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A Roadmap for a Secure, Low-Carbon Energy Economy

Balancing Energy Security and Climate Change

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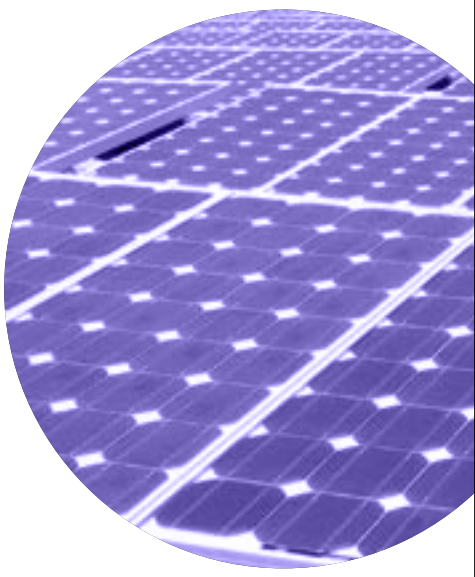

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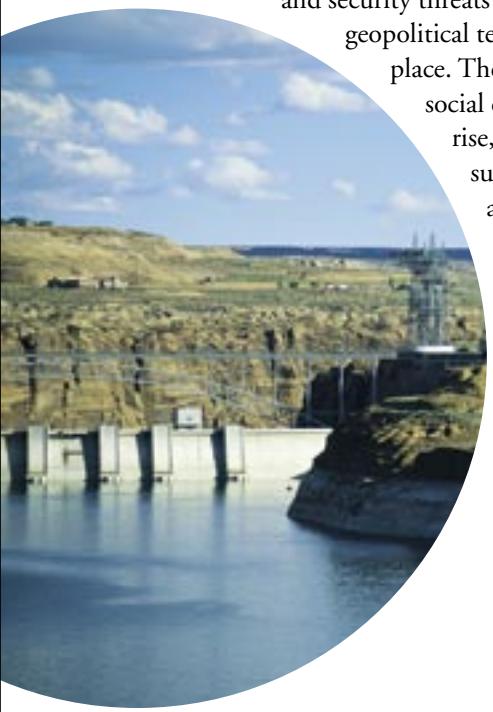
Executive Summary

At first glance, improving energy security and addressing climate change may seem irreconcilable goals: achieve an adequate, reliable, and affordable energy supply for the United States, while at the same time reducing emissions of dangerous global warming gases into the atmosphere. After all, most of the world's energy comes from burning fossil fuels such as coal, oil, and natural gas – which are also major sources of greenhouse gases. Without scalable low-carbon replacements for these fuels, actions to reduce emissions could destabilize the current energy system. On the other hand, continued dependence on these fuels will jeopardize our climate.

The hard truth is that the United States – and the world – must now figure out how to achieve energy security and protect Earth's climate.

There is abundant evidence that the current energy system is unsustainable. Prices are volatile, supplies tight, and security threats – from supply disruptions to geopolitical tension – have become commonplace. The expected environmental and social costs of climate change – sea-level rise, water scarcity, reduced food supplies, and damaged ecosystems – are rising. At the same time, the country is facing an economic crisis that strains public and private budgets, but also raises opportunities to stimulate the economy while building a cleaner and more reliable energy infrastructure in the process.



Solutions to these problems are not always clear. While some strategies – such as energy efficiency measures – benefit climate change and energy security goals, other possible solutions for improving energy security – such as relying more on liquid fuels produced from domestic coal – could significantly worsen climate and other environmental problems. Similarly, some possible climate solutions – such as relying more on the sun or wind to make electricity – could reduce reliable and affordable energy supplies in the short term.

This "roadmap" presents the results of a year-long effort by the Center for Strategic and International Studies (CSIS, an international policy and security-oriented think tank) and the World Resources Institute (WRI, an environmental policy think tank) to identify a set of policies to address energy security and climate change simultaneously.

This document presents the results of a difficult process to reconcile the priorities of two sometimes conflicting constituencies. The resulting recommendations are designed to be implemented as a package. Policymakers must not simply pick the recommendations they favor or that are most politically palatable. The balanced approach recommended in this brief would greatly increase the United States' chances of meeting both its energy security and climate goals.

It won't be easy. Shifting the United States to a secure, low-carbon economy will take decades. The costs will be high, but they will be even higher if immediate action is not taken. The United States has ample natural, human, and technological resources, and if policymakers get started promptly and make smart decisions, the benefits of this transformation can be great: economic opportunity, a healthier planet, and a more secure future for the United States.

SUMMARY *of* Recommendations

This roadmap creates a three-part framework for thinking about the transition to a secure, low-carbon economy. It recommends that the administration and Congress should:

1. **Establish a vision for the future.** Articulate a long-term vision for addressing energy security and climate change against which all policies will be measured.
   - Integrate energy security and climate change priorities into all aspects of domestic and international policymaking.

2. **Put the country's energy system on the right path.** "Reset the system" by updating policies and incentives to promote secure, low-carbon technologies and practices.
   - Establish a price on carbon throughout the U.S. economy.
   - Make and implement a public financial commitment to address energy security and climate change, including devoting resources to improved infrastructure, energy efficiency, and clean-energy jobs.
   - Reform incentives to promote low-carbon technologies and remove barriers to their adoption.
   - Engage constructively in an effective international response to climate change and energy security concerns.
   - Invest in the infrastructure and technology necessary to transform the transportation system while improving land-use planning.

3. **Manage the transition.** Continue to meet and manage U.S. energy demand while addressing the tradeoffs that occur during the transition to a new energy system.
   - Promote energy efficiency and other measures that contribute to both energy security and climate goals.
   - Reduce the greenhouse gas emissions from technologies that contribute to energy security (coal and biofuels) and make low-carbon technologies (nuclear power and some renewables) more secure.
   - Support domestic conventional oil production during the transition to lower-carbon fuels.
   - Develop a natural gas strategy to help meet short-term demand and ensure the availability of alternatives in the longer term.

