ENERGY SECURITY AND CLIMATE CHANGE: POLICY CHALLENGES
FOR THE NEW ADMINISTRATION AND THE NEW CONGRESS

VOL. 24, NO. 2
APRIL 4-10, 2009

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THE ASPEN INSTITUTE
Washington, DC
This project was made possible by grants from the Ford Foundation, The John D. and Catherine T. MacArthur Foundation, the William and Flora Hewlett Foundation, the Rockefeller Foundation, and Rockefeller Brothers Fund. The statements made and views expressed are solely the responsibility of the authors.

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The Aspen Institute
One Dupont Circle, NW
Washington, DC 20036-1133
Published in the United States of America
in 2009 by The Aspen Institute

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Printed in the United States of America
ISBN: 0-89843-506-4

1728/CP/BK
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The Aspen Institute Congressional Program conference on Energy Security and Climate Change Policies for the New Administration and the New Congress was held in Valencia, Spain, April 4-10, 2009. Five members of the U.S. Senate and 14 Members of the House of Representatives participated. The intent of the conference was to provide Members of Congress an opportunity to deepen their understanding of interrelationships among U.S. energy, climate, and national security issues and to explore relevant policy options.

The opening session, Overview of Oil Supply and Demand and the Implications for U.S. Policy, led by Amy Jaffe of the Baker Institute at Rice University, began with a discussion of the oil futures market. The run-up in oil prices in 2008, followed by a steep decline in the last quarter of the year, was driven at least in part by hedge funds, Wall Street banks, and speculators who turned from holding dollars to holding oil futures as the value of the dollar declined with respect to other currencies. As more players bought oil futures, the price went up, the U.S. trade deficit grew, putting more pressure on the dollar, which in turn prompted more traders to forego dollars in favor of oil futures, repeating the cycle. Saudi Arabia and some other oil suppliers, at the same time, discovered their economies could not absorb the rapid rise in dollar revenues. The over-inflated market collapsed suddenly. Some hedge funds and banks had to liquidate holdings based on margins in order to raise capital, fueling further price declines. China, with only 26 million cars—the United States has 240 million—could not make up for a falloff in U.S. demand.

In 2000, changes intended to facilitate trading had diluted the transparency that informed the market about who was engaged in hedging oil positions and who was speculating. Because of these changes, no one, regulators included, knew who was buying or selling oil futures. The fallout demonstrates why reasonable rules overseeing oil futures trading are necessary. Regulatory agencies do not have sufficient information to monitor what’s happening in the market, nor the expertise to decipher complex derivatives trading instruments. Especially important is increasing transparency as to who is trading. As an alternative or complementary policy, raising the margins required for oil futures investments would limit the amount of speculative capital that entered the market.

The decline in oil prices had some salutary effects for U.S. foreign policy. The U.S. trade deficit fell (Americans sent $300 billion to oil exporters last year). The dollar’s value strengthened against other currencies. Some countries found themselves unable to sustain budgets that had been fueled chiefly by rapidly-rising oil revenues, and the bravado with which they had sought to influence global events softened.

The United States has never effectively harmonized its national security, energy, environ-
mental, and economic policies, and it shows in the vulnerability the country faces today with respect to oil. One-third of world oil is consumed by the U.S. auto fleet; in comparison, China consumes only about 5% of the world’s oil. Insufficient supplies of oil would curtail Americans’ mobility, which in turn would harm economic activity.

As oil prices rose, it was timely to ask whether added revenues were being applied to new exploration and development. Major U.S. oil companies have not been drilling for new reserves since the mid-1990s. While some smaller companies are, many larger ones devoted their new revenues to stock buy-back plans, even while continuing to argue the need for tax incentives. Congress may want to adopt a policy of use-it-or-lose-it—that is, tax benefits hinged to actual spending for exploration and development.

Although the oil market is global, there is no guarantee the United States will have access to oil reserves, most of which lie in other countries, often controlled by state-owned companies. (The United States controls but 3% of the world’s oil reserves). American companies were once essential to tap hard-to-get oil deposits; today needed skills can be rented. Access to energy resources in some places can be turned off virtually overnight for political reasons. Venezuela ended foreign investment in oil exploration based on political considerations. Mexico precludes foreign investment in development of domestic oil resources, a popular position in that country. Yet U.S. companies are drilling closer to the U.S.-Mexico border, with the potential for so-called slant drilling methods, which could heighten tensions between the two countries. Africa may be a new major supplier near term and it would be wise to understand better the politics in that region. New oil finds off Brazil, Cuba, and Mexico will only make a difference in global supply if they are greater than projected. Forward diplomacy to redefine energy relationships may be helpful. Every country has and needs energy resources. Micro hydropower and other small-scale technologies, in which the United States has expertise, are needed and could help strengthen ties regionally and beyond.

The country needs a comprehensive overall plan that will reduce oil dependence. This includes improvements to the national grid, a requisite for electrifying automobiles, as well as tapping domestic energy sources more fully. The federal government needs more inspectors to ensure that drilling is done in environmentally sound ways. Though opposition to offshore drilling exists, especially in places where natural assets are a draw for tourists and underpin a community’s economy, policymakers would be wise to ensure that a percentage of revenues from energy leases and royalties are dedicated, as an offset, to preserving natural amenities through investments in land and water conservation.

Refinery capacity, too, needs attention. After Katrina and other hurricanes, refinery capacity in the U.S. Gulf region was off-line for a relatively short period, and supplies were augmented by loans from European countries. A prolonged outage of refinery capacity or the need to build new facilities because of hurricane damage, which takes three years or more, could have serious implications, including rationing.

Diversifying fuel options also makes sense. Brazil did this with sugar-based ethanol and flexi-fuel cars that can burn gasoline or ethanol, offering consumers a choice and reducing oil dependency. The United States could reduce its current tariff on ethanol imports, which would benefit the U.S. east and west coasts. Over time, the priority should be to develop the fuels of the future. Cellulosic ethanol, from crop debris and other plants, is one promising option. Further scientific breakthroughs are needed, as well as commercialization opportunities. Some alternative fuels are cost-effective now; others will become so when oil prices rise again. To inform their decisions, policymakers need to take better account of the full life-cycle costs of these alternatives. The key to investments in alternative fuels, however, is long-term signals that would give investors confidence they will be able to earn a decent return.
Among other policy options discussed were raising automobile fuel-efficiency standards and the gasoline tax. Mileage changes will take years, while a higher gasoline tax would have immediate impact. Imposing a higher gasoline tax, though, would not be popular with consumers and would hurt households that have few options but to commute long distances to work. A tax more broadly on carbon emissions would have to be high enough to affect drivers’ behavior. A $50-per-ton tax on carbon emissions, for example, would translate only into a 50-cent-a-gallon rise in gasoline prices, and that may not be sufficient. Higher mileage standards would be the single most effective tool. Smaller cars get better mileage. Safety is not an issue if more people drive smaller cars, which are also more affordable. This is the path taken by European countries and Japan, which have not increased oil consumption for transportation over the past 20 years. If the U.S. automobile fleet averaged 50 miles a gallon, that would halve U.S. oil imports.

The U.S. auto industry is undergoing profound restructuring even as vehicle sales have dropped sharply. The companies argue they cannot meet all the challenges at once, for a hydrogen car, for greater mileage efficiency, for electric vehicles. What may be useful to the industry in the short term, though, may not be over time. When Japan in the 1980s elected to reduce greenhouse gases, a public-private partnership facilitated development of more fuel-efficient cars; a goal was set and public finance supported it. Japanese companies were able to produce state-of-the-art cars and capture market share in the United States. U.S. automakers instead made larger, less fuel efficient sport utility vehicles, which left them vulnerable when oil prices rose.

Community decisions can also play a central role in reducing oil consumption through policies limiting urban sprawl and by siting new houses so they have access to public transit. Establishing urban boundaries, for example, may raise housing prices, but that is offset by decreased commuting time and costs, which are rarely factored into development decisions. Vision and planning are needed for this approach to work.

Hal Harvey, chief executive of the Climate Works Foundation, led the second session on The Potential for Renewable Technologies to Meet Energy Needs. Compared to two years ago, dramatic progress is evident in the potential for renewable technologies. Wind energy is now seeing U.S. investments of $65 billion a year. The price of solar power is dropping rapidly, in part because of growing deployment, though it remains expensive compared to conventional sources. The question for policymakers is how to encourage the growth of renewable technologies efficiently without wasting public dollars. The most important step is to look closely at the learning curve for new technologies, which is evident for medicines, automobiles, and transistors, and will hold true for clean energy.

This curve has three components: basic science in the beginning; engineering for efficiency; and economies of scale in production. Science might experiment, for instance, with the use of microbes to facilitate cellulosic ethanol production, or investigate the effects of turbine design for wind energy, or the optimal layering of different materials for solar power. This phase requires public investment as the benefits will accrue broadly to the public good. Policymakers should recognize that not every project will pay off; failure is integral to basic research. Sustained funding is essential, at a decent scale at the best research centers. Parsing research dollars in small amounts to many different institutions is not a winning strategy for developing new energy technologies.

Investment in energy research has lagged. The United States last invested seriously in such research in the late 1970s. Today, less than 0.1% of what Americans pay for energy each year is devoted to research by the private sector; public support brings that figure to about 0.5% of the $1 trillion annual energy bill. Though most of the Department of Energy’s budget is devoted to cleaning up nuclear facilities, what
research it sponsors is important, for example, maps of wind energy potential.

The second component is engineering to optimize efficiency—mountings for solar panels, the converters, wiring, and other hardware to turn DC into AC current. Here, again, the United States does not spend enough. There are dozens of orphan technologies whose potential is diminished for lack of attention to engineering. Many promising technologies developed by reputable firms, sometimes offshoots of university research or funded by federal small business innovation grants or by venture capital, suffer when it comes to developing the technology for commercial deployment. This is a serious shortcoming. The 2009 stimulus bill created the equivalent for energy of the Defense Advanced Research Projects Agency, DARPA, to bolster engineering capacity. Another promising initiative, still small, is the Department of Energy’s Cooperative Research Development program, which defines pathways to technology breakthroughs. Industry takes the first cut outlining common challenges and the government funds research that would otherwise be too expensive for a single firm.

The final component is scaling up—building better factories for production, facilitating deployment, improving maintenance. The United States has developed and paid for too many renewable energy technologies that are adopted and expanded by other countries to their benefit, while U.S. application lags. Procurement of renewable technologies for use in federal buildings or the government’s sizeable automobile fleet could help drive economies of scale. The best incentive to encourage scaling up, though, is the renewable electricity standard, now in about half the states. This requires a percentage of electricity to come from renewable sources by a date certain. The standard offers guidance but leaves the technology and market risk to the private sector, which will find the lowest-cost solutions. A portion of the mandate typically can be met through efficiency improvements, by stricter building codes, for example. Arizona has a renewable standard and a special set-aside for solar because it is more expensive than other technologies yet has large potential as costs come down. Extension of the production tax credit for wind and solar energy is another critical step. A cap on carbon emissions also would drive cost-effective deployment of renewables.

Complementary policies are essential: for example, improving the electricity transmission grid to absorb and then supply renewable energy to population centers, as well as improvements in battery storage. If the grid is not improved, the potential for large sections of the country to have a blackout increases, with substantial national security risks. Developing a smart grid is part of the formula. California cut peak demand for electricity by 10% merely by giving “smart meters” to large electricity users who were then able to manage their energy use far more effectively. (Smart meters are devices that provide real time information about electricity use to both the consumer and the utility).

Utility regulation, a province of state regulators, could be improved, too, especially to promote efficient electricity use. Without adequate incentives or an understanding of the potential, some utilities are reluctant to look at new initiatives that might encourage demand-side management or efficiency improvements. Peer-to-peer exchanges are one way to overcome this hesitancy. Though states have the lead in utility regulation, there is potential for federal policy to influence reforms through grid improvements, facility siting measures that encourage cooperative planning to identify energy resources and environmentally-sensitive places, and a strong national renewable electricity standard.

A mix of energy sources will play an important role in meeting U.S. demand. All face hurdles. Biomass could be effective as a source of electricity generation, as well as a transportation fuel, but distribution is a challenge. Ethanol, for instance, corrodes pipes so truck or train distribution is needed. This argues for decentralized facilities, which may not achieve
economies of scale but would yield local job benefits, a tradeoff many would be willing to make. For transportation, diesel fuel from algae holds great promise, as do geothermal resources for heating and cooling in some parts of the country. Nanotechnology is another technology that could yield energy breakthroughs, especially in new materials for solar energy. Though currently neglected, distributed, small-scale local generation facilities may have potential. Co-generation, where one facility uses heat generated by another nearby, has proved effective.

Natural gas is a cleaner fuel than coal, and large amounts of shale gas are available domestically. Hurdles include the amount of water needed for refraction, the need to drill in urban areas where land is typically in small parcels, running high-pressure lines through neighborhoods, and noise from constantly running generators.

Many policies have sought to facilitate nuclear energy, a no-carbon option. Maintaining existing nuclear plants, 350 worldwide, and deploying twice that number, though, would be needed to make a serious dent in reducing carbon emissions globally. The industry faces several hurdles. The potential proliferation of weapons-grade plutonium is one, though this is less problematic in countries where nuclear power is established. Siting and permitting new facilities are still expensive and lengthy. Waste disposal remains a challenge. In this regard, fuel reprocessing may provide an answer. Other countries do this but the United States lags in its capacity.

In the late 1950s, the Russian launch of a satellite, Sputnik, proved a major boon to U.S. science and engineering investments and education. The equivalent today may be China, which is committed to rapidly developing clean-energy technologies and competing the world over for market share. Efficiency improvements are a first step that could garner broad support at home and realize near-term benefits. Transforming the country’s energy sources is seen by many as a path to stimulate economic growth. But on-again, off-again energy policies kill nascent industries, which need long-term support to succeed. In the past, tax policy has been the de facto U.S. energy policy. A comprehensive energy policy is long overdue.

Joshua Schank, Director of Transportation Research at the Bipartisan Policy Center, led a discussion about surface transportation policy and how it relates to energy and climate. Current federal transportation policies have failed in many ways. The major question always has been how to finance and improve the transportation system. But that is hard to do without a better understanding of what the system needs in order to deliver better results. Whereas once the goal of building an interstate highway system drove national policy, since that system was more or less completed, no comparable objective has emerged.

As the major surface transportation law is reauthorized during the next year, an opportunity exists to rethink national transportation policy. Five goals would seem especially relevant and timely: fostering economic growth; further connecting parts of the country so as to facilitate mobility and commerce; improving metropolitan accessibility, especially access to jobs; addressing the transportation impacts on energy use and climate change; and improving safety. Pursuing these goals will require creating and tracking performance measures to assess progress—for example, the carbon dioxide emissions associated with transportation over time.

In the past, transportation policy has typically been a top-down affair, that is, it follows closely federal priorities as determined by cost-sharing formulas that mostly favor highway building. Moreover, congressional appropriators earmark funding for a large number of specific projects based on state or district needs. The next iteration of federal transportation legislation, instead, should seek to push many more decisions to over 60 metropolitan planning agencies to determine how to meet the aforementioned goals. These agencies are better equipped to
tailor solutions to their particular circumstances and fashion an overall systemic approach to meeting local transportation needs.

Demand for transportation funds almost always outstrips available funding. More than 100 federal transportation programs exist with five core programs allocating most of the money by formula. Funding should be reoriented to emphasize the following: First, preserving and maintaining the existing system to maximize investments already made, targeting funds to metropolitan areas and rewarding results; second, for new projects, direct funding to states and metropolitan areas that rank highest on the analysis of how these projects will advance the five transportation goals. But major decisions about transportation modes, such as to emphasize road building versus public transit or how to reconfigure community land use patterns to reduce congestion, are best left to states and metropolitan areas.

Improved planning at the state and local levels are a key to achieving the results anticipated in transportation reforms. New projects today take approximately 14 years to design and plan in a cumbersome process. Not every state or metropolitan area has an agency today capable of carrying out the responsibilities needed to meet a new set of goals and performance measures. Funding incentives may prove the primary way to improve their performance.

But equitably funding transportation projects has always been a political challenge. In theory, applying a principle that users should bear the brunt of the cost has merit. But many states look closely at the relationship between how much money they contribute in gasoline taxes versus how much they receive back in transportation funding. And consumers are typically only willing to pay more if they are confident the additional funds will actually help reduce congestion or yield other improvements that benefit them.

The federal government has some leverage. For instance, it could raise the gasoline tax, last increased in 1993 and whose purchasing power has dropped significantly. Or it could put priority on developing alternative fuels. It can also ensure that in making transportation decisions, full costs are factored in. This has not been true over the past 50 years with respect to U.S. dependency on oil, the contribution to climate change, or the upkeep of systems; and this fuller calculation is a primary goal of reform advocates. And the national government can ensure that the several federal offices responsible for transportation policy, now divided up by mode, are restructured to provide a more comprehensive approach to national transportation policy.

The third session, the Impacts of Climate Change on the U.S. Economy, was led by Brian Murray of Duke University’s Nicholas Institute for Environmental Policy Solutions. Climate change may be the largest cost-benefit challenge ever to face Congress. At stake not only is what may happen to the environment but also to the economy. How far should the United States go? Will policies yield needed greenhouse reductions? Should Congress mandate technology fixes? Or focus on desired outcomes? Over what time? Who should be regulated? How does Congress create clear signals that will guide investments and consumer choices?

