyreview.com/Energy/17995/?a=f.

[41] INT'L ENERGY AGENCY, WORLD ENERGY OUTLOOK 2007, EXECUTIVE SUMMARY, CHINA AND INDIA INSIGHTS 4 (2007), *available at* http://www.iea.org/Textbase/npsum/WEO2007SUM.pdf.

[42] STERN, *supra* note 24, at 24.

Bush's call in the 2008 State of the Union address for two billion dollars over three years won't get the job done, but it is a start.[43]

Much of the new U.S. contribution could come from private financial markets under a well designed cap and trade program. Specifically, regulated companies in the United States should receive credit for investing in lower-cost emission abatement projects and programs in the developing world. Developing countries that take appropriate domestic action should get preferential access to potentially profitable global carbon markets, thereby lowering their own emissions and reducing mitigation costs for businesses in industrialized countries.

5. Help Vulnerable Developing Nations Adapt

A 2007 report on climate change by the scientific research society Sigma Xi was subtitled *Avoiding the Unmanageable and Managing the Unavoidable*.[44] The phrase reflects one of the bitter ironies of climate change—that its effects will be felt most keenly by poor countries that have contributed the least to the problem. For them the challenge will be to manage the unavoidable—drought, flooding, disease, and the effects of weather on their economies and political stability. Communities that depend on natural resources for their livelihoods will be particularly vulnerable to shifting weather patterns.

To be effective, national strategies for economic development and poverty alleviation must now include increased resilience to the impacts of climate change. International development agencies must "climate-proof" their investments, planning as best they can for a changing environment. As the Sigma Xi authors noted, this "will largely require addressing the same challenges that need to be resolved to achieve global sustainability: a stable population, moderate levels of consumption more equitably distributed, and development and deployment of appropriate institutions and technologies."[45] A society that has achieved these goals will have greater capacity to adapt to sudden economic shocks.

Because of its global reach, the U.N. system is uniquely situated to help countries plan for and manage the effects of climate change. With additional funding, U.N. agencies could provide developing nations with vulnerability assessments and a menu of adaptation solutions—for example, the planting of drought-, flood-, and salt-resistant crops to deal with shifting rainfall pat-

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[43] Press Release, The White House, State of the Union 2008, Increasing Our Energy Security and Confronting Climate Change (Jan. 28, 2008), *available at* http://www.whitehouse.gov/stateoftheunion/2008/initiatives/energy.html.

[44] Press Release, Scientific Expert Group on Climate Change & Sustainable Dev., United Nations Found., Confronting Climate Change: Avoiding the Unmanageable and Managing the Unavoidable (2007), *available at* http://www.unfoundation.org/SEG/.

[45] Scientific Expert Group on Climate Change & Sustainable Dev., United Nations Found., Confronting Climate Change: Avoiding the Unmanageable and Managing the Unavoidable 100 (2007), *available at* http://www.unfoundation.org/files/pdf/2007/SEG_Report.pdf.

terns and rising sea levels. For many climate challenges, there is already a knowledge base and a set of technological and institutional options available, but developing nations need help in identifying and implementing these solutions. This will require significant new resources, but these could be raised by increasing official development assistance, allocating a share of the revenues obtained by selling emissions permits, or giving businesses credit for investing in adaptation programs in developing nations.

V. The Need for Action

Responding to the danger the world is now in will not be cheap or easy—but neither will it be optional. As the *Stern Review* observed, the costs of inaction greatly exceed the costs of action.[46] Even for the United States, rich and resilient as we are, the threats from climate change to our people, our economy, our security, and our humanitarian interests abroad justify immediate action.

Managing the climate crisis requires new forms of international cooperation to reduce global emissions and assist vulnerable societies in adapting. The United Nations is the appropriate venue for negotiation and in many cases the most effective institution for coordinating and delivering international response measures. The power and influence of rapidly industrializing countries like China and India are being felt economically, politically, and environmentally, and these countries must be brought into the bargain. The United States must lead this global effort by reducing its emissions at home, encouraging bold mitigation policies by other nations, spurring technological innovation at home and abroad, speeding adoption of clean energy technologies by rapidly developing nations, and assisting poor nations to adapt to the inevitable impacts of climate change. These efforts will require political resolve, creative negotiating, innovative policy mechanisms, stronger global institutions, and additional financial resources. The United States can protect its national interests and help the world solve the climate crisis, but it must act now and do so in concert with the international community. It is our obligation as stewards of the Earth.

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[46] Stern, *supra* note 24, at 16.