Foreword

The challenges that face our world today are daunting. On the economic front, we face a global recession, with attendant unemployment and hardship. On the environmental front, climate change threatens to put millions at risk from rising sea levels, disease, water and food scarcity, and instability resulting from mass migration. The energy system is also under siege, threatened by a wide array of geopolitical, technological, security, infrastructure, and investment challenges – all contributing to volatile prices, which in turn carry environmental and economic consequences.

While there is an undeniably clear interconnection between these issues, with a few notable exceptions (e.g., an aggressive effort to promote energy efficiency) their collective resolution requires a comprehensive and balanced approach that recognizes the importance of environmental protection, economic prosperity, and energy security.

Identifying the links between climate change and energy security – and developing a comprehensive package of recommendations that address those concerns while managing the trade-offs among competing interests – is a central thesis of the collaboration between our institutions. A policy that undertakes aggressively to reduce greenhouse gas (GHG) emissions without regard to ensuring a stable, reliable, and secure energy system risks damaging consequences for an already overtaxed energy sector. Similarly, a policy that emphasizes energy diversification through fossil fuel expansion with no regard for carbon loading the atmosphere will lead to an untenably warm world. Either outcome would have undesirable consequences for a fragile economy. Neither would make us secure. Dependent as it is on a sustained and sustainable energy supply, the U.S. economy needs a comprehensive and holistic approach – not a piecemeal response.

WRI and CSIS have spent more than a year, working jointly, to examine the intersection between climate and energy policy. Jointly we hosted a series of meetings with experts in both arenas – and seeking, through this document, to synthesize both their input and our own ideas. We have found considerable common ground – and some areas of continued differences. Thus, while this report advances some recommendations that are narrowly targeted at climate change (for example, calling for a cap on GHG emissions, a particular focus of WRI), and on energy security (supporting domestic supply additions for both natural gas and oil during the transition to less fossil-intensive fuels, a particular focus of CSIS), the overall emphasis of the paper is on policy choices that support *both* climate solutions *and* a secure energy sector and provide government with a comprehensive and balanced approach to addressing both problems simultaneously. The paper does not deal with other environmental problems – although we recognize their importance.

Getting to this point in our dialogue has moved both organizations out of our "comfort zone." In this sense, the report is a precursor to what will be necessary in the wider U.S. domestic debate on these issues. That our organizations, focused as we are on very different aspects of the global economy, can agree on this need for a multifaceted approach, is itself a critical message. We are no longer in a world in which we have the luxury of making simple policy choices without regard to the spillover consequences. Everything is connected – and energy security and climate more than many issues.

In a similar vein, while the emphasis of this report is on the United States, we firmly believe its message is universal. China, India, and Europe are no less reliant than the United States on the global energy market, and on the global commons of the atmosphere and climate. While the U.S. can and must lead, all countries must act. We hope the recommendations here provide both an impetus and a guide to that action.

JOHN J. HAMRE
Center for Strategic and International Studies

JONATHAN LASH
World Resources Institute

Introduction

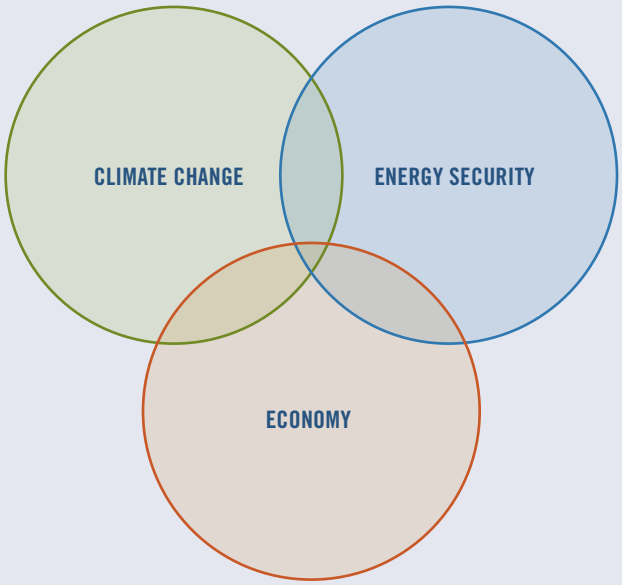
Volatile energy prices and growing awareness of global environmental problems have helped make energy security and climate change top-tier issues that routinely make headlines. During the presidential campaign, both major party candidates offered ambitious plans to take on energy security and climate change, and emphasized the potential for energy policies to help alleviate economic troubles, especially in the wake of the global economic crisis.

Now, the incoming Obama administration must reconcile those plans with a struggling economy, volatile energy prices, and competing priorities. But one thing has not changed: Moving the United States to a secure, low-carbon energy system will provide opportunities to strengthen the economy, protect national security, and improve the standing of the United States internationally.

This shift will require a transformation on the order of the first Industrial Revolution, but this new "energy revolution" must move nearly three times as fast.[1] As daunting as this challenge may seem, it must be met. Current trends in energy consumption and greenhouse gas emissions are unsustainable and put the United States on a path to an increasingly uncertain and undesirable future.

BOX 1. Balancing Energy Security, Climate Change, and Economic Concerns

Taken as a whole, the recommendations in this roadmap are intended to address both energy security and climate change concerns, and to recognize the interactions between these issues and the broader economy. Some technologies or policies will benefit all three of these issues. Others may contribute only to one or two. To avoid trading off these three priorities, policymakers should follow the roadmap in its entirety.