These are formidable questions for U.S. policymakers. Taking no action will impose substantial economic costs—for example, the need to build walls to block rising sea levels, altered patterns of agricultural productivity, adverse health effects, the necessity of relocating people in harm’s way, dramatic changes in the availability of water resources, from more flooding to more intense droughts. Though these impacts are likely to be felt most severely at first in the southern hemisphere and in poor countries, triggering national security challenges for U.S. policymakers, they will eventually affect the U.S.

Many Americans worry about unintended consequences of legislation that may adversely affect the economy, jobs, and the competitiveness of the United States internationally, while others are willing to embrace changes they see
as the way to ensure the economy prospers. For others, it is the national security arguments, the dependence on oil imports, which are most salient and offer a rationale for action.

Three options exist to address the climate problem: curtail population growth, which is difficult; curtail economic output per capita, hardly a good way forward; or reduce the economy’s carbon intensity, the most realistic. Early steps are possible, for example, switching to less carbon-intensive fuels and improving efficiency. Though these will help, alone they will not achieve what scientists say is necessary, an 80% cut in U.S. greenhouse gas emissions. Changes also are needed in power production, transportation, transmission, and energy use in the built environment and agriculture.

As an institution, Congress is typically better responding to current needs, less so to new challenges, the effects of which are likely to be long term. Invoking the plight of future generations has value, yet can seem somewhat abstract as a guide for current decisions. A stronger impetus may be the pending action of the U.S. Environmental Protection Agency. A finding that carbon dioxide is a pollutant under the Clean Air Act has forced the Agency to act. Though EPA is mindful of the profound impact of regulating carbon, the possibility EPA will adopt mandates to reduce carbon emissions could prompt Congress to act.

For EPA and Congress, policy options include prescriptive mandates, that is, setting technology-based standards, though this is not the most efficient approach. Setting performance standards is better, for instance, a low-carbon fuel or mileage standard. Applying economic instruments, by setting a price on carbon emissions, is likely to be the most economically efficient option. A tax on carbon would set a price on emissions, while the level of emissions would vary. Alternatively, a cap-and-trade regime would set a limit on carbon emissions, letting the price vary. This latter approach would set a cap, or limit, on how much carbon the economy could emit and require an allowance for each unit of emissions. These allowances could be auctioned or given away, or supplied via some combination of the two. They could then be traded among the regulated community, with entities for which required reductions would be most expensive purchasing extra allowances from those able to achieve less expensive reductions. Providing flexibility and a large enough group of regulated entities would help the market function as efficiently as possible. Clear price signals would give confidence to those responsible for investing in energy and in other sectors; without this signal, they could well delay investment decisions.

Many estimates have been made of the effects on energy prices, jobs, and other important economic measures. But they are inherently uncertain, based on assumptions about the rate of technological change, population growth, economic activity, and more. Computer models of one major climate bill last year suggested that the economy would continue to grow robustly with or without a carbon price. But this masks disproportionate impacts on energy sources and on different parts of the country. Techniques exist to provide some assurance that costs would not rise too far beyond what is projected, thus providing policymakers confidence that the transition is manageable. A cost containment safeguard could be set for a period of time to enable the market to begin functioning, then removed. Moreover, if electric bills rise, consumers may face difficult choices in using electricity more efficiently. Climate legislation would transform the economy. Activities that rely on carbon-intensive fuels that could not adapt would lose workers while jobs in sectors that use low-carbon fuels would grow. For those sectors most harmed, transition assistance might be helpful.

Preventing deforestation through offsets is another way to address concerns about cost. As a way to meet its compliance obligations domestically at lower cost, a U.S. company, for example, would pay for forest conservation in a developing country. Currently there is little incentive to prevent deforestation, which accounts for about 20% of carbon emissions, primarily by
two countries, Brazil and Indonesia. Offsets, which would need to be verified and assured over time, could be a means to entice the participation of countries with forest resources as they would then have an incentive to join an international agreement.

Under a cap and trade system, the decision about how many emission allowances to auction, and how many to award for free, will have major implications for how much revenue is generated. How to allocate these revenues among numerous proposed uses is a thorny political question: Would they be used to create new programs, expanding the scope of government? Would they be returned to consumers through, say, a tax rebate or payroll tax reduction? Would they be used to help hard-hit industries, working families, and retirees to offset price increases in states that depend heavily on coal for electricity? What are the implications for the variety of fuel sources currently used to generate electricity? What portion of the revenues should be invested in energy technology research and development to ensure there are future energy choices? How much for adaptation, which has not been emphasized in current debates over climate policy? If there is a market for carbon allowance trading, which could reach $80 to $90 billion a year, given the problems seen with derivatives and other obscure financial instruments, what assurances are needed with respect to regulating and policing a carbon market?

Enacting legislation will require responding to these questions to fashion an economically efficient and effective means of addressing climate change. The United States has undertaken bold programs before and, in context, a climate program would seem manageable. Moreover, the United States can learn from the European Union’s emissions trading effort to avoid mistakes made there. U.S. experience provides confidence there are policies that work—a trading system with complementary attention to technology investments, efficiency measures for buildings, and other measures.

Jonathan Lash, president of World Resources Institute, led the final session, *Implementing a Post-Kyoto International Agreement to Address Climate Change*. He stressed the need to align U.S. policies in energy, the environment, the economy, and national security, to reduce fossil fuel use and emit fewer greenhouse gases. The most secure way to achieve this, he argued, is through a binding international agreement.

About 190 countries are taking part in U.N.-sponsored negotiations scheduled to culminate in Copenhagen, Denmark, in December. Seventeen of these countries account for about 85% of emissions (among them, the United States, China, Russia, Japan, seven European Union nations, and Brazil). The key deal is likely to be struck by these countries, which also have been meeting outside the U.N. sessions.

Several hurdles are evident in reaching an international agreement. Negotiations are taking place amid a worldwide economic crisis. Elections are being held in countries crucial to an agreement, India and Germany included. Commitments will be made at the national level, embodying millions of private decisions about investments and consumer choices. National self-interest will determine how far these countries are willing to go. Differences are apparent in how countries perceive their self-interest. Some argue the developed world triggered the climate problem and want to see significant commitments by industrialized nations. The developed world is concerned about bringing fast-growing economies such as China and India into an accord to avoid giving those countries an economic advantage.

Key issues will have to be resolved. First are the targets, the timetable, and the base year on which to measure progress. Though some scientists argue for deeper and more rapid cuts, consensus is growing around a goal of limiting greenhouse gas emissions to levels that prevent warming of more than 2 degrees Celsius, or slightly more than 3.5 degrees Fahrenheit. This goal would require over time reducing carbon dioxide concentrations in the atmosphere from the current level of about 430 parts per million,
which is expected to rise even more for some time to come, based on current activities, to about 400 ppm. This goal translates into cutting emissions in half globally by 2050. Some countries want significant interim reductions by 2020, but the United States is likely to agree only to what is economically feasible by then. In making national commitments, countries will be called on to state what they will do, by when. Leading developing countries may not agree to a numerical cap but some increasingly appear ready to commit to specific policies with near-term payoffs.

Then comes the question of aid to less-developed countries for avoided deforestation, for adaptation to effects induced by climate change, and for transition to low-carbon energy sources. While the request for such aid is large—$60 to $80 billion a year globally from developed nations—this may be a bargaining position. The impetus for the developed world to make a contribution, which could come in different forms like offsets, not necessarily as cash transfers, is to help reduce compliance costs domestically, as well as to build markets worldwide for new energy technologies.

Still considered a developing nation, China presents a special challenge. Americans will surely ask why the United States should help pay to modernize the economy of a leading competitor, even as they point to past experience as a warning sign—faulty products, U.S. job losses, theft of intellectual property. Measures of progress will be needed, which will require access to data and methodologies, as well as standby enforcement mechanisms, most likely tariff adjustments or related trade sanctions if commitments are not met. At the same time, out of newly recognized self-interest, China has made substantial commitments to reducing oil demand through auto mileage standards more stringent than those of the United States, to deploying wind and solar power, and to improving the efficiency of its industrial base. Moreover, significant opportunities exist for U.S.-China collaboration to develop energy technologies, such as for carbon capture and sequestration, through, for example, the Asia Pacific Partnership, which would benefit both countries.

As in every international treaty, verification in meeting national commitments, including those of the United States, will be necessary. Many large emitting countries have the capability to monitor and report their emissions. For verification, the World Trade Organization tribunals have done a reasonable job investigating trade disputes, and may offer a model. Though several international agencies have offered themselves to monitor, verify, and report on progress, a new institution may be desirable as it would provide for appointment authority, decision-making and other governance rules that could be tailored through the negotiation process. Enforcement measures will also be needed to ensure compliance.

U.S. negotiators are wary of making commitments in international negotiations until they know what Congress will do with respect domestically. Evidence of progress by the United States will be necessary to reach a global accord. Congress has a full agenda aside from climate legislation, though, and with the range of concerns legislators have, they may be hard-pressed to enact a domestic program by the Copenhagen session. Substantial activities are under way at the state and local levels (900 mayors have signed a climate change commitment) as well as at universities, congregations, businesses, and through regional greenhouse reduction programs. Short of passing climate legislation, whether these activities and additional energy measures Congress may adopt this year will suffice to show serious intent by the United States, paving the way for a global agreement, remains to be seen.
The U.S. Energy Predicament

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The United States’ Energy Situation

The United States is the third largest oil producer in the world, but its production has been declining since 1970 as older fields have become depleted. U.S. oil production averaged 5.06 million barrels a day (b/d) in 2007, down from 5.7 million b/d in 2002. In recent years, U.S. production has been lower than might otherwise have been expected due to production disruptions at oil producing platforms in the Gulf of Mexico during Hurricanes Rita, Katrina and Ike.

In the wake of the economic contraction, U.S. oil demand experienced its sharpest year on year decline since 1980. U.S. oil demand averaged 19.2 million b/d in December 2008, down more than 1.5 million b/d versus December 2007. The decline is expected to continue into 2009 and probably into 2010, reflecting a continuation of the poor state of the U.S. economy.

History has proven a tight link between economic contraction and lower oil demand in the United States. U.S. Gross Domestic Product fell by 6.2% in the fourth quarter of 2008, with jet fuel and distillate fuels demand falling 13% and 11% respectively. Baker Institute projections show that even if GDP growth recovers slightly in 2010 to 0.5%, oil demand will continue to fall from 2008 levels for the next two years.

Even with lower demand, the United States remains highly dependent on foreign oil. It imported 13.468 million barrels per day (bpd) in 2007 or about 60 percent of total consumption. That is up from 35 percent in 1973.

More than three decades after the 1973 oil crisis, U.S. supply of oil is no more secure today than it was thirty years ago. Moreover, its dependence on oil for mobility has never been stronger—all told, there are over 242 million road vehicles in the U.S.

Each vehicle is driven over 12,000 miles annually, and virtually all vehicles are powered by petroleum-based fuels, either gasoline or diesel. As a result, despite the fact that the United States accounts for only 5 percent of the world’s population, it consumes over 33 percent of all the oil used for road transportation in the world. By comparison, China, even with its growing economy, has about 26 million vehicles and consumes only about 5 percent of all the road fuel produced in the world, despite having a population that is more than four times the size of the United States.

While rising Chinese car ownership has been a feature of Chinese economic growth in recent years (up until late 2008), Chinese gasoline demand is not likely to come close to U.S. levels for many years.

Rather, rising U.S. oil imports, not rising Chinese demand, has been the most significant factor strengthening OPEC’s (Organization of the Oil Exporting Countries) monopoly power in international oil markets over the past decade. U.S. net oil imports rose from 6.79 million b/d in 1991 to 10.2 million b/d in 2000 while global
oil trade (that is oil that was exported across borders from one country to another) rose from 32.34 million b/d to 42.67 million b/d. In other words, the U.S. share of the increase in global oil trade over the period was a substantial 33%. In OPEC terms, the U.S. import market was even more significant—representing over 50% of OPEC’s output gains between 1991 and 2000.

Strong U.S. import demand not only enhances OPEC’s monopoly power, it also has a deleterious long-term impact on the U.S. economy. The U.S. oil import bill totaled $327 billion in 2007 and topped $400 billion in 2008. This represents an increase of 300 percent from 2002. The U.S. oil import bill accounted for as much as 40 percent of the overall U.S. trade deficit in 2006, compared to only 25 percent in 2002. This rising financial burden contributed to the ongoing challenges for the U.S. economy in 2006 through 2008 and put extreme pressure on the U.S. dollar. The high oil price contributed to a weakening of the dollar, through mounting trade deficits and U.S. debt. The dollar then got caught in a vicious cycle where continually rising oil prices fed the U.S. trade deficit, leading to increased U.S. indebtedness and thereby an even weaker dollar, which further drove oil prices higher in a self-perpetuating pattern. Oil-linked index funds became an asset class for investors wanting to escape the falling dollar and weakening stock market, adding to the speculative fervor in oil and causing even more damage to the U.S. economy. The lack of proper regulation, transparency and speculative position limits in U.S. oil futures and related financial markets greatly raised the dangers of this harmful pattern which culminated in great damage to the U.S. economy and financial system.

Petrodollar flows also played a major role in creating the initial credit bubble dilemma and the asset inflation that led to the financial crisis. Some argued that the importance of recycled petrodollars is lower today than it was during the 1970s. They pointed to China as a main source of global financial flows. Indeed, the importance of Chinese outflows is critical. But it also needs to be better understood that the acceleration in asset bubbles and the worsening financial crises have been in large part driven by the rise in oil prices and related petrodollar boom that began to take shape after 2003. Outflows from Saudi Arabia and Kuwait alone have rivaled those of China in recent years and the policies of oil producers and where they invest their surplus funds have had great bearing on the global financial situation. In the case of several Middle East sovereign wealth funds, monies have served to stabilize the banking system. But in considering future policies, the role of petrodollar recycling needs to be better managed and understood.

The coincidence of oil crises and financial crises has a long history. The geopolitical and financial circumstances of the global economic crisis of 2008 are in fact part of a continuum: a repeating cycle of concomitant economic and geopolitical shocks that keep repeating themselves because each time we do not address the root causes. High U.S. dependence on oil, as well as the inability of Middle East countries to diversify their economies and alleviate income inequality, threatens to replay a repeating history of global financial crises linked with oil crises over and over again until new policies are put in place. In particular, the habit of recycling petrodollar accumulations through massive sales of military equipment perpetuates the cycle by adding to the inherent instability in a region that is already plagued by sectarian turmoil.

Thus, while oil demand in the United States is falling temporarily due to the economic slowdown, left unchecked, America’s dependence on Middle East oil in the coming years will continue to worsen an already precarious level of national debt. Oil prices can be expected to rise again once the global economy resumes a growth path. Now, as in the 1970s, despite new economic and educational megaprojects, the current crisis has demonstrated once again that Middle East economies have not truly expanded their ability to absorb large inflows of oil money. Rather, in the Arab Gulf, petrodollar inflows of the last few years fueled real estate, stock market, and credit bubbles regionally and glob-
ally. The recent meltdown of Dubai’s booming economy is but one case in point. Riots in Saudi Arabia’s Shia-populous territories are another. The region remains vulnerable to a new round of instability, this time coming against a more dangerous backdrop of a nuclear arms race.

A Changing Definition of Energy Security

As global oil demand has risen and oil resources in the industrialized countries have become increasingly depleted, there has been a rising concentration of control over the remaining oil resources. The top five global oil producers now control 62% of remaining proven global oil reserves. Reduction in the number of players means each player will be more tempted to try to extract rents (economic and geopolitical) using the lever of their energy resources.

In light of Russia’s sudden, brief cutoff of natural gas supplies to Ukraine in January 2006 and December 2008 and threats of oil supply cutoffs by Iran during the geopolitical standoff over its nuclear program, energy security is taking on greater policy salience, as national security analysts think through the consequences of important oil producers using access to their vast energy supplies as a lever to gain political ends. This concern over the relative power of nations is fostering a new concept of energy security—one where oil consuming countries wish to minimize the chances that a key oil supplier could use the threat of a cutoff to supplies to gain geopolitical advantage or even, in the case of Russia, to impose political conditions inside the oil importing country.

In this new setting, where suppliers might be more inclined to use oil as a lever to political ends, energy security could be redefined as reducing the vulnerability of the economy to the reduction or cutoff of oil supplies from any given supplier or group of suppliers or to sudden large increases in prices of specific energy commodities such as oil and natural gas. This new definition differs from conditions of the 1980s and 1990s when the focus on energy security was more economic in nature, directed mainly at protecting the U.S. economy and other major importing countries against the negative effects of supply interruptions and oil price shocks on the economic performance of the U.S. and global economies. During that earlier period, the existence of strategic oil stockpiles and alliances with producers who would increase oil production during times of supply disruption seemed adequate to the challenges faced.

To reduce current vulnerabilities, the consuming country must increase its elasticity of demand for that commodity. This can be achieved several ways. First, consuming countries can adopt policies that broaden the flexibility of energy-using industries or transport vehicles to shift amongst alternative fuels. Consuming countries can also adopt policies that lower the oil intensity of their economies. Finally, countries can enhance the diversity of alternative oil suppliers and the shares of alternative fuels and energy sources in their mix of primary energy use.

Geopolitical Risks

In recent years, concerns about a growing scarcity of energy commodities worldwide have heightened the influence of geopolitical risks and threats on energy pricing and supply. While the wide range of geopolitical risks to oil supply are too numerous to discuss in a short essay, there are a number of geopolitical situations that pose such a threat to oil market stability and to U.S. national security interests that they should be a high priority for U.S. diplomatic intervention.

1) Iran’s nuclear aspirations

Iran is a major supplier to the international oil market. It produces about 4 million b/d of oil. Its internal consumption is about 1.7 million b/d, leaving about 2.3 million barrels a day for export. The 2006 Israeli incursion against Hizbollah in Southern Lebanon highlighted the risks to oil markets of an escalation in tensions between Iran and Israel. Tehran is a major backer of Hizbollah and the possibility of
Hizbollah’s attaining sophisticated missile technology from Iran that could be used against Israeli civilian populations represents an unacceptable risk to Israel’s national security. In the past, Israeli leaders have threatened a possible attack on Iran if Tehran doesn’t abandon its nuclear aspirations. Although Israel might be expected to hit key targets like Iran’s nuclear plants at Natanz or Bushehr, Tel Aviv has hinted it might opt instead to attack more strategically or politically important targets such as Iran’s only oil export terminal at Kharg Island, possibly eliminating Iran’s ability to produce or export oil.

In the past, Iran has threatened that it would cut its oil exports to the West if a U.S.-led coalition imposed sanctions on it in response to its alleged plans to develop nuclear weapons. Iranian Supreme Leader Ayatollah Ali Khamenei in June 2006 warned the United States that Washington “should know that the slightest misbehavior on your part would endanger the entire region’s energy security...You are not capable of guaranteeing energy security in the region.”

Iran has geographic leverage over oil and gas shipping through the strategic Strait of Hormuz, through which 16-17 million b/d of Mideast oil passes each day. Saudi Arabia responded initially to this rhetoric by increasing its investments in upstream oil production capability in order to be able to replace any lost Iranian exports. Saudi Arabia currently has enough spare capacity to replace Iran’s exports to international buyers, but also runs the risk it could be drawn into any regional military conflict with Iran.

2) Instability in Shia-Sunni relations in Iraq or beyond

The Saudi government has a strong interest in national reconciliation in Iraq and in the peaceful coexistence of Sunni and Shi’a Arab populations. With the rise of a Shi’a-dominated government in Baghdad, Iran has been able to expand its influence in Iraq, a development of concern to Saudi Arabia and other countries with regional Arab Sunni majorities. With its own Shi’a minority estimated by some to be between 10 and 20 percent of its population, Saudi Arabia is clearly worried about a “pan-Shi’a” movement in the Persian Gulf hostile to the Saudi regime. The possibility of popular unrest in Shi’a areas is no small matter of concern for Riyadh. Most Saudi Shi’as live in the oil-rich Eastern province where the vast bulk of Saudi Arabia’s oil production is located. A majority of skilled workers for Saudi Aramco, the state oil monopoly, in the Eastern province oil fields are of Shi’a origin despite a program to diversify the workforce in recent years. This means any kind of politically motivated work stoppage, strike, social protest or repressive clamp-down could have immediate ramifications for stable oil production flows. Skirmishes between Saudi religious police and Shia populations have taken place in recent weeks.

3) The Russian “Energy Factor”

Energy relations have given Russian leaders the platform they seek to gain international influence and created openings for Russia to assert itself in its “near abroad.” Russia’s energy minister recently asserted that Russia has “such a significant position in the high society of world oil, a Russian factor should appear.”

Russia has also acted decisively to reassert its influence over its “near abroad,” culminating in its armed conflict with Georgia in August 2008. Russia’s “success” in Georgia, for the foreseeable future, sent the message to neighboring countries that Russia is willing to play hardball and might be willing to cut off energy supplies to achieve its objectives.

However, Russia has not actually threat-
ened to cut off oil or natural gas supplies as a geopolitical tool. Rather, its commercial disputes with neighboring states that had previously received subsidized energy supplies have opened debate about Russia’s foreign policy goals and whether it might use an energy-supply lever to achieve political ends and enhance its regional or global power.

Some West European countries, such as Germany, are particularly dependent on Russian resources, with Russia supplying more than one-third of Germany’s crude oil and natural gas. Europe as a whole relies on Russia for about one-quarter of its oil and natural gas. Since the economies of Eastern Europe, the Baltic countries, and Former Soviet Union (FSU) states such as Ukraine and Belarus, were closely integrated with the Russian economy in the Communist era, these countries are even more dependent on Russian energy supplies. This latter point, in particular, has drawn geopolitical fault lines in recent years as Ukraine, Belarus, Lithuania, and Georgia have all experienced temporary energy supply cutoffs.

In an effort to forcibly renegotiate prices to reflect the market value of natural gas in Europe, Russian gas giant Gazprom temporarily reduced its flow of natural gas to Ukraine on January 1, 2006 and again in December 2008—actions that greatly affected consumers in both Ukraine and Western Europe because the cutoff coincided with a period when winter fuel demand is generally at or near its peak. While the motivation for such an action may have been to raise prices, the move was widely interpreted as an attempt by Moscow to discourage the anti-Russia, pro-NATO (North Atlantic Treaty Organization) stance of the newly-elected government of Ukrainian President Viktor Yushchenko. Following the Ukraine affair, speculation about the risk of Russia using energy as a lever in foreign policy began to affect energy policy in the European Union, as countries within that community started increasingly to seek alternative sources of supply. Russia’s seemingly successful strategy in maintaining the dependence of Central Asian suppliers on Russian pipeline infrastructure to get their supplies to market has increased concerns about Russian intentions.

Beyond its leverage on Europe, Russia could also enhance its geo-strategic power through collaboration or collusion with Iran. Moscow is supplying Iran with military equipment and nuclear technology and has been one of the major players blocking UN sanctions against Iran over its nuclear activities. While Iran and Russia are natural competitors over access to European gas markets, the possibility of energy collusion between the two could represent a potentially serious challenge to the current global energy market. Russia through an Iranian proxy can put enormous pressure on regional producers like Saudi Arabia and Qatar.

Still, Iran’s desire to tap into the European market is not in Russia’s interests and is out of step with more common agenda items—such as protecting oil price levels and trade in nuclear equipment. Iran’s keen interests in building up its natural gas industry is thus out of step with a key goal of Russia’s Iran strategy and may eventually provide an opening for the West.

4) The Emerging Role of National Oil Companies

Since oil supply from member states within the Organization of Economic Cooperation and Development (OECD) is potentially limited, national oil companies (NOCs) will be responsible for a lion’s share of the increased output and investment that will be needed to meet rising global oil demand. The picture is similar when it comes to natural gas. NOCs or
state-owned natural gas companies already play a substantial part in international markets, and their role could become even more critical as more natural gas is needed from Russia, Iran, Iraq and perhaps some day, Saudi Arabia.

As the world becomes more dependent on NOCs for future energy supplies, the possibility of future oil shortages looms large. The list of NOCs with falling or stagnant oil production in recent years is long. Production has been affected by civil unrest, government interference, corruption and inefficiency, and the large diversion of corporate NOC capital to social welfare.

The current financial crisis has worsened the outlook for investment by key NOCs by restricting their access to international capital. According to Russian investment bank Renaissance Capital, Russian oil and gas stock shares lost over 23 percent between January and August 2008, with some firms losing over 40 percent of their value. State-controlled and politically favored Rosneft suffered the least with a drop of 11 percent in the value of its shares, whereas, at one point, Gazprom shares had lost as much as roughly 70 percent of their worth. The squeeze on capital is prompting Russian companies to cut spending budgets for 2009, and analysts are predicting Russian oil production could fall by 3 to 5% this year as a result. Continued production declines are expected from key U.S. suppliers Mexico and Venezuela whose NOCs have been thwarted by government policies and bureaucratic inefficiency from making adequate investments to replace declining fields. Mexico is the third largest supplier to the United States, followed by Venezuela.

5) Natural Disasters and Severe Storms

Hurricanes Katrina and Rita in 2005 and Gustav and Ike in 2008 exposed the potential supply shortages and price spikes that can occur when gasoline inventories are inadequate in times of extreme stress on production and delivery infrastructure. The U.S. fuel system remains vulnerable to severe storms and other weather related disruptions. In the aftermath of Hurricane Katrina, Gulf coast refinery production of finished gasoline fell by 700,000 bpd versus levels a year earlier. Hurricane Rita made landfall in Texas on September 24, 2005, and resulted in an additional, larger loss of refining capability. For the week ending September 30, finished gasoline production was down by 1.4 million bpd versus levels a year earlier. Seventy-five days after the hurricanes, over 90 million barrels of crude oil and over 175 million barrels of refined products had been lost from the market. In December 2005, close to 750,000 bpd of U.S. refining capacity was still affected by the aftermath of the hurricanes and was not brought back on line until the end of March 2006.

The hurricanes of 2005 affected not only refinery capacity, but also negatively influenced deliverability of product. For example, in the immediate aftermath of Hurricane Katrina, which forced the shutdown of two main gasoline transport pipelines from the Gulf coast to the Eastern seaboard, temporary fuel shortages occurred at retail stations from Florida all the way to Canada. Retail gasoline prices as high as $6.99 per gallon were reached in some markets. The events of 2005 highlighted the possible dangers of having so much U.S. refining capacity concentrated in one geographical region that is vulnerable to weather-related disruptions. The area stretching from Corpus Christi, Texas, to Lake Charles, Louisiana, is home to 21 refineries, comprising 27 percent of U.S. refining capacity. The Houston/Beaumont/Port Arthur area of Texas represents 20 percent of U.S. refining capacity. The Gulf of Mexico provides 29 percent of U.S. domestic crude oil
production and 19 percent of its domestic natural gas supply. This heavy geographic concentration of oil refining and energy production means that similar or worse disruptions are possible in the future, especially if global warming and sea level rise contribute to an escalation of severe weather along the U.S. Gulf coast.

During the disruptions to U.S. refinery output in the aftermath of Hurricanes Rita and Katrina, the United States had to borrow gasoline from European strategic gasoline stocks because, unlike Europe and Japan, the United States has no strategic minimum stockpiling requirements for domestic commercial gasoline inventories.

The Unique Challenge of Climate Change

It is frequently said that energy security and climate security are “two sides of the same coin.” But while many policy measures to reduce the threat of global warming would indeed enhance both climate and energy security, restriction in the use of coal and some unconventional fossil fuel resources to achieve climate goals would at the same time reduce energy security and possibly national security, especially in the short run, and especially in the United States.

The International Energy Agency (IEA) projects that unconventional oil could represent as much as 9 million b/d of the incremental 30 million b/d to 40 million b/d of new oil supply that will be needed to meet the rise in oil demand by 2030. Canadian tar sands could provide between 4 million b/d to 5 million b/d while upgraded heavy oil could represent an additional 2 million b/d. Coal to liquids and oil shale are another alternative source of energy, should conventional oil resources from the Middle East be cut off. If this supply were to be curbed to meet carbon reduction goals, as has been proposed by various groups and legislation, dependence on Middle East oil supply would be substantially higher in the coming decades.

However, there are many energy policies that meet both security and climate goals, such as reducing the consumption of fossil fuels through alternative energy, enhanced energy efficiency, and conservation. Improvements in automobile fuel efficiency represents one of the most effective tools for both reducing U.S. oil demand, thereby weakening the monopoly power of major oil exporting countries, and for reducing U.S. greenhouse gas emissions.

Policy Frameworks

- Raise the U.S. corporate average fuel efficiency (CAFE) standards to 50 miles per gallon
- Negotiate to have an international CAFE standard among major oil consuming countries as part of a global climate agreement
- Phase in a higher federal gasoline tax to maintain conservation gains
- Require industry to hold average minimum gasoline inventories
- Establish a special diplomatic energy envoy to China to promote bilateral energy cooperation and coordination as well as joint approaches to climate policy
- Substantially increase federal spending on new energy technologies, energy efficiency, and alternative energy
- Expand the International Energy Agency System to include natural gas
- Regulate speculation in U.S. energy futures markets to reimpose speculative position limits on all non-commercial players, including those engaged in promoting risk management financial tools. The United States should also engage regulators of foreign exchanges to tighten rules for products that have settlement in the United States and give U.S. regulators the right to know what players are operating in U.S. markets.
- Elevate the importance of active diplomacy with Russia, Iran, Saudi Arabia and Israel
over the conflict related to Iran’s nuclear aspirations, while keeping open the option to expand sanctions on Iran to prevent a dragging out of negotiations.

• Work bilaterally and in tandem with international institutions such as the International Monetary Fund to help oil states to liberalize domestic energy markets and begin to foster energy efficiency by easing fuel subsidy programs. These states should instead replace subsidies with more sound fiscal policies and less distortionary social welfare programs to aid the poor in their countries.

• Enhance the institutional mechanisms that favor markets over political intervention by energy producers. Much international economic architecture already exists to try to influence this process, including the World Trade Organization (WTO) trade and investment rules, free trade agreements, the Energy Charter and other multinational agreements. Access to consuming country markets and preferential trade status should be linked in some measure to oil-producing states’ energy sectors delivering more liberalized policies toward investment in their oil resources.

• Show U.S. leadership by looking seriously at ways to bring the rules of global oil trade and investment in harmony with the rules governing trade in manufacturing and services. This would mean building on open trade and investment agreements and discriminating more actively against those countries that do not permit foreign investment in their energy resources and that limit their exports to manipulate prices.

• Bring China, Saudi Arabia, Kuwait and the United Emirates more consistently into the G-8 plus framework and begin frameworks needed to moderate the problem of extreme petrodollar flows. The United States should also be willing to consider the possibility of a multilateral, organized shift away from dollarization to a basket of currencies post Bretton-Woods system.

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Part I – One of the Fastest-Growing Industries on Earth

Across the globe, the clean energy sector is in the midst of a prolonged period of expansion. Solar and wind power industries alone have sustained annual growth rates of 30-50 percent (Figure 1), creating tens of thousands of jobs, reducing reliance on foreign energy sources, and shrinking carbon emissions.

As these new industries achieve economies of scale, costs fall. Wind power is now one of the most affordable sources of electricity on earth, and competes with new coal-fired power plants. With projected cost reductions, solar power will also soon compete in the marketplace. By 2030, these and other renewable resources are expected to lead the list of low-cost power generation options (Figure 2), setting the stage for a massive, decades-long expansion at double-digit annual growth rates (Figure 3).

A small set of interrelated factors are enabling this rapid growth: intelligent government policies, including standards, incentives, and funding for R&D; favorable market conditions, including high prices of incumbent energy sources such as natural gas and oil; and a broadening field of financial support from savvy investors, entrepreneurs, and business leaders who have increased investments into clean technologies at an annual rate of over 80 percent (Figure 4).

Despite this growth, clean energy’s worldwide market share is still tiny compared to its potential. The success to date in driving down prices does not mask the need for smart policy in the years ahead. While carbon-free technologies could in theory supply the world’s total energy needs many times over, renewable sources today account for less than three percent of the world’s power generation (Figure 5). The opportunity is enormous: only about a third of the generation capacity that will be needed to meet expected demand in 2030 has been built today (Figure 6).

This paper examines the current “state of the art” of clean energy technologies and includes a summary of related policies that can help them reach their full potential. A profile of several of the most promising clean energy technologies (Part II) sets the stage. Next, the main barriers to wider adoption are explained (Part III). The paper concludes with five key policy choices that can remove these barriers and unleash a clean energy revolution (Part IV), and a short conclusion (Part V).

Part II – Technologies That Work

The good news is that we can meet almost all new demand for energy, improve energy security, and combat climate change with clean energy technologies and processes that already exist. Wind, solar, and geothermal energy technologies are mature and have been widely deployed. Each of these technologies continues to fight its way down the learning curve, reduc-
ing costs along the way. Carbon capture and sequestration, a promising early-stage technology that could potentially eliminate carbon emissions from the use of fossil fuels, is less mature. Yet it will likely have to play a major role in diversifying the portfolio of carbon-free sources of energy (Figure 7).

One common theme cuts across these energy options. Like other technologies before them (Figure 8), the costs of solar, wind, and geothermal power decline over time (Figure 9). These cost reductions are driven by numerous factors, including economies of scale, design innovations, and improved supply chain efficiency. The cost reductions tend to persist with time. “Moore’s Law”—which accurately predicted continuous reductions in the cost of microprocessors also applies to clean energy technologies, though with a smaller cost reduction rate than integrated circuits. Detailed modeling by McKinsey & Company suggests that a similar pattern is taking shape for clean energy, making each of these technologies more competitive as time progresses.

Wind Power: Cost-Competitive, Transmission-Dependent

Among all clean energy technologies, wind power leads the sector in growth, cost-competitiveness, and global potential. If deployed in utility scale wind farms, wind generation competes with natural gas and coal-fired power plants. Although wind is a relatively mature technology, additional cost reductions are expected through:

- the deployment of larger turbines on taller towers;
- improvements that increase energy generation and reduce operations and maintenance costs; and
- development of offshore wind sites that take advantage of stronger, more persistent winds.