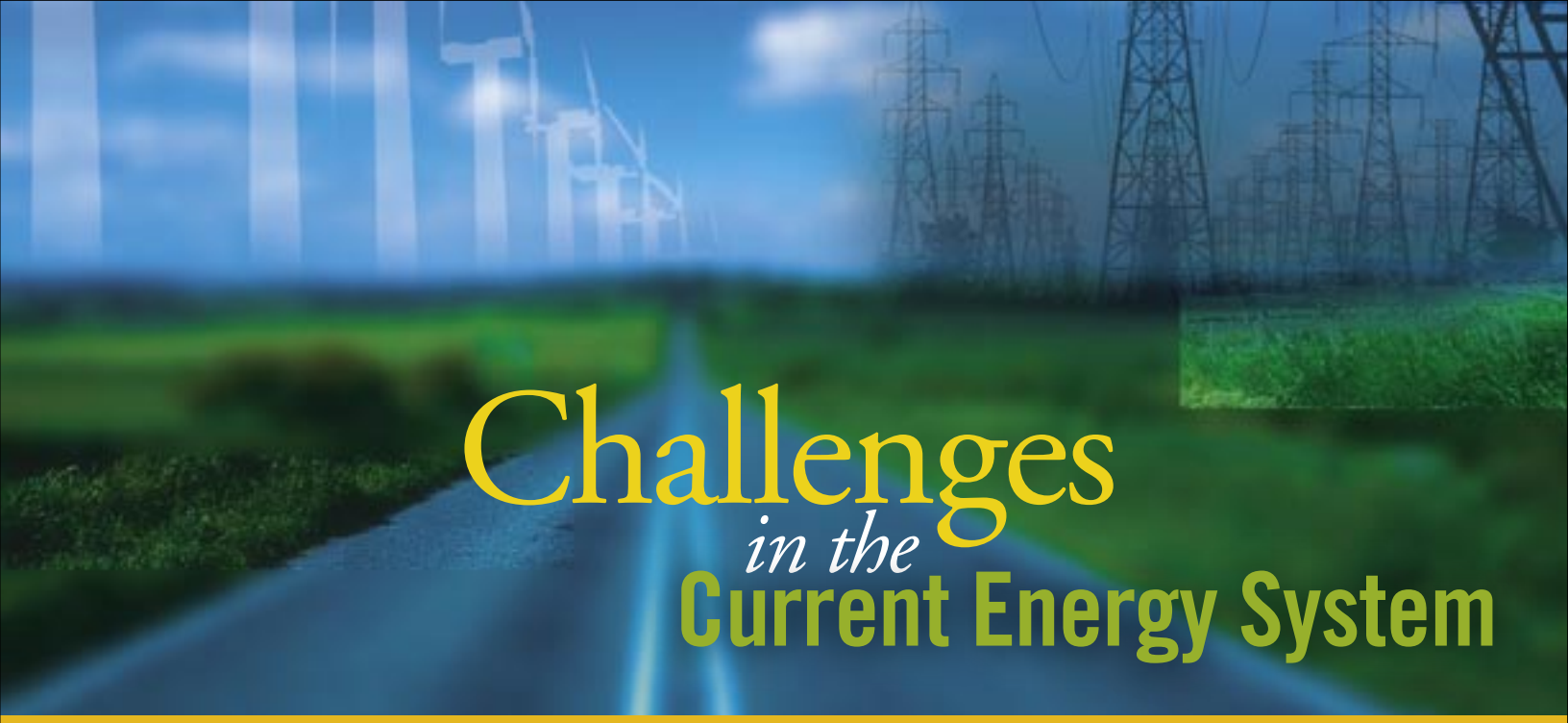
To develop a roadmap for meeting this challenge, over the past year the Center for Strategic and International Studies (CSIS) and the World Resources Institute (WRI) jointly explored paths to a secure, low-carbon energy system. In particular, the authors have tried to reconcile tensions between the goals of achieving energy security (defined for this process as the availability of adequate, reliable, affordable energy[2]) and reducing the threat of climate change. Technologies, policies, and regulations that help achieve one goal may not contribute to the other. Indeed, some solutions may exacerbate other problems (see Box 1). To avoid unnecessary and dangerous tradeoffs, policymakers should follow the roadmap in its entirety and not pick and choose among the recommendations.

This roadmap has been informed by input from energy, climate, national security, and economic experts from academia, business, government, non-profit organizations, and international institutions. The authors are grateful for their input but take full responsibility for the following recommendations. These recommendations differ from what either CSIS or WRI would have developed on its own, reflecting the common ground between two different constituencies on these important issues.[3] This document reflects our commitment to hashing out solutions to difficult problems and to demonstrating that these goals can and should be integrated to ensure that both are met successfully.

A transition of this magnitude will require that policymakers:

- establish a long-term vision for the future;
- put the U.S. on the right path by updating energy policies and incentives; and
- continue to meet U.S. energy demand while addressing the tradeoffs between climate change and energy security that occur during this transition.

Implementing these recommendations will require the Obama administration and Congress to think comprehensively, take aggressive action, pay sustained attention, and engage globally. In short, it will require unprecedented levels of leadership.



Challenges *in the* Current Energy System

Energy's Critical Role, and Why it Must Change

Access to energy shapes the global economy and social development. Indeed, energy powers our daily lives; it runs our factories, fuels our vehicles, and heats and cools our homes and businesses. The stability and reliability of the energy system only becomes more important as society becomes more dependent on electronic data and services.

The United States cannot, however, take the continued availability of affordable energy for granted. Recent trends in energy markets suggest that the current trajectory is unsustainable and undesirable. Prices have become volatile and supplies tight. Before the economic crisis, demand was growing while excess capacity was shrinking. Whether the economy recovers in one year or five, the fundamentals won't change. Conventional supplies are increasingly concentrated in volatile regions of the world. Investors see heightened geopolitical risks undermining efforts to ensure the uninterrupted production and delivery of energy supplies and to build and maintain infrastructure. U.S. influence in global energy markets is eroding due to the emergence of important new players like China, India, and Russia. All of these factors threaten U.S. energy security.

At the same time, the energy sector is a major contributor to our changing climate. Worldwide, 61 percent of greenhouse gas (GHG) emissions are linked to energy production, delivery, or use.[4] In the U.S., the energy sector is responsible for 86 percent of GHG emissions.[5] To avoid

> *Without energy there is no economy. Without climate there is no environment. Without economy* and *environment there is no material wealth, no civil society, no personal or national security. And the problem is that we have been getting the energy our economy needs in ways that are wrecking the climate that our environment needs.*
>
> — **JOHN P. HOLDREN,** National Science Advisor

catastrophic increases in global temperatures, these emissions must peak within a decade and then decline rapidly.[6] The U.S., however, still lacks a comprehensive federal program for limiting emissions, although some cities, states, and regions have taken preliminary steps.