Wind power does face hurdles on its race to achieve scale, however. Wind resources are intermittent, and often peak in power generation at night when demand is low. The windiest sites are often located far from urban centers with high electricity demands. For these reasons, integrating large quantities of wind will require significant transmission and grid upgrades. A national, high-voltage transmission system could largely eliminate the issue of intermittency, as the wind is almost always blowing somewhere across the U.S.

There are, however, other options for large-scale wind integration. Low-cost energy storage and demand response technologies can intelligently match demand to supply, and have the effect of “smoothing out” the supply/demand imbalance that can accompany broad deployment of intermittent energy resources.

The costs associated with these solutions are quite reasonable. A recent Department of Energy report estimates that the U.S. could generate 20 percent of its total electricity with wind power at an average cost per U.S. household of just 50 cents per month.4

Solar Power: Huge Potential, High Current Costs

The solar power sector is dominated by two established technologies: solar photovoltaics (PV) and concentrating solar power (CSP). In solar PV applications, light from the sun is converted directly into electricity as it interacts with wafers or films of silicon or other materials. CSP plants take the light from the sun, concentrate it with mirrors or lenses, and then heat a fluid, which then drives a turbine to generate electricity.

Both technologies share enormous potential. All of the U.S.’s electricity needs could theoretically be met by solar power developed on an area equivalent to about one-fifth the land area of Arizona. By developing a small fraction of this potential, the U.S. could become a world leader in solar power.

Solar PV’s modular nature makes it a highly versatile technology with numerous applications, ranging from powering watches to household energy generation to utility-scale solar farms. Its
ability to be installed at the point of consumption, on private homes and businesses, and at industrial sites, also provides secondary benefits that are not yet fully accounted for in the marketplace. By reducing the need for power transmission and distribution infrastructure, solar PV can ease grid congestion, lower costs for utilities, and potentially reduce the need for transmission upgrades in certain areas.

But its intermittency—solar PV only works when the sun is shining—will require integration solutions similar to those needed for wind power, such as low-cost storage and demand response technologies.

CSP is less versatile than solar PV, as it requires large sites and only works in strong, direct sunlight. CSP is therefore limited by geography to deserts and other regions with reliable and intense daytime sunlight. However, its reliance on thermal energy rather than the photovoltaic effect means that it can be converted into a “round-the-clock” energy resource through the use of thermal storage systems.

At present, both of these solar technologies have high generation costs and rely on tax incentives and subsidies to compete in the marketplace. A stable, long-term policy framework for both kinds of solar power would give manufacturers and project developers confidence, foster investment and innovation, and continue to drive solar power down the learning curve.

Enhanced Geothermal: “Dispatchable” and Abundant

Geothermal power plants typically generate electricity by extracting hot water from shallow, underground volcanic caverns; the hot water is used to drive a steam turbine. Geothermal facilities produce reliable, low cost power that can be dispatched 24/7. But current geothermal options require very specialized geological conditions and consequently have limited potential. The global potential for traditional geothermal resources is roughly 70 gigawatts (GW), or approximately 1 percent of the world’s expected power needs in the year 2030.

An emerging form of geothermal power known as “enhanced geothermal” is more broadly available. An enhanced geothermal system (EGS) uses drilling technology to tap into heated rocks a few kilometers beneath the earth’s surface. Water is pumped into these hot rocks, where it absorbs heat before being extracted to run a turbine.

Since these hot rocks encircle the planet, the theoretical potential of EGS is massive. Advances in low-cost drilling technology, such as rock-melting penetrators pioneered by Sandia’s Subterrene Program, will need to work their way down the learning curve. The prospects look good. EGS is expected to be a significant power source by 2050.5

Governments can help create incentives for geothermal energy development by passing Renewable Portfolio Standards (RPS). In California, geothermal energy currently contributes half of the state’s renewable energy capacity. Significant traditional geothermal resources have yet to be tapped in California, Nevada, and Oregon.

In some cases, governments may need to help alleviate exploration risk in order to encourage investment in geothermal development. Iceland, which leads the world in geothermal energy deployment, lures investors to develop projects by providing a form of insurance against “dry holes,” or geothermal wells that don’t pan out. The U.S. offers no exploration risk insurance, but may be able to stimulate the geothermal sector with such an insurance program.

Carbon Capture and Sequestration: An Urgent Need

Carbon Capture and Sequestration (CCS) describes a suite of technologies that can be integrated into fossil fuel power plants to capture CO₂ emissions and then transport them off-site for permanent storage. There are several promising technology options for carbon capture, and several projects are in various stages of development. Nonetheless, the world
has yet to witness a successful, commercial-scale CCS project. Countries with substantial coal deposits urgently need commercial-scale CCS in order to tap their coal reserves without exacerbating carbon emissions.

Unlike traditional pollution “scrubbers” that can be added to old power plants to clean up their emissions, CCS is unlikely to be used at existing power plants as retrofit costs appear to be prohibitive. A small group of modern fossil fuel combustion technologies are ideally suited for CCS, and will likely be prerequisites to the success of CCS projects.

Storage options for CCS are highly dependent on local geological conditions, and small-scale demonstration projects can cost up to $1 billion each. A successful CCS program will require substantial investments in pipelines for transport, and rules that address storage liability. As has been the case with nuclear waste, the government will likely have to take over long-term storage responsibilities.

Despite these significant challenges, the successful development of CCS is an urgent need for nations that will continue to rely heavily on fossil fuels for many years to come.

Technologies That Enable a Diverse Energy Portfolio

Each of these clean energy technologies has different strengths and weaknesses, and none is sufficient on its own. A prudent strategy for deployment would apply the lessons of investment portfolio theory: by diversifying our energy options, we can effectively hedge against the ever-present risks of technological failure, price volatility, and market uncertainty.

A number of enabling technologies and processes can help achieve the goal of a diversified energy portfolio, reduce risks and costs, and expand the system’s capacity for clean energy deployment. They include:

- **Energy efficiency.** Improving the energy efficiency of buildings, vehicles, appliances, and equipment is the fastest, cheapest, and most reliable way to achieve energy security, cut energy costs, and reduce carbon emissions. Investments in a host of energy efficiency technologies typically cost a small fraction of investment required for new generation. Of these, the most important can be found in modern lighting systems, super-efficient windows, and insulation techniques. Boilers, air conditioners, toasters, and other appliances can now be found in the marketplace consuming a fraction of the energy of their older counterparts.

- **Transmission.** New transmission is necessary to bring renewable power from remote sites to consumer markets. Wind power from the Great Plains, and solar power from the Southwest, will need new transmission to reach the large power markets in urban centers.

- **Demand response technologies.** Demand response technologies allow energy managers to remotely turn down or shut off commonly used electric appliances in order to balance loads and reduce costs. These technologies, deployed in a “smart grid” that closely tracks energy use across the system, can reduce peak power demand by 20 percent or more, limit the need for new generation capacity, increase the integration of intermittent renewable resources, and reduce costs for consumers.

- **Storage technologies.** These technologies eliminate the problem of intermittency by storing energy during periods of high generation and low demand. Storage technologies take many forms: compressed air, pumped hydro, large-scale battery systems, and thermal storage are all under development and finding their spot in the marketplace. Eventually, plug-in hybrid electric vehicles are also expected to add storage through the battery capacity under their hoods.
Part III – Barriers to Progress

Given the technological maturity and proven potential of clean energy options, one might wonder why clean energy doesn’t have a substantially larger share of the global energy market. Due largely to policy imbalances, a small and daunting set of hurdles remains for clean energy to break out of “boutique” status and become a major player in the business of supplying the world with energy.

Outdated economic models favor fossil fuel options. Most utility regulators around the world judge the economic viability of an energy project based on its initial capital expense. This creates a natural bias that favors fossil power plants over clean energy projects: close to 100 percent of a solar, wind or geothermal project’s lifecycle cost is upfront capital; for a coal- or natural gas-fired power plant, the initial investment is closer to just 10 percent of its lifecycle cost; the remainder is hidden by decades of uncertain fuel costs that are not explicitly included in the original price tag. Even when lifetime fuel costs are fully taken into account, renewables are often not given proper credit for the role they play in hedging against fuel price volatility. As leading energy economists with the International Energy Agency (IEA) have pointed out, this reduced price volatility has measurable economic value—a concept that utility regulators are only beginning to grasp. Finally, the costs of fossil fuel’s public health and climate change impacts are not included in cost-benefit analyses, masking their true financial impact on society.

Uncertain government policy. Government policy determines the fate of the entire energy industry; stable policies result in stable energy investments. Yet clean energy policies in the U.S., the world’s largest energy market, have been highly uncertain. As Figure 10 shows, the U.S. wind industry has suffered huge losses from the uncertainty caused by the periodic expiration of the federal production tax credit (PTC) for wind power. The PTC’s periodic expiration increases costs in the wind industry by more than 20 percent. It also makes the tax credit unnecessarily expensive for the government. Wind developers routinely discount the value of the PTC due to its perceived risk, meaning that the government must provide more money in tax breaks to inspire the same level of deployment that would be motivated by a risk-free, smaller tax break.

Permitting, siting and transmission issues. Resource assessments suggest North Dakota’s wind or Arizona’s sun could power the entire nation. But a $50-$100 billion investment in thousands of miles of new transmission lines would be needed to deliver that power to market. The current regulatory system is highly efficient at approving, siting, and permitting new natural gas pipelines. Transmission lines, however, do not receive the same level of federal coordination and prioritization as these natural gas pipelines and are therefore mired in process and permitting delays.

Capital costs. Pushing renewables down the learning curve will require some form of intermediate financial support. As Denmark’s experience shows, the return on investment for government investment in renewables can be huge. Danish leaders invested $1.3 billion in wind subsidies from 1993-2001, and created a domestic wind industry that enjoyed over $20 billion in export-driven sales between 2001 and 2007 (Figure 11). As a bonus, Denmark generates more than 20 percent of its total energy needs from wind power.

Part IV – Smart Policy + Free Markets = Success

Given what we know about clean energy technologies and the proper role of policy and markets, what can U.S. policy makers do to overcome these existing barriers and unleash the full economic development potential of renewables?
1. Use policy to send the right signals, and then let markets take care of the rest. The private sector has the resources, skills, and will to rapidly deploy renewables. Policy makers should focus on consistent rules and incentives that enable innovation and gradually shift risk to markets, where it belongs. More than half the states in the U.S. have adopted a renewable portfolio standard (RPS) that requires utilities to produce a steadily increasing portion of their power from renewable sources. The state public utilities commissions set a clear requirement, but the utilities use the market to find the lowest cost way of meeting that requirement. This gives producers a clear market volume, and exposes all actors to the discipline of competition.

2. Stability is critical. Renewables are capital intensive and require long payback periods. Investors will balk if the policy outlook is uncertain. As Figure 10 shows, policy uncertainty kills projects, slows progress, and thus raises costs. Lawmakers must think in ten-year horizons.

3. Set clear goals, and make sure they are enforced. Whether the goal is to make the U.S. get 20 percent of its energy from renewable resources, or to reduce carbon emissions 80 percent by 2050, policy objectives should send clear signals to the marketplace—and be backed up by real penalties for non-compliance. Corporations and the private sector have shown they can meet strong targets for social goals: from reducing fire risk in buildings to eliminating child labor to increasing food and labor safety. Producing clean energy is just as much in the social interest, and must be taken as seriously. U.S. energy policy has historically been more a pastiche of tax incentives than a serious drive to achieve any goals. This needs to change.

4. Financial incentives should be provided on a matching basis, decline over time, and be tied to results. Most clean energy technologies will require some financial support while they slide down the learning curve. But such support should be structured strategically. Investors should have “skin in the game” and be required to invest a large fraction of the required capital. Rewards should target energy production, not investment totals. Subsidies should fall over time to maintain pressure for cost reductions. These features can be found in an RPS, which uses the marketplace to select new energy sources. The European approach—with a “feed-in tariff” which gives higher prices to clean energy—is perhaps more costly, but provides real certainty, and can be structured to decline over time.

5. Support should be technology-specific (but not overly so). Although theoretically ideal, beware that technology-neutral policies have a tendency to favor incumbent technologies like wind while doing little for emerging technologies. Government should not pick winners, but should provide new technologies with the support they need to reach market scale. The RPS of some states, such as Arizona and Nevada, have specific tranches for solar power so that it does not have to compete on price with wind. This is an elegant strategy to encourage competition within a technology category, but allow for the differences between, for example, solar and wind. Current U.S. energy R&D budgets, at 0.1 percent of energy sales, are insufficient to achieve the nation’s environmental and economic goals.

Part V – Conclusion: Technology Ready, Investors Able – Political Will?

Among energy engineers and investors, few question the ability of the U.S. to derive at least 20 percent of its energy from renewable resources by 2030. Over the past decade, U.S. clean energy business leaders have watched as countries like Germany, China, Spain, Denmark, and Brazil have taken aggressive—and successful—measures to foster large-scale clean energy deployment. Ironically, in the case of some clean technologies, these nations took concepts originally developed in the U.S. and,
through focused policy interventions, brought them to scale. While the U.S. took back the lead on wind power in 2008, China could overtake the U.S. in the next few years unless the U.S. harnesses the synergy of technology, markets, and policy.

As a global leader in technology innovation, the U.S. certainly possesses the intellectual and industrial capacity to reclaim a clear leadership position in all clean energy choices. The market is primed, and the community of investors and developers is capable of the task. The industry’s success hinges largely on the enactment of proven policy mechanisms and incentives. It is up to policymakers to take the next step.

References

1 According to recent estimates from the DOE, NREL, Navigant Consulting, and the Geothermal Energy Association, renewable energy projects create four to six times as many jobs per unit of energy as equivalent investments in fossil fuel energy projects.

2 Available solar technologies could by themselves provide more than 15 times the total projected energy consumption for the entire world by 2030, according to IGA’s World Energy Assessment.

3 “Small wind” technologies designed for residential or on-site use are not discussed in this paper, and are typically more expensive than grid power. Turbine sizes for utility-scale deployment range from 1.5 – 4 megawatts per unit.


5 MIT estimates roughly 10 percent of U.S. generation capacity will be met by EGS in 2050.

6 FERC, 20 percent is the reduction in peak usage achievable in the Upper Midwest through existing demand response mechanisms.

7 Dr. Shimon Awerbuch, The Real Costs of Electricity Generating Alternatives: A Portfolio Approach, 2005.

8 Dean Gosselin, Vice President, FPL Energy. Testimony to Congress, May 24, 2005.


10 In the U.S., pre-1990s grid capacity supports only limited amounts of inter-regional power flows and transactions (Eric Hirst, U.S. Transmission Capacity: Present Status and Future Prospects, 2004)
Figures

**Figure 1 - World Installed Capacity in Gigawatts**

- Solar (50% Annual Growth)
- Wind (30% Annual Growth)
- All Others (3% Annual Growth)

Source: OECD/IEA Renewables Info, IEA WEO, EIA IEO 2008

**Figure 2 - Forecast Costs of Electric Generation by Technology**

- Solar PV
- Wind
- Natural Gas
- Coal (range)*
- Geothermal

*Coal range derived from observed power plant construction costs

Source: McKinsey Cost Curve 2.0 LCOEs, McKinsey Analysis
**Figure 7 - Reductions in Global Power Sector Emissions by 2030**

Gigatonnes in Carbon Dioxide Equivalents

<table>
<thead>
<tr>
<th>Technology</th>
<th>Emissions (GtCO₂e)</th>
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<tr>
<td>Required for temperature stabilization of +2°C</td>
<td>10.1</td>
</tr>
<tr>
<td>Traditional Sources</td>
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<tr>
<td>1264 GW of Wind</td>
<td>2.7</td>
</tr>
<tr>
<td>1281 GW of Solar</td>
<td>2.2</td>
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<tr>
<td>425 GW of CCS</td>
<td>1.9</td>
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<tr>
<td>70 GW of Geothermal</td>
<td>0.3</td>
</tr>
<tr>
<td>Other Renewables</td>
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</table>

70% of required power-sector CO₂ reductions come from four promising technologies.

Source: McKinsey Cost Curve V2.0

**Figure 8 - Cellular Phone Learning Curve**

Cost Per Unit

USD

Cost Per Unit vs. Millions of Units Sold
Figure 9 - Renewable Energy Capital Cost

![Graph showing Renewable Energy Capital Cost over time, with various sources and references.]

Source: Worldwatch Institute; IEA; BTM Consult; ABS; NREL; IIEE; ABB; Drewry 2007; UC Berkeley EER; Navigant consulting

Figure 10 - Effects of Expired Production Tax Credit

![Graph showing the effects of expired production tax credit over years, with annual installations in megawatts.]

Source: AWEA
Figure 11 - Denmark Cause/Effect of Government Subsidies

Subsidies and Revenues
Billion U.S. Dollars

<table>
<thead>
<tr>
<th>Year</th>
<th>Subsidies</th>
<th>Revenues of Danish Wind Industry</th>
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<tr>
<td>1993-2001</td>
<td>1.4</td>
<td>2.7</td>
</tr>
<tr>
<td>2001</td>
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<td>5.4</td>
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<td>2006</td>
<td>5.4</td>
<td>6.7</td>
</tr>
<tr>
<td>2007</td>
<td>6.7</td>
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Source: Neuhoff 2006: company financials; Lewis 2007
The Federal Role in Tackling Energy and Climate in Surface Transportation

Joshua Schank, Ph.D.
Director of Transportation Research
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Introduction

Since the founding of the American republic, transportation has been viewed as critical to the nation’s interconnectedness and prosperity. The federal government’s role in transportation is grounded in Article 8 of the U.S. Constitution, which states that “Congress shall have power to regulate commerce with foreign nations, and among the several states.” Over the course of more than two centuries, federal involvement was central to the creation of a vast nationwide network of canals and railroads, interstate highways and airports. As that network evolved and expanded, public investments in transportation came to be seen as serving multiple values and objectives well beyond merely facilitating interstate commerce—among them promoting economic growth and competitiveness, regional connectivity, public safety, equal access, and national security.

Today, these core values and objectives remain as important as ever, but the nation’s transportation infrastructure is worn out, dated, strained to capacity, and widely viewed as inadequate to the demands and challenges of a new century. Globalization, growing unease about petroleum dependence, and climate change are central concerns of our age, and they are transforming the way we think about and balance all facets of our transportation system. New thinking about growth, investment, and what citizens are, or are not, willing to sacrifice must influence the way we as a nation identify our values. Federal transportation policy stands at a crossroads. Many observers agree that it has lost direction and a clear sense of purpose, and the central challenge is how bold federal leadership can most effectively advance the transportation goals most Americans share.

Not only is our transportation infrastructure aging and deteriorating, characterized by growing congestion in major metropolitan regions and at key interregional, international, and intercity bottlenecks, but it is operating at declining levels of efficiency, and it is ill-suited to meet the challenges of the 21st century. These challenges include:

- Competing in a global economy in which the efficient movement of goods and people is a strategic advantage; imports and exports account for about one quarter of American gross domestic product.
- Grappling with the nation’s continued and still growing exposure to, and dependence on, petroleum from hostile and insecure sources—in part because of limited domestic resources.
- Reducing the transport sector’s contribution to global climate change.

To some extent these challenges reflect the success and the unintended consequences of the interstate highway project, which constituted the nation’s last great public works and transportation initiative. Those highways, the
inter-regional arterials that grew up around them, and the vehicles that use them made possible low-density urban development with ever greater demands on land, water, and air resources. This fostered an increasing dependence on petroleum that is at the root of growing concerns about national security and the environment.

Some of the tangible, immediate results of shortcomings in our current transportation infrastructure are glaring. As the National Surface Transportation Policy and Revenue Study Commission (National Commission) stated, our highways have an “unacceptable” safety record. With over 40,000 deaths and 2.6 million injuries recorded each year, our system is dramatically more dangerous, both in absolute and relative terms, than Western Europe’s—a region similar to the U.S. in population size and development. According to the Organization for Economic Co-Operation and Development, from 1970 to 2004 American traffic fatalities fell only 19%, from 52,627 to 42,636, whereas Western Europe’s fatalities decreased 59%, from 80,093 to 33,158. The Federal Highway Administration estimates that bad road conditions are a factor in 30% of fatal accidents.

Congestion is another major problem. The U.S Department of Transportation (DOT) estimates that traffic congestion wastes roughly $200 billion a year. The American Society of Civil Engineers believes that poor road conditions cause $54 billion worth of damage to vehicles a year—an average of $275 per driver.

These “traditional” transportation problems have been central to calls for policy improvements for decades, but newer problems of energy and climate change have rarely been addressed at all when considering surface transportation. Our transportation system is about 97% dependent on oil, a significant amount of which is sold to us by hostile nations and all of which contributes to the carbon dioxide emissions that are implicated in current concerns about global climate change. In 2007, America spent nearly $319 billion on imported petroleum, accounting for 14% of total imports, and oil price swings and long-term supply concerns continue to represent an important source of economic insecurity. Overall, the transportation sector accounts for over one-third of U.S. greenhouse gas emissions and 67 percent of oil use.

Current conditions, and particularly our energy and climate challenges, demand a response, just as the challenges of earlier eras brought forth new transportation policies, programs, and investments. The same core values that have guided U.S. transportation policy for 200 years—economic prosperity and national connectivity, joined by others—must be applied to the circumstances of a new era.

How We Got Here: A Brief History of U.S. Transportation Policy

Current U.S. transportation policy is not the result of a visionary, comprehensive examination of transportation needs in the 21st century. Rather, we have inherited a patchwork system cobbled together over the course of several decades, with little regard to modal integration or modern realities such as the energy and climate dilemmas we now face. To understand the flaws in current policy, it is essential to understand some of the history that led us to where we are today.

The multi-billion dollar authorization bills that Congress passes every six years have the words “surface transportation” in their titles, but it would be inaccurate to say that this legislation constitutes federal policy for all surface modes. Such bills do not cover intercity passenger rail, do not (for the most part) explicitly deal with freight, and have only recently included public transit. Nonetheless, these bills are the largest pieces of legislation dealing with surface transportation, and their history is instructive.

It was the Federal Highway Act of 1938 that first set in motion a study to examine the possibility of building new “superhighways” across the country. However, the large federal-aid highway system structure—most of which still remains in place today—was established under the Federal-Aid Highway Act of 1956. Although
Congress has since passed more than twenty pieces of legislation reauthorizing federal surface transportation programs, essential elements of the 1956 Act continue to guide federal policy today.

For example, the 1956 legislation called for the federal government to provide 90% of funding for the construction of the Interstate Highway System. The system itself would be constructed and owned by individual states, which had to provide the remaining 10% of funding. In addition, states had to follow the network plan laid out by the federal government and conform to federal design standards when constructing the system. The federal share of highway funding is now typically less than 90% (80% in most cases), but the basic structure remains.

The financing mechanism used to construct the Interstate Highway System—a Highway Trust Fund (HTF) supported by revenues from a federal tax on gasoline and diesel fuel—is also still in place. In effect, the HTF taxed users of the existing road network to pay for the construction of a new system. Given the dominance of gasoline and diesel-powered vehicles as a primary means of transport, the HTF ensured that there would be ample funding for what was at the time the largest public works project in history.

The 1956 bill set the tone for how federal highway funds would be distributed over the next fifty years. In particular, it created a formula for distributing funds based on population, land area, and road miles. The federal government distributed funds to states for the specific purpose of building a particular type of project—in the case of 1956, the Interstate Highway System. When additional highway and later transit projects and funding were folded into the highway legislation, they followed a similar model.

The 1956 legislation responded to a clear need—it would have been extremely difficult, if not impossible, to construct such a large system on a state-by-state basis. Subsequent federal transportation bills, while they introduced some important modifications, have been more incremental in nature and have, over time, lost the clarity of purpose that characterized the 1956 Act. Some of the most consequential changes to federal transportation policy occurred in 1991 when Congress passed the Intermodal Surface Transportation Efficiency Act (ISTEA). ISTEA was the first transportation bill of the post-interstate era. It attempted to integrate public transit into the federal policy framework, significantly increased state and regional control over the distribution of federal funds among eligible programs (for example, states could use federal funds to address goals like mitigating congestion and meeting air quality standards), and strengthened the state and local role in transportation planning. ISTEA also broadened the range of eligible projects that could be funded to meet local highway and transit needs, and emphasized new technology as well as new financing mechanisms.

The next major highway bill, the Transportation Equity Act for the 21st Century (TEA-21) maintained the core ISTEA framework, but added new programs and increased the minimum share of federal fuel tax revenues guaranteed to be returned to states (known as the “Minimum Guarantee”). It did not eliminate any of the programs created by ISTEA; instead it simply added new categories to the eligible uses of transportation funds, further diffusing any sense of federal purpose in the name of flexibility and local responsibility.

Unfortunately, the latest bill (and the one under which we are currently operating) has further confused and obscured the federal role. The Safe Accountable Flexible Transportation Equity Act—A Legacy for Users (SAFETEA—LU) made virtually no major changes to existing programs. It did, however, reconfigure the Minimum Guarantee program as an “Equity Bonus” program and increased to 92% the minimum share of fuel tax revenues returned to all states by the last year of the bill. SAFETEA—LU also added several new programs, many of which were fully earmarked—indeed, this bill shattered the number of earmarks included in previous
highway bills by a large margin. The result is a federal program that is larger than ever in terms of size, legislative language, and regulation, and yet lacks a clear and distinct purpose.

During the same period, federal policies for other modes of surface transportation remained outside the TEA framework. Intercity passenger rail, for example, continues to be addressed in separate authorization bills, despite many parallels to the federal role with respect to highways. Passenger rail has also been operating under an outdated paradigm for many years. As part of a strategy to prevent the collapse of the nation’s railroads, the federal government took over their passenger operations, which were unprofitable, allowing them to focus on shipping freight. Amtrak was created in 1971 to consolidate national passenger rail service, and was given exclusive rights to operate over freight railroad property at the insistence of those railroads. Providing financially viable national service has proved challenging, particularly in the absence of a mission focused on performance towards clear national goals. Lacking sufficient resources, Amtrak has often been forced to incur debt and defer maintenance on its own infrastructure. A chronic and negatively reinforcing circle currently exists. Despite several attempts, according to the Congressional Budget Office (CBO), there has never been a successful effort to reform the nation’s passenger rail policy or to integrate it with broader transportation policies and objectives.

If federal policy on highways, transit, and passenger rail seems stuck in another era, at least these modes have a policy. By contrast, there has been little coherent and ongoing federal policy involvement in freight transport, despite its enormous economic significance for the nation. Although federal highway policy certainly has relevance for the trucking industry, there has been an absence of federal leadership on critical freight infrastructure needs even as the nation’s international trade flows grow and system performance degrades. Despite its direct significance on the nation’s productivity and diverse calls for national leadership there has been no comprehensive legislation for freight. Indeed, aspects of current policies perpetuate a bias against the expansion of freight rail.

The results of this history are clear. We currently have a transportation policy and system that fails to address modern transportation challenges. These problems are described in more detail below.

**Problems with Current U.S. Transportation Policy**

The current state of the nation’s transportation infrastructure reflects the consequences of allowing modally distinct policies and programs to evolve slowly, while the world in which these systems operate changed rapidly. Some aspects of federal transportation policy have received much attention, while others have been neglected. But all aspects of our infrastructure are plagued by insufficient resources, in part because there is little prioritization based on value defined by a host of factors including economic, environmental, and energy terms. The federal government uses the resources it does have in a broad, opportunistic manner that has produced a number of programs, each with its own advertised purpose. As a result, important policy discussions often devolve into battles over funding that focus on earmarks and states’ individual success in maximizing their share of federal resources. Each of these issues is discussed in more detail below.

**Insufficient Resources**

One might think that a growing federal program that is larger than ever would provide adequate resources for transportation investment. However, there is widespread concern that the nation is currently under-investing in its transportation infrastructure. Many reports have tried to identify this shortfall, such as the recent National Surface Transportation Infrastructure Financing Commission’s estimate that the gap between “needs” and current available funds is approximately $214 billion per year. Yet it is critical to note that “needs” estimates assume
that there is some calculable ideal level of investment that in reality does not exist. Too many factors (such as policy choices, technology, and prices) can affect the performance of the system and the “need” for capacity, making the term itself relative and shifting. The focus should be on valuable investments. For example, how many dollars could the government invest in transportation where the returns to society would be greater than five dollars for every one invested? What about 15 to 1? Transportation investment has not traditionally been thought of in this way.

While there is broad consensus about the value of increased public investment in infrastructure, the federal government’s share of investment is, of course, a separate but also important question. Surprisingly, federal outlays funded by fuel taxes only account for approximately 20% of national public spending on transportation. States and localities are still the primary funders of transportation infrastructure. However, states in particular orient a large part of their own programs to the task of getting money from the federal government. The picture is complicated by the fact that the federal fuel tax—currently set at 18.4 cents per gallon—remains the primary mechanism used to raise funds for federal spending on highways and transit. In real terms the HTF fuel tax rate has been declining since 1993, which is the last time it was increased; and its spending power has been further diminished by rising construction costs. Moreover, the tax has never reflected the full social, economic, energy, and environmental costs of automobile use. At the same time total revenues to the HTF have recently begun to stagnate or decline as high gasoline prices have prompted a shift to more efficient vehicles and reduced demand for driving. The result has been a revenue shortfall, which in turn has led to an increase in the use of general fund revenues, which are already used to fund a portion of federal transit and intercity passenger rail programs, to fund highways. In September of 2008 Congress transferred $8 billion from the general fund to the HTF.

Rather than establishing clear spending priorities and introducing measures to maximize the cost-effectiveness of scarce infrastructure resources, Congress has consistently chosen to expand the size of federal funds without updating the revenue sources. This approach has eroded the user-pay principle that initially guided federal funding for transportation, and prevented the fuel tax from functioning in any way effectively as a carbon tax. Relying on general funds to support transportation investment breaks the link between demand for use of the system and the resources needed to support that system, leading to the type of fiscal crisis in transportation that we now face. It also leads to overconsumption of the primary energy source for transportation, due to the fact that oil’s negative externalities are not included in its price.

Finally, Congress has never forced the issue of ensuring that federal transportation investments are actually being used effectively. Congress does not require states to perform any analysis regarding costs and benefits on the vast majority of federally funded projects. Without any sense of whether existing resources are being spent with maximum effectiveness, it is extremely difficult to accurately assess the need for additional resources. If energy and climate are to be goals of transportation policy, for example, there must be some way to measure whether those goals are being achieved through transportation investments.

Program Proliferation

The sheer number of separate, federally administered programs for surface transportation contributes to an overarching lack of clarity about the federal role in this arena. The National Commission has identified 108 different programs that are being administered by DOT under various legislative requirements. There may very well be good reasons for each of these programs, but it would be extremely challenging to argue that the sum of these efforts represents a program targeted toward specific national goals.

The current proliferation of federal programs is perhaps unsurprising, given the incremental
way transportation policy and spending have evolved since 1956. The challenge facing policy makers is that it would be politically difficult—and in many cases poor policy—to propose eliminating a particular program. Typically, each program reflects worthy intentions and has a caring and committed constituency that worked hard to get it enacted. In the context of finite resource constraints, however, a worthy purpose cannot alone justify federal spending. Federal dollars should be spent for national purposes, and targeted to programs that create the biggest gains toward those goals.

Earmarking

Earmarking is probably the issue in transportation policy with the highest public profile. This is due in part to the widespread media attention directed to the now infamous “Bridge to Nowhere.” This bridge, proposed with the intent of connecting the small town of Ketchikan, Alaska to an airport on nearby Gravina Island, struck a chord with the public as an example of government waste. With a price tag of $223 million and only 7,000 Ketchikan residents as likely beneficiaries, the money for the bridge was eventually diverted to other projects. It continued to feature prominently as a campaign issue in the mid-term elections of 2006 and again in the Presidential election of 2008.

Although the popular press rarely connects the issue of earmarking to a deeper flaw in national transportation policy, the link is undeniable. As we have already noted, the number of Congressional earmarks has increased dramatically with each new highway bill since ISTEA. For example, ISTEA listed 538 “high-priority projects”; under SAFETEA-LU that number increased to 6,371 projects. In dollar terms, the funds authorized for these priority projects increased from $5.2 billion $13.5 billion.

And yet high-priority projects are only the tip of the iceberg. Some of the real growth in Congressional earmarking has occurred under discretionary programs that were designed to allocate money to worthy projects on the basis of certain criteria. In theory, prospective grantees apply to these programs and the funding is then awarded at the discretion of DOT. In practice, however, these programs have become earmarked so that there is no objective system for distributing funds left in place.

![High-Priority Projects in Transportation Reauthorization Bills, 1973-Present](image-url)
The lack of objective analysis and competitive prioritization that is evident in highway and transit funding decisions also affects other areas of federal transportation policy, including passenger rail. If federal funding for Amtrak were subjected to cost-effectiveness analysis, it would likely be directed to a limited number of highly utilized corridors connecting cities separated by distances under 500 miles. Instead the current system supports a number of highly subsidized long-distance routes that essentially amount to earmarks to maintain support for what would otherwise be recognized as a high-cost and underutilized program.

While it may not be possible, or necessarily even desirable, to completely eliminate earmarks, a clearer articulation of the goals of federal transportation policy and a more transparently systematic application of those goals to funding decisions could significantly reduce the influence of this phenomenon and help build public support for programs that demonstrably improve transportation services performance.

The Equity Bonus Program

Although earmarking gets all the bad press, it is not the worst symptom of a program without vision. Whereas identified high-priority projects accounted for about 6% of all funding in SAFETEA-LU, they were dwarfed by the Equity Bonus program, which accounted for 16% of the funding total. Equity Bonus is a program intended to balance geographic “equity” by returning to each state a minimum portion of its estimated fuel tax contribution to the HTF. The Minimum Guarantee provisions in ISTEA and TEA-21 served the same function, but the program was overhauled and renamed for SAFETEA-LU. Thus, one of the most important changes in transportation policy introduced under SAFETEA-LU involved taking a purely political program with no policy purpose and rearranging it to meet the needs of those now writing the legislation.