Given these challenges, it is clear that our energy system – which evolved in a world very different from today's – must undergo a radical modernization. The market can no longer count on inexpensive and abundant supplies. Nor can the social and environmental costs of energy production, transport, and use continue to be ignored.

Transforming the energy system, however, cannot happen overnight. It will require new – and often disruptive – technologies. It will require taking steps to ensure that the energy system remains structurally sound and economically viable during potentially difficult transitions. And although modernization poses a significant economic challenge, it also offers a clear opportunity for the United States and other global players to sustain economic growth while shifting energy priorities in favor of greater efficiency and low-carbon fuels. Seizing this opportunity will fundamentally alter the geopolitical, economic, and environmental dynamics of what appears to be an increasingly challenging future.

Emerging Energy Trends

Over the next 25 years, the world population is projected to grow to almost nine billion people.[7] Living standards are expected to rise, and society will need more basic resources – including food, water, and energy – to fuel and sustain this expansion.

The current global economic crisis is adding an element of uncertainty to short-term energy forecasts, and is likely to influence near-term political and economic decisions (see Box 2). The crisis, however, is unlikely to alter the basic outlines of the long-term energy picture. Regardless of economic swings, the following energy trends pose fundamental – and daunting – challenges to the United States and the world:

Increasing Demand, Fewer Oil Suppliers

Absent major shifts in policy, global energy demand will increase approximately 45 percent between 2006 and 2030, according to forecasts by the International Energy Agency (IEA). Developing economies will account for nearly 87 percent of this growth, with just two nations – China and India – accounting for 51 percent.[8] The current mix of fossil fuels – coal, oil, and natural gas – is projected to meet much of this increased demand. These fuels would be supplied by many of the same nations that provide today's energy.

For oil, however, the forecast calls for tighter supplies and greater dependence on fewer suppliers -- ultimately leading to higher prices. Prior to the current economic crisis, projected growth in energy demand suggested an ever-tightening oil market, with some analysts forecasting a significant gap between global supply and demand.[9] While the economic downturn has reduced oil prices and projections for near-term demand growth, lower prices will also decrease new supplies and investment, and lead to a resurgence in energy demand. In the future, the leveling off of Russian output, coupled with production declines in the North Sea, the U.S., and Mexico, will increase the leverage

BOX 2. Energy and the Economic Crisis

Potential impacts of the economic crisis include:

- Lower energy demand, but also delayed supply investments
- More difficulty acquiring capital for projects
- Lower prices for materials due to cancellation of projects
- Pressure on public financing
- As cost of energy goes down, easier to implement carbon price
- If economic crisis impacts household spending, harder to implement carbon constraints

Examples of potential new challenges:

- Renewable energy projects could have trouble finding funding.
- The economics of enhanced oil recovery projects may be more challenging due to a significant drop in oil prices.
- New technology ventures like carbon capture and storage (CCS) that require major federal support and private investment may not be demonstrated and deployed.

SOURCE: Michael Schewell of McGuire Woods, On-Point, E&E TV, 10/16/2008, http://www.eenews.net/tv/video_guide/878?sort_type=date&page=4

of a small number of major oil producers, most notably OPEC nations.[10] These producers have different agendas and production policies and are focused on maximizing their revenues and political influence – even if at the expense of the United States and other importing nations.

Energy is Getting Harder to Produce and Move

The world is not running out of energy. But it is becoming more difficult to access, produce, and convert energy resources and deliver them to the people who need them. For instance, supplies of oil, natural gas, and coal are increasingly located far from demand centers. Moving these products requires an increasingly complex delivery infrastructure that increases vulnerability to disruptions. The adequacy and security of this infrastructure, which is already transporting large volumes of oil and gas over long distances through increasingly crowded transit points, is a critical concern.[11]

High-carbon unconventional forms of energy are not viable replacements. The Western Hemisphere, for instance, is rich in unconventional fuels such as oil sands, oil shale, and extra-heavy oil deposits, as well as coal, which can be used to make liquid fuels. From an energy security point of view, the presence of these unconventional reserves adds some comfort for the U.S. But these supplies will be costly to develop, and present sizeable environmental challenges, including significantly higher carbon dioxide emissions relative to conventional fossil fuels.

Energy Markets Are Becoming More Volatile, Creating Uncertainty

Over the past year, energy markets have experienced periods of volatility not seen since the first Gulf War in 1991.[12] And although most analysts foresee lower prices in the near term, they see increasingly high future prices, given expected growth in demand.[13] This volatility creates uncertainty that hinders investment and long-term business planning – particularly in an economy accustomed to cheap energy. It also threatens to increase public pressure for counterproductive government policies. For example, when energy is already unaffordable, governments may subsidize the price of fuels and/or electricity. These subsidies, in turn, mute consumer response to prices, reducing incentives for energy efficiency and placing further pressure on government budgets.

Geopolitical Dynamics Are Shifting, Challenging Existing Institutions

Recent high energy prices have contributed to a tendency for national governments to exert greater control over energy resources. This "resource nationalism" has heightened geopolitical tension, slowed public and private investment, and caused prices to increase even more. In a dramatic shift from previous decades, national ministries and national oil companies (NOCs) now control over 80 percent of global conventional oil reserves and their share of world oil production is expected to rise from 57 percent today to 62 percent by 2030.[14] Some nations, most notably in the Middle East, have prohibited foreign investment in their energy sectors, while others have demanded a greater share of control or revenues.

These shifts have highlighted growing questions about the relevance and effectiveness of existing international trade and security institutions. Many of these institutions are the product of a post-World War II order that reflected a decidedly different time and place. Now, the emergence of new global players with different cultures, business practices, and foreign policy agendas have left these institutions struggling to adapt to changing circumstances. The IEA, for instance, is grappling with how to draw in major new consumers like China and India that are not OECD members. The United Nations is attempting to address the energy and environmental concerns of its diverse member nations. Regional and global treaty organizations – including the World Trade Organization (WTO), the Economic Commission for Europe (ECE), and the Association of Southeast Asian Nations (ASEAN) – are now pressed to expand their traditional mandates to include increasingly complex and expensive endeavors.

Other geopolitical and diplomatic developments further complicate the international landscape. Over the last several years, numerous energy initiatives have been established. Energy-focused political agreements such as the Energy Charter;[15] technology cooperation initiatives like the Carbon Sequestration Leadership Forum;[16] and organizations that engage non-state actors like the philanthropic community add a significant number of new

voices. A variety of additional factors affect the dynamics behind public and private sector decision-making. These include the changing role of geopolitical alliances in forming energy deals (e.g., Venezuelan state-to-state agreements); poor governance and political instability; security threats to facilities, infrastructure, and transit areas; and a greater focus on human rights, environmental degradation, poverty alleviation, and energy access. All of these factors can complicate or delay energy investments, driving energy prices higher, increasing market volatility, and increasing government concern about immediate and long-term energy security.

For years our efforts to address the growing climate crisis have been undermined by the idea that we must choose between our planet and our way of life; between our moral duty and our economic well being. These are false choices.

— **AL GORE** Former Vice President

Anticipated Impacts of Climate Change Are Growing More Severe

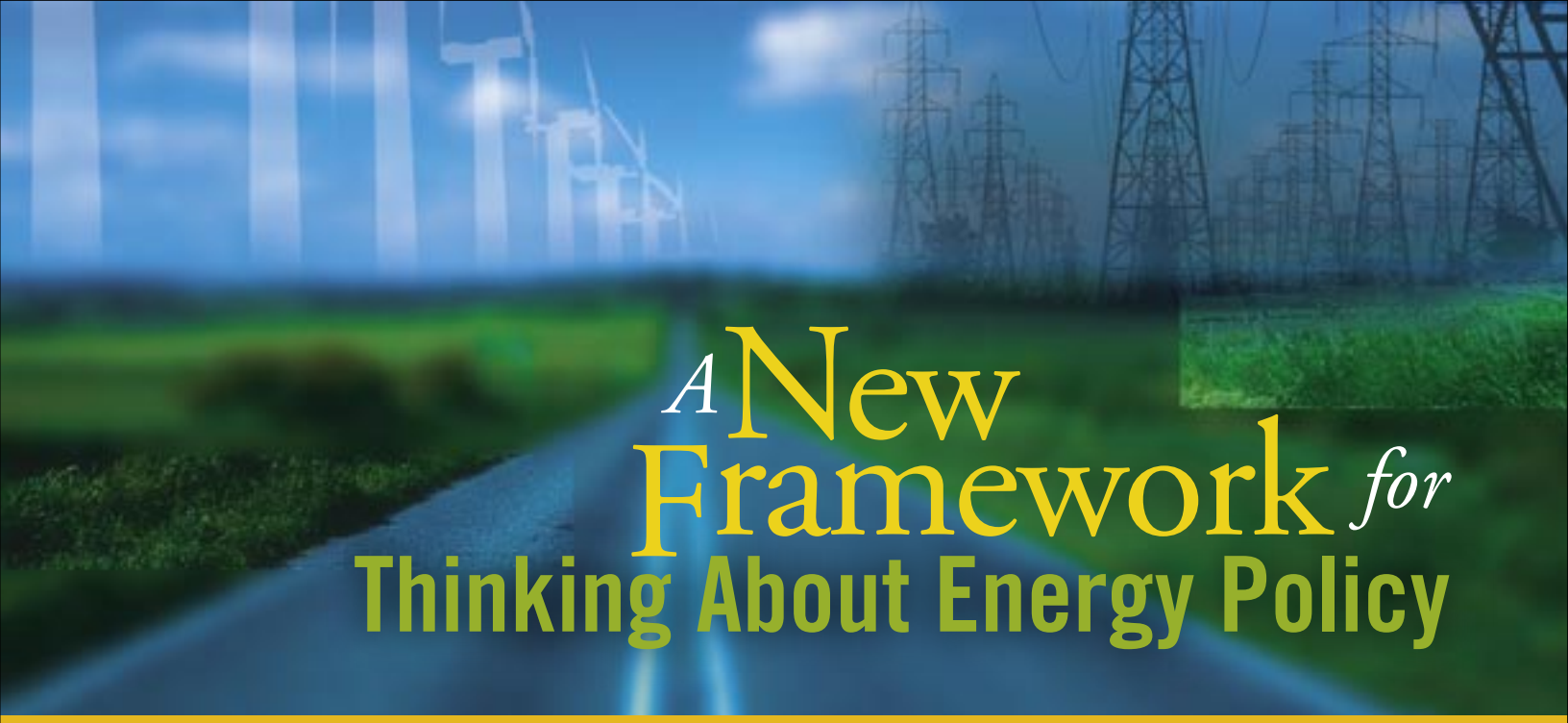
The international community has agreed that atmospheric concentrations of greenhouse gases must be stabilized at a level that prevents a dangerous change in climate.[17] Recently, it has been suggested that to avoid such changes, average global surface temperatures should not rise more than two degrees Celsius.[18] Beyond that level, widespread impacts are expected on food and water supplies, weather patterns, ecosystem stability, and, in turn, on national economies.[19]

Preventing that harm will require fundamentally transforming the energy system. While these changes are likely to be expensive, studies have concluded that ignoring the problem will cost even more. The Stern Review, for example, concluded that "if we don't act, the overall costs and risks of climate change will be equivalent to losing at least five percent of global GDP each year, now and forever."[20] The same study estimates the cost of GHG emissions mitigation to be between one and two percent of GDP per year.[21] Moreover, even ignoring climate change, simply meeting global demand for energy would require a more resilient and sustainable system.

Global Economic Crisis

The past year's global economic crisis adds uncertainty to the energy outlook. While the economic recession is slowing energy demand, limited access to private capital is also likely to delay investment in energy production (see Box 2). Most analysts agree that the underlying trends listed above will prevail over the long-term,[22] but the economic and political implications of the economic crisis could alter near-term decision making.