The focus of the Equity Bonus program is to address a concern that all states send their fuel taxes to the HTF, but some states get back more than they contribute while others receive less. This was perhaps less problematic when federal efforts were primarily focused on constructing the Interstate Highway System. States couldn’t easily object to other states receiving a greater share of collected fuel taxes if those states had more lane-miles of interstate highway to construct. As federal gas tax revenues were increasingly used to support other transportation projects and objectives, and even some uses only tangentially related to transportation, however, equity emerged as a more volatile issue. Like its predecessor, the Minimum Guarantee program, the Equity Bonus program uses complicated formulas to add to the total amount of money each state receives from the federal transportation program. The program is designed to ensure that by the end of 2009 each state receives back at least 92% of the gas tax revenues it contributes to the HTF.

As a mechanism for promoting sound transportation investments, the Equity Bonus program is highly flawed. The money it provides to states is free of restrictions—states can choose to spend it on almost anything they choose. Thus, a significant portion of funds collected for transportation infrastructure investment is being disbursed with little assurance that it will be spent effectively for that purpose.

A New Way Forward for U.S. Transportation Policy

Conversations about federal transportation policy almost inevitably devolve into a discussion of how future programs will be funded. This is not surprising in light of the fact that the HTF, which remains the only distinct funding source for transportation programs, will go into deficit next fiscal year without a new infusion of cash. Even if the political will existed to increase the fuel tax and index it to inflation, which is by no means a certainty, this mechanism will still produce declining revenues if other policies aimed at improving vehicle fuel economy and reducing U.S. oil dependence succeed.
This funding discussion is in many ways a red herring. There is little doubt that more resources are needed, and there is little doubt that states will need the federal government’s help to raise these resources. Regardless of whether additional funds are raised, the federal program must be reformed or else existing and additional funds will be spent poorly and not address the issues we currently face.

**Clarify the Federal Role**

The national interest in transportation policy is different from any given local or state interest. A state may want to put forward a transportation project for any number of reasons, such as easing congestion, putting people to work, repairing an aging bridge, or connecting a farm to a market. All of these reasons may be sound but that does not mean they will lead to investments that are consistent with national interests and priorities.

The ability to prioritize public expenditures based on a clear definition of national interest and federal purpose is particularly important in the context of limited resources. At present, America faces not only a shortfall in identified revenues for needed transportation investments, but a severe economic and financial crisis. Given that there are simply not enough resources to do everything in all places there should be a premium on targeted investments in those programs and projects that will produce the greatest benefits. We face a huge deficit in the federal budget, major reductions in state and local spending for the next several years, and a severe economic recession. It cannot be assumed that more public resources will be committed to the transportation sector absent a demonstration of significant economic, social, and energy returns on such investments, and fundamental reforms in the planning, management, and financing of the nation’s transportation system. The current crisis seems likely to compound a number of perennial difficulties and resource constraints, but it may also create the best opportunity in years to undertake the institutional and financial transformations needed to effectively address our transportation challenges. Moreover, if we know where we want to go, we will have a standard by which to choose those immediate statutory and administrative steps that can move us in that direction.

There is a dominant federal interest in preserving and strengthening the nation’s existing transportation infrastructure and its great connecting networks. At the same time, the federal government does share with state and local governments an interest in expanding and improving metropolitan and intra-regional transportation systems to enhance connectivity, accessibility, reliability, safety, and environmental sustainability. This suggests that a critical role for federal policy—and for the deployment of federal funds—is to stimulate and support state and local innovations and initiatives that are consistent with national goals and values.

**Emphasize Performance and Accountability**

The current federal transportation program features no true performance measurement of any kind. Funding is distributed to states, and though there are some requirements for how that money can be spent, no mechanisms exist to evaluate whether these expenditures are improving the performance of transportation networks. Just as investors need to know how their investments are performing, taxpayers and the federal government need to be able to evaluate the performance of their transportation investments. Greater accountability and an increased emphasis on performance at all levels of transportation policy making and funding are essential to achieve national transportation goals.

For energy and climate change this must mean understanding the energy and climate ramifications of transportation investments and decisions before they are made. Too often our policy with respect to these issues has relied on mitigation—building the investment first and dealing with the environmental problems later (energy problems have mostly just been ignored). If we are serious about energy and climate problems caused by transportation, we must proactively use transportation policy to tackle them. Performance and evaluation of
transportation programs and plans must include these indicators so that they can be understood before further investment decisions are made.

Results not Modes

The current federal program, with its historic roots in the construction of the Interstate Highway System, was not designed to accommodate a multi-modal transportation system. This is reflected in the methods currently used to raise funds, which rely on road users, and distribute funds, which is still done on a very mode-specific basis. Funding streams are divided between highway and transit, and the vast majority of funding programs are targeted only toward a specific mode. Not surprisingly, these programs mirror the fractured jurisdiction over transportation issues in the U.S. Congress; in the Senate, for example, different committees authorize highway programs (Environment and Public Works), transit programs (Banking, Housing and Urban Affairs), and safety, rail, and aviation programs (Commerce, Science, and Transportation).

One predictable result of this mode-specific approach has been a series of long-running battles between highways and transit. Elected officials from rural states and highway advocates have often pushed for increasing funds for highways at the expense of transit, based on the idea that since it is highway users who pay for transportation funding, they should not have to support public transit. Meanwhile, elected officials from urban states and transit advocates push transit as the lone solution to the congestion and environmental problems of the current transportation system.

A holistic approach to transportation investments is even more essential in the context of energy and climate change. The goals of sustainability, reliability, and accessibility, must be addressed across modes and across facilities or they will not be met. This suggests that public investments, whether federal, state, or local, should be programmatic in scope rather than project or mode-specific. The “best” programs, and those most worthy of federal support, will be those that lead to improved system performance—including performance with respect to energy and climate—across all modes.

Conclusions

A new federal transportation policy is needed to tackle the economic, environmental, and energy problems we currently face. Such a policy will need to include specific goals that define the ends to be achieved by expenditure of federal dollars. The policy will also need to include specific performance measures that can track the achievement of these goals by proposed and actual transportation policies and investments. Only then will there be the accountability necessary for the public to believe that spending more federal tax dollars in transportation is a worthy investment.

One key to this approach will be permissiveness. Every state and metropolitan area is different. Therefore the precise content of state and metropolitan transportation programs will vary from state to state, and region to region. Different states and different regions will choose to achieve the federal goals and performance measures specified through different types of programs, projects, and operations. Federal support for such programs should not be prescriptive or constrained by mode, but should reward innovations that enhance the overall performance of the transportation system.

Energy and climate change problems cannot be solved through transportation policy. But they also cannot be solved without changes in transportation policy. By setting clear goals and providing the resources to obtain them, the federal government can play a vital role in advancing climate and energy goals in transportation. This is a logical role for the federal government, because these goals cannot be met by states acting alone. In advancing these energy and climate goals in concert with the economic goals of transportation policy, the federal government will go a long way towards tackling some of our most pressing national concerns.
Recent times have produced a subtle yet profound shift in the policy debate over climate change. The science is not—and probably never will be—settled, but there is less doubt that climate change is real and problematic and more debate about what should be done about it. When an issue moves from whether to what, it becomes a matter of identifying options and selecting the best among them. Economics is certainly not the only filter used for identifying and choosing among policy options—moral imperative, precaution, equity, and political feasibility all enter in the mix. Yet understanding how these options could affect the economy is central to the lengths we take to pursue climate action, particularly with economic concerns as heightened as they are at this time.

The Benefits of Action/Costs of Inaction

The Intergovernmental Panel on Climate Change projects that if greenhouse gas (GHG) emissions continue at a business-as-usual pace, the atmospheric concentrations could rise to almost four times pre-industrial levels by the end of this century. Global climate models project that such concentrations could raise average global surface temperatures by about 2-4°C (a range of 1.1 – 6.4°C Centigrade)¹. Such a picture is not pretty, bringing a rise in sea level, largely adverse impacts on ecosystems, food production, coastal infrastructure, human health, water availability, ocean acidification and more extreme weather events. These impacts will be regionally uneven, with more severe impacts felt in the lower latitude developing world and could produce irreversible effects on species survival, ocean currents, and coastlines. Such ecological effects could have extreme economic consequences, such as relocating people in low-lying areas, building sea walls, reduced agricultural production, and developing new sources of drinking water. These are the expected costs of not taking action.

Given the possibility of such dire outcomes, what are the economic benefits of adjusting course? Economists have struggled to answer this question for years, producing wide-ranging estimates that depend on the severity of the climate scenarios, the scope of benefit categories covered, whether and how extremely unlikely catastrophic events are incorporated and how future benefits are discounted to be comparable with dollars spent today. The most ambitious effort by far in this field is the 2006 Stern Review, a comprehensive study that attempts to measure at a global scale the economic consequences of unabated climate change.² Stern's findings are provocative. Most prior economic studies had suggested the economically optimal path for combating climate change was to start slowly and modestly, smoothing in investments over time. But Stern's prescription was exactly the opposite—take strong, decisive action immediately to rein in the prospective economic damages from climate change, damages that were, on the margin, up to 5 times larger than the costs of taking (even such sudden) action.
Stern’s analysis created quite a stir. Many praised it as a strong economic justification for what they consider a logically intuitive call to action now. Some economists were critical of Stern’s methods, especially those involving extremely low discount rates on future damages (which turn out to be enormously influential in creating the large economic estimates). Harvard economist Martin Weitzman offered that Stern may have “gotten it right for the wrong reasons.” Weitzman argues that there are some threats out there so ominous that, even if their probability is low, they warrant strong preventive action as a form of insurance. The operative question is whether this insurance is worth the premium we pay (the costs of taking action), to which we now turn.

Cost factors in controlling greenhouse gases

GHG emissions in our economy are the product of three fundamental factors: population, output (GDP) per capita, and GHG intensity of GDP. GHG policy is unlikely to affect the population rate so it must affect either the size or GHG composition of the economy. In the very short run, our technologies and production processes, and feedstocks are largely fixed. Fossil fuels provide about 80-85 percent of U.S. energy. Within this mix, producers can switch from existing processes that use high carbon fuels to those using low carbon fuels and can shift from more energy-intensive goods to those using less energy. But with a fixed capital stock, these substitutions will be fairly limited; moreover, they often incur higher material costs or lower energy output and these costs may grow progressively larger with the scale of emission reductions sought.

The short run takes the most static view and produces the least desirable outcome. It defines GHG emissions and economic activity in a largely fixed relationship and implies that to reduce the latter you must reduce the former. If the economy has limited means to change inputs or practices, the only way to cut emissions would be to slow down the economy. This underlies many of the concerns expressed about policies to reduce greenhouse gases being a threat to economic prosperity and employment. But economies are dynamic, constantly responding to changes in conditions. For instance, when the cost of some materials goes up, manufacturing firms use less-expensive substitutes. Similarly, producers can switch from high-carbon to low-carbon alternatives if faced with the economic incentive to do so. Over the longer term, new low-carbon technologies can be developed and deployed, new infrastructure can be designed and built to reduce transportation-related emissions, and more energy efficient buildings, machinery and vehicles can take hold in the market—all factors that reduce the GHG intensity of the economy.

These long-term investments, if properly directed, make low-carbon operation easier and less expensive than it would be with the old capital and practices. This is why it is important to recognize the role that technological change plays in the cost equation. A price for carbon (discussed below) can provide economically rational signals to drive these investments, but will this be enough? The private sector is responsible for a vast majority of research and development in our economy as it pursues new products and processes that are profitable. But economists have long understood that the private sector underinvests in basic research that creates new knowledge because it is hard for private firms to appropriate the economic benefits. But basic research in low-carbon and highly energy efficient technologies appears necessary to reduce emissions at the rate needed to stabilize global atmospheric concentrations at a level that scientists believe will forestall the worst of the adverse outcomes. And public-funded basic research could lead to the development of technological solutions as yet unimagined that could significantly reduce the cost of achieving these reductions even further.

What are the most economically sensible mechanisms for controlling emissions?

There are two broad types of policy options for controlling greenhouse gas emissions: prescriptive regulation and economic instruments.
**Proscriptive regulation**, commonly referred to as “command-and-control,” has been widely employed to address environmental problems to date using *technology-based* or *performance-based* standards. Proscriptive regulation is capable of achieving the desired emissions reductions; however, it may be more costly to firms and governmental or program administrators than alternative approaches. Effective proscriptive regulation often requires a high level of information, such as sufficient knowledge of available technologies, pollution control costs for firms, and damage costs associated with the pollutants (e.g., health care costs), as well as sufficient monitoring to verify that the standards are met.

For the last forty years or so, economists have argued for the use of *economic instruments*, sometimes called “market-based” approaches to control pollutants as an alternative to proscriptive approaches. These instruments place a monetary value on the pollutant (GHGs), creating a profit-loss incentive to substitute to lower emitting and energy efficient products and for technology change to low-carbon solutions. The two market-based approaches most commonly proposed are a *carbon tax* or *cap-and-trade*.

**Carbon tax**

With a carbon tax the government imposes a price on the quantity of GHGs emitted and retains the proceeds to use or redistribute. Some favor a carbon tax because it is perceived as a more predictable, long-term price on emissions, allowing carbon emitters to act accordingly. Moreover, revenue generated through a carbon tax could be used to offset high energy bills and fuel prices for lower-income households, finance basic R&D for low-carbon technology development, or replace taxes on productive inputs (e.g., income tax) with taxes on unproductive byproducts (pollution). In principle, the higher costs of carbon-intensive actions, associated with a carbon tax, will increase motivation for moving to low-carbon solutions. But a carbon tax does not guarantee a specific emission result; emitters will continue to emit as long as the tax is cheaper than the cost of reducing an emissions unit. As a result, there is concern that governments will not have sufficient information, or will face political resistance, to set the tax at a level that would stabilize emissions and effectively combat the underlying problem.

**Cap-and-Trade**

Cap-and-trade controls the quantity of emissions, distributes the fixed number of allowances to emit to the regulated entities either for free (“grandfathered”) or through an auction, and allows regulated entities to trade these allowances in a market which ultimately determines the price of carbon. The underlying goal is to set the cap at a level that science and economics tells us is commensurate with the problem, ensure the desired emissions reductions are achieved, and allow the market to set the price. In principle, by fixing emissions rather than allowing them to vary (as a tax does), a cap-and-trade program can provide more certain protection from environmental damage.

**“Cap and Dividend”**

Recent policy discussions have seized upon the prospect of operating under cap-and-trade, auctioning all the permits to emitters, and redistributing the auction revenues directly back to households via a dividend or a tax cut, incorporating some of the potential advantages of a tax-based system discussed above, while holding emissions to a hard cap. This contrasts with earlier proposals under which most permits are given away for free to emitters, the remaining were auctioned, and revenues were used for a wide range of programs targeting, e.g., technology development, energy efficiency, and low-income assistance. The “cap-and-dividend” approach is simpler in many ways, but runs the risk of constituting a large transfer from regions initially hard hit by the cap and transferring revenues to taxpayers in other regions less impacted.
Cost containment under cap-and-trade

Because cap-and-trade has emerged as the primary climate policy option in U.S. proposals, I focus the remainder of our discussion on it. Choosing cap-and-trade means that at least the initial emphasis is on containing emission quantities, with the cost of achieving the emissions target allowed to vary. The most direct measure of the cost of meeting the target is the price at which the emission allowances trade in the market. If legislators approve a cap-and-trade bill they will do so informed (potentially) by economic modeling projections of the allowance price. These projections will reflect a range of assumptions about future technological change, population, costs, etc. that will not be known with certainty at the time of the vote. If the law were to pass, this might be interpreted as defining a range of prices that a majority of lawmakers deemed acceptable. But if actual prices exceed this range, this may be more than legislators bargained for. Therein lies a reason for cost containment under cap-and-trade—ensuring that allowance prices do not fluctuate too far above some level.

What causes allowance prices to vary? The supply of allowances is essentially fixed, so it is the variation in demand for those fixed allowances, both systematic and random. Systematic variation may arise because the demand for allowances ends up being consistently higher or lower than expected. Higher allowance demand would reflect that emission reductions were costlier than anticipated (allowances are only needed when emissions cannot be cut). This might occur, for example, if new low-carbon technologies are slower to come to market or energy efficiency stagnates. The opposite occurrences (faster technology, higher efficiency gains) might lead to lower allowance demand and allowance prices than expected. Random variation in demand will occur from year to year as some of the factors underlying emissions demand (e.g., weather and economic fluctuations) vacillate.

Cost containment mechanisms

Because the factors driving compliance costs cannot be known with certainty in advance, and because allowance markets have exhibited variability in practice, different instruments have been developed to contain costs under cap-and-trade to ensure against runaway costs. These mechanisms differ in how they operate but they share the common features of adding flexibility in when, where, and how to comply. Three primary forms of cost containment are defined below. Each of these mechanisms warrants its own in-depth discussion, but I must summarize them briefly here, and suggest references for further in-depth review.