Many of these trends have existed for some time, but until recently policymakers have not seen them as parts of a coherent challenge requiring sustained policy attention. The next U.S. administration must consider the transformation of the energy sector in the context of these climate and energy security challenges, grounded in today's realities, and with a strategic approach to the future. This roadmap proposes such an approach – a three-part framework for approaching the world's energy security and climate change challenges in an integrated way, while recognizing that both are closely intertwined with the global economy.



A New Framework for Thinking About Energy Policy

The new U.S. presidential administration will be at the forefront of a long-term energy transformation. New energy projects take years to complete; once built, facilities have life-spans of decades or more. Therefore, significant changes to the energy system, much like changes to the climate, will happen over the course of decades and even centuries, timeframes completely outside political horizons.

This roadmap is designed to help policymakers put the U.S. on a path to a secure, low-carbon energy system while managing the difficulties likely to arise along the way (see Box 3). It does so by creating a three-part framework for navigating this transition. The United States must:

1. **Establish a vision for the future.** Articulate a long-term vision for energy security and climate change against which all policies will be measured.
2. **Put its energy system on the right path.** "Reset the system" by updating policies and incentives to promote secure, low-carbon technologies and practices.
3. **Manage the transition.** Continue to meet and manage U.S. energy demand while addressing the tradeoffs that occur during this transition.

Within this framework, CSIS and WRI propose a series of specific policy recommendations for the incoming U.S. administration and Congress, including a number of actions that policymakers can take immediately.

BOX 3. Navigating the Energy Transition: Guiding Principles

In 2008, CSIS and WRI convened energy, climate, national security, and economic experts to discuss the principles that should be used to evaluate energy policies. The following criteria emerged from those discussions (see "Managing the Transition to a Secure, Low-Carbon Energy Future," a 2008 CSIS/WRI publication outlining these principles).

POLICIES MUST BE:

(1) Effective - Able to limit and adapt to global climate change and secure adequate supplies of reliable and affordable energy

- Adopting a global and integrated approach
- Promoting but dependent on technology breakthroughs
- Applicable to a robust range of future scenarios and adjust to evolving circumstances

(2) Politically Feasible - Supported by a number of political constituencies and able to build broad political consensus

- Based on an appropriate time horizon
- Recognizing costs
- Integrated with other political priorities
- Creating space for development needs

PART 1

Establish a vision for the future

Articulate a long-term vision for energy security and climate change against which all policies will be measured.

After World War II, global leaders had a vision of creating greater economic security through a liberalized economic system. To realize that vision, they established the Bretton Woods system – rules to guide the commercial and financial relations of major industrialized countries. Over time the rules have changed to reflect new dynamics, incorporate new members, and respond to new information and a better understanding of global economic activity. However, the key principle of greater economic efficiency, security, and prosperity through free markets and global trade still prevails and is broadly applied to other areas of policymaking.

In much the same way, the incoming administration should clearly articulate a long-term vision for a secure, low-carbon future. It can set forth the architecture and the framework, and help generate the political will, public support, and commercial rationale needed to transform the current energy system. And, as with the global economy, the vision set forth at the outset is not likely to be perfect. It will need to be revised as time and experience dictate. A clear goal and commitment, however, is needed to inform the development and implementation of consistent policies.

A compelling vision for a secure, low-carbon energy system would be one in which:

> *Energy is produced, delivered, and consumed without releasing harmful greenhouse gases into the atmosphere. Society has adequate, affordable, and reliable energy to sustain improved standards of living. Communities are unaffected by global climate change because of successful efforts to mitigate emissions and adapt to unavoidable impacts. New technologies and fuel sources provide the basis for economic opportunity. The diversity of energy sources and suppliers alleviates the geopolitical tensions associated with competition for fossil fuel resources today.*

The practical reality is that many political visions go unmet. Success will require clear and convincing action. The following steps should be taken to implement this global vision.

Making progress on energy and climate will require greater public understanding of the challenges we face, the sacrifices that must be made, and the opportunities that lie ahead. Any new policy initiatives must be accompanied by a coordinated effort to communicate directly with the American public about the role they will play in helping to reach these goals."

—**SAM NUNN,** Cochairman and CEO of the Nuclear Threat Initiative (NTI) and former U.S. senator from Georgia

■ RECOMMENDATION 1:

Integrate energy security and climate change priorities into all aspects of domestic and international policymaking.

It is not enough to pass energy or climate legislation, to sign long-term international commitments, or to establish domestic targets and timetables. Supporting a long-term vision requires metrics to evaluate progress toward this vision, followed by incorporation of the vision into all aspects of governing, including economics, trade, agriculture, labor, development, land-use, transportation, and foreign policy. For example, this vision should be central in designing upcoming economic stimulus efforts. Responsibility for executing this vision must be shared by all branches of government, including states and local jurisdictions, the public and private sectors, international partners, and individual citizens.

FIRST STEP – The administration, acting in consultation with Congress (see Box 4), should articulate the long-term energy and climate vision in a public process, along with metrics to gauge success. To coordinate action and track progress toward this vision, the new White House energy and climate change coordinator should build upon the Climate Change Policy and Program Review interagency committee structure.[23]

BOX 4. Governance and Process

The U.S. administration (through specific agencies within the Executive Branch), Congress, and civil society all have an important role to play in implementing the steps in this roadmap. Historically, energy policy in the U.S. has been a byproduct of prevailing economic, foreign, security and environmental policy choices and circumstances. The development and passage of policy is frequently piecemeal and suboptimal, due to the overlapping and sometimes contradictory responsibilities of cabinet agencies and Congressional committees, and complicated and time-consuming legislative procedures.

This roadmap generally does not assign specific roles and responsibilities to those implementing these recommendations. Offering such details often leads to disputes about jurisdiction that bog down substantive policy discussions. It is urgent, however, that the President and Congressional leaders explore options for streamlining energy policymaking. Such options might include the use of joint and concurrent committee referrals, or the creation of an *ad hoc* committee representing all relevant interests. This group would be empowered to resolve conflicts on major legislation traditionally assigned to multiple committees, thereby accelerating the process for passing multi-faceted legislation.

Such committees and task forces should conduct their activities in a transparent and inclusive manner. Open deliberations enable the participation of all relevant experts as well as public debate on the economic and social trade-offs of various policy choices.

SOURCE: Moncel, R. (2008). "Presiding with Principle: Restoring Good Governance in the U.S. Executive Branch, and Why Voters Should Care," Washington, DC: World Resources Institute.

PART 2

Put the U.S. energy system on the right path

"Reset the system" by updating policies and incentive systems to promote secure, low-carbon technologies and practices.

To make the U.S. economy less vulnerable to energy security and climate change concerns, policymakers must replace the complex web of political and economic incentives that have created these vulnerabilities with policies that promote technologies and practices in line with the long-term vision. This will involve internalizing the societal cost of energy options and the security risks of our current energy system. The right economic and political signals can unleash the power and innovation of the private sector, yielding both reductions in greenhouse gas emissions and new sources of low-carbon energy. Incentives, subsidies, and regulations are set at the federal, state, and local levels. It will be important for the new administration to recognize the role of these actors and seek to make policies consistent without discouraging innovation (see Box 5).

Positioning the United States to achieve significant emissions reductions requires measures that "push" technology innovation through direct investment, and policies that "pull" innovation in the right direction through market signals, standards, and incentives. Economic analysis shows that incorporating both "push" and "pull" policies costs less than relying on either approach alone.[24] Energy and climate change policy will be most efficient if policies that impose a cost for carbon are combined with complementary policies (such as performance standards and incentives), and the public is committed to financing energy investments in cooperation with businesses. Without these structural changes, the more targeted policy efforts described later in this roadmap will not produce the needed scale of overall shifts in public and private investments.

BOX 5. The Role of State and Local Leadership

For the last several years states and local communities have led U.S. action on climate change and pioneered new programs for low-carbon energy promotion. Around the country, regional groups of states have formed climate partnerships to develop and implement coordinated cap-and-trade programs. Other states and local communities have instituted climate action plans, renewable portfolio standards, and other programs that go beyond what is mandated at the federal level.

The new administration is likely to be much more aggressive on many energy and climate policies than the previous one. Such aggressive action, however, will raise questions about federal preemption of state programs in the name of national consistency. While some level of consistency is critical for businesses operating across state lines, the federal government should recognize the enormously important role that states have played – and can continue to play – in energy and climate policy. The new administration will need to find an appropriate leadership role for states, harnessing their political will and innovation, and recognizing the progress they have made.

SOURCE: Litz, F., K. Zyla (2008). "Federalism in the Greenhouse: Defining a Role for States in a Federal Cap-and-Trade Program," Washington, DC: World Resources Institute.

■ RECOMMENDATION 2:
Establish a price on carbon throughout the U.S. economy.

The most efficient and cost-effective way to reduce GHG emissions is to establish an economy-wide price for carbon, allowing reductions to be achieved wherever they can be found at lowest cost. It is impractical to expect society to value emissions reductions in the absence of such a price.

Higher prices could reduce energy security if energy becomes unaffordable for some subset of the population, or if less secure fuel sources are given an advantage over more secure sources (see natural gas and coal discussion later in the roadmap). However, a price on carbon can increase energy security by increasing energy efficiency and promoting greater fuel diversity through new technologies and energy sources.

Recent studies indicate that dramatic increases in the deployment of low-carbon technologies could be achieved at a price of approximately $50 per metric ton of carbon dioxide.[25] An explicit price on carbon need not reach $50/ton to have an effect (other incentives can contribute to making low-carbon technologies more competitive). A carbon price can, however, incorporate a technology's emissions profile into its price, encouraging investment in low-carbon technologies and energy efficiency over high-carbon alternatives.[26]

Whether based on a cap-and-trade program or a carbon tax,[27] domestic climate change policy should send a stable, long-term price signal that increases over time, providing businesses with guidance in making long-term investment decisions. The policy should establish a clear and straight-

forward framework with long-term as well as incremental goals, allow adequate time for capital stock turnover, and ensure compatibility with regional and state-level programs already underway to reduce uncertainty for businesses.[28]

While any federal carbon tax or cap-and-trade program will take several years to plan and execute, it is likely to generate a significant amount of money. These revenues should be used in ways that are aligned with the long-term vision and help manage the process of achieving it. For example, funds could be used to offset the higher cost of energy for low-income households; to pay for energy technology research, development, and deployment (RD&D), technology transfer, and adaptation measures; and to smooth the transition for competitive industries.

FIRST STEP – Outline the new priorities for a domestic climate change program and work with Congress to ensure passage of legislation that limits GHG emissions while recognizing the energy security concerns of doing so.

■ RECOMMENDATION 3:
Establish a public financial commitment to the energy security and climate change challenges.

Tackling energy security and climate challenges will cost money, but these expenditures could pay off in the long term, and the cost of inaction will be significantly higher. Investments could yield lower energy costs, reduced energy market volatility, more efficient transport, upgraded infrastructure, and more energy-efficient homes. In fact, studies indicate that investments in energy efficiency improvements involve "net negative costs" – more money is saved than invested.[29] Significant public spending on infrastructure, such as recent stimulus proposals, is often controversial,[30] but can also help jump-start the economy.[31]

In particular, the administration should commit to long-term, adequate funding in four areas that support both climate change and energy security goals. These are:

- energy infrastructure;
- job training for the low-carbon energy industry;
- adaptation to climate change; and
- research, development, and demonstration of efficient and low-carbon technologies and fuels.

Worldwide, studies suggest that investing an extra $800 billion to $1.3 trillion annually in energy technologies could put emissions on a path to limit global temperature rise within 2 to 2.4 degrees.[32] Other studies suggest new investments in cleaner energy could help create 2.5 million new jobs in the U.S. by 2018.[33] In general, however, public spending will pale in comparison to the potential investments of private companies. Therefore – especially in light of the fiscal challenges facing the new administration – it should use federal support to leverage greater private sector investment and innovation.