Banking and Borrowing

From a climate standpoint, the level of emissions each year is less important than the cumulative emissions over time. This suggests some flexibility to shift compliance across time periods in response to market fluctuations. This can help contain costs without undermining environmental goals. Allowing firms to bank allowances means that they can opt to hold on to allowances obtained in one period to use for compliance in future periods. This allows them to cut emissions in periods when it is less costly and save the allowances they would otherwise have used and apply them to a future period when costs are higher. This not only has cost advantages, it has environmental benefits by yielding reductions sooner than they would have otherwise occurred if banking was not allowed. On the other side, if firms are facing high costs currently and have not built up a bank of allowances, they may choose to borrow against a future allotment of allowances. While this has the same fundamental cost advantages as banking, it puts future reductions at risk of not being realized, so most programs that allow banking limit it and also charge interest on borrowed allowances.
Offsets

Cap-and-trade can be designed to allow net GHG reductions in uncapped sectors of the economy, such as agriculture, forestry, landfills, and livestock to be used as a source of compliance in capped sectors. An offset is an agreement by which an uncapped entity agrees to reduce its emissions in exchange for a payment from a capped entity. The transaction takes place only if the uncapped (offset seller) can cut emissions less expensively than the capped entity (offset buyer). The sellers will do so if they are paid more than the cost of the emissions reduction.

To date, key international and domestic cap-and-trade policies have included emissions offset provisions. The Clean Development Mechanisms (CDM) under the Kyoto Protocol allowed signatory countries to meet their targets using emissions reduction credits generated through offset projects in developing countries not bound to Kyoto targets, in addition to using internal emissions reductions and trading credits with other signatory countries. Domestically, the Northeast States' Regional Greenhouse Gas Initiative (RGGI) has included an offset provision in its cap-and-trade program. The Lieberman-Warner bill of 2008 had domestic and international offsets as a significant component of the policy’s cost containment design. New proposals also feature a potentially significant role for reduced emissions from tropical deforestation as a source of offsets for a U.S. compliance market, combining cost control with the other attendant benefits of conserving tropical forests.

Although offsets can provide a number of economic, environmental, and social benefits, there are a number of critical issues in ensuring their environmental and financial integrity. Of specific concern associated with offsets are additionality (reductions would not have occurred anyway), leakage (emissions were not merely shifted to another location outside the cap), and permanence (carbon stored in a forest or soil carbon project does not get emitted in the future). These are all valid concerns; however, well designed and properly implemented offset protocols can reduce the costs associated with meeting the cap and ensure the system’s integrity. The challenge for legislators will be how to incorporate standards and rules to ensure offset quality without choking off the opportunities and capital flow for legitimate offsets with high administrative hurdles.

Allowance Market intervention

The final and most direct way to rein in prices is to directly intervene in the allowance market. One way is to establish a “safety valve” by which the government issues an unlimited number of allowances into the market for sale at a set price. This would set a ceiling on the allowance price since market participants could buy as many allowances as they want from the government. The critical issue is where to set the price. The Bingaman-Specter bill in 2007 included a safety valve price starting at $12/ton of CO₂. Many political constituents felt this price was too low and effectively transformed a cap-and-trade bill to a tax with effectively no quantitative limit on allowances. An alternative idea that emerged from those debates was the introduction of an allowance reserve, wherein a fixed number of allowances are set aside in an account that could be accessed if certain conditions were met—generally if the price went above a certain high level.8 An allowance reserve was included in the provisions of the Lieberman-Warner bill and the Dingell-Boucher discussion draft.

The emphasis in these discussions has been primarily on containing high costs (prices), but low allowance prices may also be a concern. As events from mid-2008 through winter, 2009 have shown in the EU carbon market, allowance prices can drop precipitously if market fundamentals shift. While low prices are generally good for the buyer, their prospect can fend off investment in low-carbon technologies whose rate of return depends on the allowance price. Some have thus argued that a price floor
should be instituted to ensure some return for low-carbon investors. If allowances are auctioned, a price floor can be incorporated by setting a minimum price at which auctioned allowances can be sold. Any unsold allowances can then be either retired, thereby lowering emissions below the cap, or held in reserve and introduced at a later time.

**Economic Studies of the Lieberman-Warner Bill**

Economists use computer models to project the impact of large-scale policy changes such as cap-and-trade on the economy. These models use data on general economic activity across sectors of the economy, with special emphasis on energy use, technical change and GHG emissions. They depend critically on assumptions about how the economy will evolve over time due to factors such as population growth, technical progress and energy efficiency.

Differences in model assumptions can greatly influence the results. For instance, a model assuming energy efficiency will increase by 1.5% per year over the next 50 years under baseline (“business as usual”) conditions will estimate it to be much cheaper to cut greenhouse gases than if energy efficiency was assumed to remain unchanged over time. Similarly, assuming that low-carbon technologies such as carbon capture and storage (CCS) will be widely available by 2020 will make emission reductions in the electric power sector much easier to achieve sooner than if it is assumed unavailable until 2030 or later. Because of the uncertainty in the future direction of these factors, it is better to use the models to provide useful insights on the nature, scale, and distribution of economic impacts of the policy rather than as specific predictions of what will happen if the policy is adopted.

With these caveats, it is nonetheless instructive to look at the economic modeling results from studies of the Lieberman-Warner America’s Climate Security Act of 2008 a cap-and-trade program proposed to reduce GHG emissions 70% by 2050 in sectors covering 85% of all emissions in the U.S. economy. This is the most recent formal proposal to advance through the U.S. legislative process. The results are too voluminous to discuss in much detail here, but I summarize key findings across studies below.

1. **Gross Domestic Product (GDP) per capita impacts of the policy are small relative to expected future levels.** Per capita GDP is projected to rise about 40% from 2010 to 2030 without a policy in place. Under a policy the scale of Lieberman-Warner, the estimated per capita GDP growth increase is slightly smaller (about 37-39.5%), with the annual growth rate of 1.7% declining perhaps to 1.6%. Note these GDP effects do not include the positive GDP effects expected from reduced climate damages. While it is useful to know that the proposed climate policy should not derail economic growth through mid century, using GDP as an evaluation metric, because the effects are relatively small, can obscure important differences across policy options. The GDP signal is hard to find through the noise.

2. **Climate Policy transforms energy markets.** Pricing carbon raises the price of fossil fuels (coal, natural gas, petroleum) and products that use them (electric power, transportation, manufacturing). Because of carbon content, coal price impacts are largest by far (several multiples); other prices are moderated by the ability to switch between fossil energy and other sources and by demand responses by consumers (generally less than 20%). The effect on natural gas use is highly uncertain, depending on whether coal power plants shift a large portion of their capacity to natural gas or to lower carbon generation such as CCS, nuclear or renewable. Under some scenarios, the electric power sector would have largely carbon-free generation by 2050.
3. A carbon price has smaller impact on transportation emissions. The price that emerges from an economy-wide cap-and-trade program of this magnitude may not be high enough to significantly alter transportation practices and emissions. This means that the transportation sector may end up buying reductions from other sectors to meet compliance. Policies that specifically target transportation (e.g., CAFE standards, renewable fuels standards) can have a greater impact on transportation emissions, though possibly at a higher cost than reductions from other sectors.

4. Banking allowances reduces the cost burden. Lieberman-Warner allowed parties to bank unused allowances, which tempers future price increases. When model scenarios exclude banking, allowance prices are as much as 3 times higher in 2030.

5. The use of offsets greatly reduces the costs of compliance. Lieberman-Warner would have allowed up to 30% of compliance to be met by domestic and international offsets. Model scenarios that exclude offsets for compliance will as much as double the allowance price.

6. International trade and leakage effects depend critically on what other countries do. Most studies assumed the rest of the developed countries will continue to have binding commitments (like the Kyoto Protocol) through 2050 that are similar in nature to the U.S. proposals. When developing countries take targets (e.g., hold to 2000 levels by 2050), very little trade and emissions leakage to those countries is expected to occur. If developing countries take no action, some emissions leakage to developing countries (estimated at about 10% of the U.S. reductions) could occur, though provisions for a "border tax adjustment" on imports from countries taking action can reduce this problem.

Concluding Thoughts

Economic analysis suggests that climate policy, if done in an economically rational and flexible manner, can guide a transition to a low-carbon economy without hindering long-term economic growth. Pundits argue whether this will be a “job destroyer” or a “job creator” but in the long run it is effectively a job shifter. Firms and industries currently using high carbon processes and technologies will be hard-pressed to continue this way if GHGs are priced and limited through a climate policy. They will either need to invest in lower-carbon alternatives or cede ground to competing firms, products and processes that do. Ceding ground is another term for suffering losses, but these losses are countered by gains elsewhere in the economy as low-carbon production processes attract capital, are developed and deployed. For instance, operation of, and employment in, older high-emitting coal-powered power units will decline in a carbon constrained world, but society will still demand electric power and suppliers will need to shift efforts, and employment, to new, low-carbon alternatives. Employment in these new sectors will run the gamut from “knowledge" workers developing the new technologies to traditional employment in infrastructure construction and process operations. Part of the response will come in the form of reducing energy use, which is enabled by developing and operating new, more energy efficient technologies. This too creates development and deployment opportunities for entrepreneurs, and can lead to energy cost savings that can spur economic growth or at least diminish the cost of responding to the climate problem.

While this transition can be accommodated in a dynamic economy over time, it will not be a pain-free exercise. Some firms and workers will find it difficult to adapt their processes and skills to the new low-carbon economy, and it will be in the public interest to address this problem with economic relief and training. The price of
some energy and carbon-intensive goods and services will rise to reflect carbon costs, and consumers of these products may face some interim hardship as they search for substitutes or invest in efficiency. And, as discussed above, price signals from cap-and-trade may be insufficient to drive private investment in transformational technological change, requiring public investment in basic science and technology to develop effective long-term solutions. Taken together, this means that a climate policy with cap-and-trade at its core must allow sufficient flexibility to ease transition costs; provide resources to sectors, workers, and households feeling the difficult impact of the initial transition stages; and invest in science to enable the long-term goal of a low-carbon economy.

References


4 I follow the common practice of using high and low “carbon” when referring to any and all relevant greenhouse gases, including non-carbon greenhouse gases such as nitrous oxide and fluorinated gases.


9 I draw primarily from a synthesis of 6 different government and private sector studies of S.2191 conducted by the Congressional Research Service (CRS 2008), a study of Lieberman-Warner by EIA, and in-house work of the Nicholas Institute.
Secretary of State Dean Acheson titled his memoirs “Present at the Creation” in a self-deprecating allusion to his role in the design of the international architecture that established the framework for security and growth after World War II. We are at another such seminal moment as we confront the need to create national policies and international architecture to shift the world to a low-carbon path of growth and security.

The Fierce Urgency of Now

The world is warming faster, the effects of warming are occurring sooner and the emissions that cause warming are increasing more quickly than scientists anticipated, or modelers forecast. Glaciers and ice sheets are retreating, storms have grown more severe, droughts more frequent, and floods more extreme. Biological patterns are changing, from bird migrations to the advent of spring. Over the last two decades the Earth’s drylands have doubled in size. Droughts have forced power plants in the United States, China, India, France, and Australia to suspend operations due to lack of cooling water. A bark beetle plague triggered by longer drier summers is devastating forests from New Mexico to British Columbia.

There is increasing evidence that warming is creating positive feedback mechanisms that will accelerate the process. Scientists have detected increased releases of methane—a potent greenhouse gas—from melting tundra and the coastal shelf off Siberia. Shrinking summer ice exposes more heat absorbing ocean to the sun, thereby increasing Arctic warming. A massive study of the 2005 warming of South Atlantic and Gulf waters that spawned Hurricane Katrina reported that it also caused a severe Amazon drought that shifted the world’s largest rainforest from a carbon sink to a carbon source for the duration of the drought.

All of the impacts that we have witnessed, at an accelerating pace, over the past decade, are the consequences of a mere 0.8 degrees Celsius of warming. It will take our utmost efforts to halt the process at 2 degrees of warming, and if we do not act soon, children living today are likely to experience the consequences of 5 degrees of warming. When the Earth was last 5 degrees cooler than it is today much of Europe and North America was covered with ice, and sea levels were hundreds of feet lower.

Because warming will cause disruptive physical changes it is likely to engender conflict over resources and catalyze the movement of large numbers of refugees. Security panels in the U.S. and Europe have concluded that uncontrolled warming will not only limit options for development, but will increasingly undermine security. The case for urgency is strong.

The Moment of Possibility

Today’s historic moment is also defined by two other key events: The reemergence of the
United States as an engaged and committed partner in the negotiations, and the collapse of the global economy. Because of the power and influence of the U.S., the scale of our economy and our greenhouse gas (GHG) emissions, and our history of environmental leadership there is both need and hunger for the U.S. to play a strong role in the Copenhagen negotiations.

The lurching retreat of the global economy has focused governments on economic recovery. Stimulus packages from Washington to Beijing have taken on a green tinge, launching massive investments in the clean energy technologies of the next economy. However, those investments alone are too little, and too late—without the multiplier effect of a price on carbon—to reduce greenhouse gas emissions significantly.

Reviving growth is an urgent priority, but “business as usual” high carbon growth would be self-limiting. Low growth, while slowing the growth of greenhouse gas emissions, would be morally and politically unacceptable. That leaves low carbon growth as effectively our only option. Fortunately it is also an attractive one. A managed transition to low carbon growth is technically feasible. Rooted in innovation, it would also create jobs and opportunity, as has every shift in which human beings have used knowledge to augment well being.

But warming is global, and the shift to low carbon growth is a global challenge. This paper explores how the nations of the world might agree to undertake that challenge.

A Brief History of Climate Agreements:

Seventeen years ago President Bush and 153 other world leaders signed, and the U.S. Senate ratified, the United Nations Framework Convention on Climate Change (UNFCCC). This set the world the objective of stabilizing atmospheric concentrations of greenhouse gases “at a level that would prevent dangerous anthropogenic interference with the climate system.” Participating governments agreed to act “in accordance with their common but differentiated responsibilities and respective capabilities”, with developed countries taking primary responsibility for reducing emissions and agreeing to pay the “full incremental costs” for developing countries to implement emissions reduction measures. Developed countries also committed to provide “new and additional” funds to assist “…developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting the costs of adaptation to those adverse effects.” Finally, developed nations made non-binding (and mostly unmet) commitments to stabilize their emissions at 1990 levels by 2000.

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**International Climate Change Processes: A Timeline**

- **1992**: U.S. and 153 other countries sign the UNFCCC. Today there are 192 signatories.
- **1997**: Adoption of the Kyoto Protocol, which set GHG emissions caps on developed countries; since ratified by 179 countries, but not the United States.
- **2007**: Bali Action Plan agreed by 192 countries, including the U.S.
- **2008**: Copenhagen meeting of UNFCCC signatory countries, including the U.S., will seek to conclude the negotiation of a post-2012 global climate change agreement.
Five years later the signatories to the UNFCCC negotiated the Kyoto Protocol. This set binding emissions targets for developed countries, and introduced verification and compliance procedures to give the provisions some legal force. It established funds for developing countries, but no requirement that they cut emissions. The U.S. wrote much of the Protocol, and President Clinton signed it, but, facing Senate hostility, it was never submitted for ratification. Some countries have made serious efforts, and progress under the Protocol. The European Union is expected to meet its target of reducing emissions 7% from 1990 levels, albeit helped in part by steep emission declines in the former East Germany. Japan is making major efforts to meet its (much tougher) target, with the help of international offsets.

The first commitment period under the Kyoto Protocol ends in 2012. The 2007 Bali action plan, agreed by 192 nations, including the U.S., provides the roadmap for either a second commitment period or a successor climate agreement (which of the two is a subject of disagreement within the negotiations). Its terms take into account developed country reluctance to negotiate new commitments in Copenhagen without developing countries also cutting emissions. Developing countries would take “nationally appropriate mitigation actions” to reduce their ballooning emissions and submit these to monitoring, reporting and verifying mechanisms in return for financial, technological and capacity-building assistance. Developed countries would set quantified GHG reduction objectives, and resulting emissions cuts would also be monitored, reported and verified.

What is the goal at Copenhagen?

Nine months from now 192 nations will convene in Copenhagen in an effort to complete a new agreement. To be effective it must include commitments by both developed and developing countries, address emissions from forests and land use change, and provide safeguards against abuse. Above all, it must set the framework for sizeable but manageable global emissions reductions.

There is an emerging consensus that warming above 2.0 degrees C will trigger physical and biological effects, and positive feedbacks that will be very dangerous, and that the Copenhagen Agreement should be designed to avoid warming greater than 2.0 degrees. That probably means GHG stabilization at concentrations between 400 and 450 ppm. As we are already at 430 ppm of CO₂ equivalent, this would require reducing global emissions by about 50% below 1990 levels by 2050. As Lord Nicholas Stern has observed, “the rest is simple arithmetic.” With a global population of about nine billion in 2050, average per capita emissions will need to fall to about two tons—an 80% reduction for developed countries.

The Negotiation Dynamics

The 50% by 2050 goal, even if globally accepted, leaves the thorny questions of who should reduce emissions how much, when, and under what conditions to be answered by national policies and the terms of the Copenhagen agreement. It is in the nature of
negotiation among sovereign nations that each will act in its own interest as perceived by its government. Those perceptions are inevitably shaped by a mix of long-term vision, ideology, and political expedience.

Europe is highly invested in the UNFCCC process. The EU’s 25 nations have invested in real GHG reductions, believe that they have worked through the problems of their carbon trading scheme, and take seriously the mandate of the “Bali Roadmap.” The most recent EU declaration called for developed countries to reduce emissions 25-40% below 1990 levels (a target that the U.S. has rejected as neither necessary nor feasible), and urged the “most advanced” developing countries to commit to actions that would reduce their emissions “15% - 30% below business as usual”. At the same time European leaders understand that strong U.S. participation is essential to the creation and success of an agreement.

The U.S. has recognized “our responsibility, as the largest historic global emitter of greenhouse gases, to play a leading role in the effort to contain global warming”, and the President has said he will seek legislation to reduce national emissions to 1990 levels by 2020 and 80% by 2050. Special Envoy Todd Stern has said that the U.S. will seek a global agreement that “reflects important national actions by all major economies to contain their respective emissions.” Such an agreement would ensure a flow of funds to developing countries, especially “the most vulnerable”, and would recognize that even rapidly growing economies like China and India have legitimate claims to develop.

For the developing country bloc, the G-77, the agreement is, at least in part, about money. Since 1997, its members’ position has been that any actions they take to reduce greenhouse gas emissions should be contingent on being paid to do so. From this perspective, developed countries bear the responsibility both to reduce their own emissions and to finance mitigation and adaptation in poorer nations.

I’m going to argue that this view, codified in the UNFCCC and other instruments agreed in 1992—this “Rio Bargain” needs to be renegotiated. But first let’s be clear that this view holds significant merit. Developing countries have historically done little to contribute to the buildup of greenhouse gases. Even mighty China still emits only a quarter as much per citizen as does the U.S. Developed countries have become rich through the clearing of their own forests and the large-scale use of fossil fuels. On what grounds should this opportunity be denied to countries whose only fault was turning up late to the industrial revolution and suffering colonialism? Furthermore, although some major developing countries are catching up with the rich world, almost all still face daunting development challenges. Small wonder that emerging countries such as India bridle when lectured about the need to cut emissions, when more than half a billion of its citizens lack access to electricity. And that poor nations facing devastating (and in the case of some island states, even existential) threats from the climate change they did nothing to create, see a refusal to deliver funds for adaptation aid as bad faith.

Still, the world has changed since the days of Rio and, while the “Bargain” has not been honored, we need to find a good faith path to re-open it. Several major emerging economies are seen in the West less as lands of the needy poor than as rising competitors or even strategic threats. And the remorseless arithmetic of climate change means that a solution is not possible without the active participation of these economic powerhouses in cutting emissions. As the figure below shows, fifteen or so countries (counting the European Union as one) account for almost 80% of global emissions, and ten of these are either developing countries or recovering former Soviet states.
Aggregate GHG emissions by country, 2005

Those who insist that the verbatim logic of the “Rio Bargain” must be honored, despite all the changes in the intervening years—that the North must pay for all the South does to limit emissions—are seeking to replace what was aspirational with what is impossible. A glance at the figure above shows the limits of this approach. The political appetite in Europe or the U.S. for funding emission cuts in China or Russia is sharply limited. The scale of the efforts needed is vast—after all, we are talking about the wholesale transformation of the world’s energy systems—and it is hard to see how international transfers could ever reach the scale needed. It is not even clear that it would be effective: the history of development assistance shows us the limits of change generated from outside a country. Success against climate change is likely to be based as much in political will and national investment in institutions, as in North-South financial flows.

This may seem like a gloomy tale. But in many respects the international debate on climate policy has yet to catch up with real life. Despite much rhetoric from developing
countries defending the Rio mindset, Brazil, China, India, Mexico and South Korea have all quietly produced comprehensive domestic climate change plans, which include significant unilateral actions.

So significant, indeed, that they render these countries’ negotiating stances somewhat surreal. While China’s international representatives argue on principle that their country should not have to take action on climate, their compatriots back home are engaged in what President Obama has correctly described as “the world’s most ambitious energy efficiency program.” This is already producing results, with China improving its national energy use per unit of GDP at a faster pace than the EU or U.S. despite its burgeoning heavy industry sector.

Indeed the internal dialogue on climate in these countries is increasingly similar to the one we have in Washington. Policy makers are largely convinced that climate change is a major threat to their future prosperity, and are seeking to balance their policy on climate with other priorities such as economic development and energy security. They are trying to stake out a place for their economies in new clean energy technologies. And above all they are asking how far they can or should go in tackling emissions while other major emitters—and here they are looking straight at Washington—are doing nothing?

This is exactly the kind of impasse that an international treaty ought to help us manage. Both the U.S. and major developing economies such as China see the need for action and are ready to take it, but are looking for reassurance that their international competitors are not “free-riding” and that the overall effort will be effective. They are looking for an agreement based in verification and trust.

What is an international agreement for?

We need a global agreement. Both warming and the emissions that cause it are global. The economy, trade, and competition are global. U.S.-based multinationals want a level playing field in the many countries in which they operate. A global agreement provides a basis on which countries can act with some confidence that others will do so as well. It can resolve issues of fairness and competitiveness.

But while there are signs of openness behind the scenes, there is still a yawning gap between the official positions of the U.S., Europe, China, India, Brazil and other developing countries on commitments, money, and institutions. This divergence partly reflects negotiator machismo, and partly genuine differences in interests. But it also derives from profoundly different views of what an agreement can and should achieve.

In order to illustrate how the negotiations might move forward I will describe two alternative outcomes: The Global Deal, and a Trust and Verify Framework.

The Global Deal:

This is what negotiators are currently focused on and the Europeans are seeking. Its key components include: A goal of 50% reductions in global emissions by 2050 implemented through binding commitments by developed countries to reductions of 25%-40% below 1990 levels by 2020, and 80% cuts by 2050. These would be matched by binding commitments from other major emitters to implement policies and measures to reduce emissions by agreed amounts below business as usual necessary to achieve the 2050 goal. Other, poorer developing countries would be required to submit plans for development that avoids CO2 growth. The intent would be immediate creation of a global price on carbon.

This would be bankrolled by funding on the order of $60-80 billion a year for technology development, implementation, forest protection, and adaptation. The money would come from developed nations’ commitments, levies on carbon trades, and international offsets. The funds would be managed through newly created international agencies, under the UN umbrella.
The “Global Deal” has much to recommend it:

- It is where the current negotiations are focused.
- It provides a complete and comprehensive roadmap of how the world will halt global warming.
- It fulfills the UNFCCC terms, and addresses concerns on each side about commitment and fairness, especially the legitimate claims of the poorest nations who will bear the brunt of climate change impacts.
- The shift to the low carbon path is beneficial both environmentally and economically, and the Global Deal would represent a massive commitment to get there.

But it faces huge obstacles:

- The world is in recession. Developed countries are spending vast sums to restart their own economies and are unlikely to commit as much as developing countries are demanding.
- There will be profound skepticism about the rapid creation of, and heavy reliance on, very large new international institutions.
- It is not clear that there is political will for such a quantum leap. The U.S. has said it will not make 25%-40% cuts by 2020, and the large developing country emitters have objected to quantitative caps.

So, if the Global Deal proves untenable, is there a path in which *some* money, and *some* commitment can produce *some kind of deal*? If so, would it be enough to start the world on an effective path to a stable climate and low carbon growth? Various participants have suggested a fallback on sectoral agreements, regional pacts, or bilateral agreements—between the U.S. and China, for example, or China and the European Union. Each of these might have a role in any final agreement. The following is another scenario built on elements of arms control, trade, and atomic energy agreements.

**A Copenhagen Trust and Verify Agreement:**

This agreement would be based on national action commitments by all countries consistent with achieving a 50% reduction in global emissions by 2050. These would be “measurable, reportable, and verifiable”—as defined by the Bali Action Plan—and all actions would be enrolled in a registry (as already proposed in different models by South Africa and South Korea). Each country would bring emissions reductions or avoidance actions to the table appropriate to its national circumstances. For example, the U.S. would submit a federal cap and trade program, while China would submit its thousand enterprises program and its energy intensity reduction program. Developed countries would also bring forward funding commitments through a variety of channels.

The commitments would be legally binding, and enforcement would be through mutual accountability. There would be a rigorous report and review process overseen by an international agency with powers similar to those of the WTO’s Trade Policy Review Mechanism or the IAEA. (The WTO mechanism requires major trading countries to undergo an independent two-year assessment of their progress against trade commitments). Developed countries would invest in technology development and seek to leverage private sector investment, but the agreement would not create major new international institutions or mechanisms. Transactions in international offsets would remain under national control.

Significant adaptation assistance for the poorest and most vulnerable nations would remain a critical component and might be channeled through both a multilateral adaptation fund and bilateral development assistance agencies, such as USAID, with longstanding capacity and expertise. The key would be periodic review and adjustment. As policies were implemented and experience built, and more countries adopted caps, the system would move toward a global price for and trade in carbon.

The more fragmented structure of this approach would still need to be driven by an
overarching vision of the emission reductions demanded by the science, and this vision would be a reference point for periodic reviews of global and national progress.

This agreement would not provide the comprehensive assurance that the Global Deal would, but it would enable the world to take a step forward consistent with the low carbon path. It would achieve a commitment to global action, and it is realistic. It would enable countries to trust, but verify. It would not rely on big new institutions or limitations on sovereignty, but would provide a period of “trust but verify” that could lead to other forms of commitment and linking of carbon markets.

**Conclusion**

To many negotiators the choice between these options is obvious. The Global Deal is the only model that seems to ensure that the collective action is at the scale needed. It reflects the view, held most strongly perhaps by the Europeans, that an international agreement is where this ambition is generated—that countries will take the results of that agreement home and feel bound to implement them. Many developing countries see the comprehensiveness of the agreement and guaranties of implementation as the only credible measures of good faith.

But many other countries, including the U.S., see international processes differently. International agreements reflect a commitment to act; they don’t generate that commitment. Trust would be built on the basis of performance, not negotiation. Commitment would build on the basis of investment and success. To paraphrase Justice Holmes, the life of such an agreement would be experience.

Nothing like this second option is now in negotiation, and many negotiators would recoil from it, but something like this is under consideration in private, and could emerge publicly from key U.S.–China discussions, and a meeting of major emitting nations to be chaired by the U.S. in the summer. Indeed, hopes for agreement of any kind largely depend on some form of big arrangements among big emitters that reflect understandings on mitigation, technology (especially coal technology), and forests.

It is quite possible that an agreement will be forged that draws elements from both approaches. Neither treaty obligations nor money, however, will turn pro forma agreement into political will, they can only reflect it. We have to find a level of agreement in Copenhagen on “common but differentiated” responsibilities that countries commit to because it is in their interest to do so.
Energy Security and Climate Change: Policy Challenges for the New Administration and the New Congress

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April 4-10, 2009

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Overview of Oil Supply and Demand and the Implications for U.S. Policy
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Rapidly rising prices in the global oil market over the past year—with significant price volatility, including falling prices—has significant consequences for the United States, which depends almost exclusively on oil for transportation. Though demand has moderated somewhat as prices rose, and new vehicle fuel efficiency standards are in the pipeline, demand for oil is nonetheless projected to grow substantially, at home and in fast-developing economies. Potential new supplies, including offshore deposits along the U.S. coasts, are being identified. Some of these supplies, off Brazil’s and Mexico’s coastlines, for instance, may be costly to recover, other sources may raise environmental and health concerns, while still other current or new providers have or may present serious concerns for U.S. foreign policy. What are the oil trends, issues and risks with which U.S. policymakers will have to contend over the next several years?

Discussion Questions

- What steps need to be taken to decrease the transportation sector’s dependency on oil?
- What is the overall picture for supply and demand for oil, in the United States and worldwide?
- What are the prospects for new or additional supplies of economically recoverable oil? Where are these supplies? What are the hurdles for securing them?
- With respect to those supplies, what are the key issues affecting relations between the United States and major providers of U.S. oil imports?
- What role can public transportation play in mitigating oil consumption?
- How are other countries, industrialized and developing, responding to changes in oil demand and supply and the associated impacts on their development plans?
- What are the consequences and implications of oil price volatility for the United States and other countries?
The Potential for Renewable Technologies to Meet Energy Needs

Hal Harvey, ClimateWorks Foundation

Great hope is being placed on new, alternative, and renewable energy technologies—including energy efficiency, wind, solar, fuel cells, biomass, and more—to generate electricity to meet U.S. energy demand and at the same time reduce emissions of carbon dioxide and other greenhouse gases linked to climate change. Similarly, in the transportation sector, bio-fuels and new ways of powering vehicles offer promise of reducing U.S. dependence on imported oil while also reducing greenhouse gas emissions. Some countries and more than half the states have adopted renewable standards to guide utilities in their energy services and investments, and there are incentives for cellulosic ethanol production and tax credits for hybrid vehicles to spur their sales. Yet some experts warn that because these technologies now provide but a very small fraction of U.S. energy, even with a rapid ramp-up in their availability, conventional sources, such as coal, natural gas, and oil will be needed in large quantities for years to come.

Discussion Questions

• What is the potential for new, alternative and renewable technologies, including energy efficiency, to meet U.S. needs?
• What is the potential for bio-fuels, hybrid engines, and related developments in our transportation sector to reduce U.S. dependence on oil while also reducing greenhouse gases?
• What are the barriers to realizing their potential? What national policies would be helpful to overcome the barriers?
• How could investments in research, development, and demonstration projects be deployed to maximum advantage?
• How are renewable energy technologies viewed by developing countries in their economic development plans?
• Is the development of these new technologies important in job creation?
• What are the impacts on the global food supply by the development of biomass energy sources?

Innovative Options for New Transportation Systems of the Future

Joshua Schank, Bipartisan Policy Center

Reauthorization of the surface transportation bill offers a near-term opportunity to consider new policies and innovative approaches that over time could help the country improve mobility and reduce dependency on oil. Currently, the transportation sector is almost totally tied to oil. The sector accounts for 70% of domestic oil consumption, and 97% of the energy consumed by this sector is petroleum-based. Moreover, transportation accounts for about a third of domestic carbon dioxide emissions, a leading contributor to climate change. Seldom do the connections among transportation policy, energy security, and climate change receive sufficient attention in policies that could enable the country to make progress on all three at the same time.
Discussion Questions

- What role could transportation policy play in moderating oil consumption while lowering greenhouse gases?
- What are some of the innovative approaches to transportation that could meet mobility needs while also helping to reduce demand for oil?
- How could research, development, and demonstrations most effectively foster new options for transportation?
- What institutional or funding barriers might limit new approaches to transportation? How could they be overcome?

The Impacts of Climate Change on the U.S. Economy

Brian Murray, Duke University

A credible U.S. program to reduce the emissions of carbon dioxide and other greenhouse gases associated with global warming will be essential if the United States is to join with other nations in addressing the harmful effects that are likely to accompany a warming climate. The predominant strategy is to put a price on carbon emissions, which will entail compliance costs and have economic consequences more generally. At the same time, there may well be economic benefits that follow as consumer choices change, as business practices adapt, and as new energy technologies emerge. Concern by policy makers over the potentially high costs of a program have long been a stumbling block, with the economic turmoil that emerged in the last half of 2008 heightening their anxiety. Consequently, considerable attention is being focused on what’s called cost containment, measures that could provide a means by which to moderate costs should they prove higher than projected. Another strategy is to create a program of “offsets,” by which U.S. companies could undertake agricultural or forestry projects in developing countries in exchange for credits that would be applied to their greenhouse gas reduction obligations at home.

Discussion Questions

- What are the major economic impacts of a U.S. program to reduce carbon emissions? What are the economic benefits? How reliable are these projections?
- How will such a program affect Gross National Product? Jobs? Prices for oil, coal and natural gas? Key industries and parts of the country? What will be the impact on our transportation sector?
- How would the United States be affected competitively in international markets if a program of offsets goes into effect without commensurate commitments by other countries, especially China, India, and other rapidly-growing economies?
- What measures could be considered to moderate the economic costs of a U.S. climate change program should cost-containment safeguards seem warranted or prudent? How would they work? What are the pros and cons of the options?
- How can a program of offsets be designed to help U.S. companies meet their permit obligations while improving the agricultural and forestry sectors in developing countries, thereby fostering economic development opportunities?
Implementing a Post-Kyoto International Agreement to Address Climate Change

Jonathan Lash, World Resources Institute

As a new international climate change treaty is negotiated, a long-standing priority has been to engage the developing world, including major greenhouse gas emitting countries. Aside from this critical issue, many other questions remain to be settled: targets and timetables for reductions by industrialized and developing countries, the degree to which offsets might be applied, the role of tariffs and other trade mechanisms that might be adopted as penalties for non-compliance with the accord, and the terms by which technical assistance and technology transfer might be provided to developing countries. At the same time, existing international institutions, UN organizations, multilateral and bilateral aid agencies, and nongovernmental groups will be called on to meet urgent needs in poorer countries in addressing the health consequences stemming from climate change, in adapting agricultural, forestry, and water resource management practices, and in fostering economic development strategies consistent with emerging climatic conditions.

Discussion Questions

• What is the status of negotiations for a post-Kyoto international climate change agreement? What are the major policy issues in these negotiations?

• What are the prospects for China, India, and other countries with rapidly-rising carbon dioxide emissions joining the agreement? What is needed to secure their participation? How will a climate treaty affect their development goals?

• How would this new agreement be monitored and enforced? Is there an international institution capable of overseeing implementation effectively? What responsibilities would be included?

• What positions are developing nations staking out, especially with regard to their priority to promote economic development?

• How well equipped are the range of international, multilateral, and bilateral aid agencies to help developing countries adapt their development strategies, as well as their agricultural, forestry, and water resource management capabilities to meet the challenges presented by climate change?