New federal spending commitments should:

- ***Modernize and improve the efficiency of energy infrastructure***

  Much of the national public infrastructure is aging, inefficient, and reliant on high-carbon fuels. The new administration should look for ways to encourage public–private partnerships to create new and improved infrastructure, as proposed for a potential economic stimulus package. It should start by seeking to improve the efficiency and capacity of the country's electrical transmission system, and to modernize public transportation. Such a partnership should have clear upfront rules with respect to spending to ensure taxpayers get full value for their investments. One type of innovative public–private financing mechanism that deserves further consideration is outlined in 2007 legislation that would have created a National Infrastructure Bank. Such a Bank would allow the federal government to finance projects of substantial regional or national significance more effectively.

- ***Invest in worker training***

  There is a shortage of skilled labor in all parts of the energy industry. To seize the opportunities presented by the modernization of the energy system, American labor, and particularly workers in carbon-intensive manufacturing, must not be left behind. A federal financial commitment to workforce education and retraining will allow these workers to compete and profit in the new economy. The federal government should also invest in future generations of workers by offering more robust science, math, and engineering educational paths. This can be accomplished through existing worker training programs or through various innovative mechanisms to create stronger curricula and research and teaching opportunities for students in these fields.[34]

- ***Increase financial and technical support for adaptation to climate change***

  Considerable climate-related changes have already occurred, and additional impacts are unavoidable.[35] The world must be prepared to spend considerable sums of money addressing these impacts, including food and water shortages, more extreme weather patterns, and ecosystem instability. Billions of investment dollars

annually will be needed in the United States alone. Global cost estimates are in the tens of billions, and have been increasing as more is learned about the scale of climate change impacts.[36] It is important that a new administration understand the dangers of climate change impacts and make addressing them a national priority. The administration must prepare the American public, state and local governments, and our federal emergency management services to assist with adaptation.

- ***Increase Funding and Improve Spending for Low-Carbon Energy Technology Research, Development, and Demonstration (RD&D)***

  The U.S. Department of Energy currently spends approximately $3 billion per year on energy RD&D, less than half of what it spent 30 years ago.[37] Technological advances can improve efficiency, reduce pollution, reduce costs, and provide greater diversity in energy supplies. By developing and deploying cleaner, more efficient technologies, society can reduce the costs of GHG emissions reduction.[38] Despite widespread criticism of the federal government track record in energy RD&D, several studies conclude that RD&D funding should be ramped up dramatically, two to three times higher than current levels, and sustained through at least 2030.[39]

How the government invests its research dollars matters just as much as the amount of money it spends. Given the nature of the government budgeting process, federal RD&D spending has been inconsistent, highly politicized, and poorly managed.[40] A new administration should ensure greater funding consistency as well as provide the research community with greater flexibility to follow promising leads in the RD&D process (see Box 6).

FIRST STEP – The new administration should ensure that investments in low-carbon energy and efficiency are executed through a combination of direct grants, funding to states, federally backed loan guarantees, and public–private partnerships. Likewise, it should ensure that such programs are managed through institutions with the capacity to assess the long-term value of projects and to encourage private-sector spending.

RECOMMENDATION 4:
Provide private-sector energy incentives to promote low-carbon fuels and technologies, and remove barriers to their deployment.

The current mix of regulatory regimes and incentive structures favor conventional fuels and have created significant barriers to new forms of energy that require different production and delivery infrastructure. In addition, the current system of frequently expiring incentives, such as the tax credits offered for energy efficient appliances, inhibits technology progress. The new administration should evaluate the effectiveness of these current regulations and incentives in promoting efficiency, fuel diversity, new technologies and fuels, and reducing greenhouse gas emissions. Successful programs should be extended for a period of no less than several years.

The federal government, however, controls just a subset of clean technology incentives and regulatory barriers. The new administration should work with state

BOX 6. A New Approach to Energy RD&D

The history of energy technology research, development, and demonstration in the United States is one of fits and starts. Policymakers and the private sector often fault the U.S. RD&D system for being underfunded, over-politicized, poorly structured, and poorly managed. Several new ideas have been proposed for carrying out basic energy research, technology development, demonstration, and deployment.[i] Some were modeled after DARPA, the Synthetic Fuels Corporation, or Richard Branson's X Prize, while others simply recommended doubling or tripling the amount of money budgeted for current RD&D programs. Each proposal has strengths and weaknesses. Moreover, each is as likely to fall into the same trap of fluctuating funding levels and inconsistent support for or agreement about the appropriate role for government in RD&D.

Another idea is to add some consistency to the RD&D review process by establishing a Council on Innovation. This independent body of leading scientists and innovators would periodically review government RD&D spending programs and proposed budgets, and release public reports about the quality and adequacy of these programs. The Climate Change Technology Program could provide input to this independent group, based on their review of technology RD&D programs. The Council would report to whomever the new administration puts in charge of innovation policy.

The Council would recommend levels of funding and suggest a mechanism for providing more consistent funding levels, as well as the most appropriate mechanisms for executing the funds. In reality, basic RD&D, demonstrations, public–private partnerships, technology prizes, etc. can all be effective when managed appropriately and given the time to succeed.

[i] A review of various RD&D mechanisms is available at Newell, Richard G., *Climate Technology Research, Development and Demonstration: Funding Sources, Institutions, and Instruments,* Resources for the Future, November 2007, http://www.rff.org/RFF/Documents/CPF_11_IssueBrief_9.pdf. New proposals were offered by Ogden et al. *A New Strategy to Spur Energy Innovation,* Center for American Progress, http://www.americanprogress.org/issues/2008/01/pdf/energy_innovation.pdf.

policymakers and regulators, as well as local governments, to shape comprehensive and coherent policies. Many of these entities are far ahead of the federal government and would welcome greater federal action and leadership.

FIRST STEPS – Work with states to align private-sector economic and financial incentives and remove barriers at the state and national levels to promote investments in low-carbon energy technologies. Work with the Treasury Department on its implementation of financial incentives such as loans guarantees and grants.

■ RECOMMENDATION 5:
Engage constructively in the development of an effective international response to climate change and energy security concerns.

The new administration should work cooperatively with the global community to address energy security and climate change. Designing the new post-Kyoto policy framework for a carbon-constrained world offers a unique opportunity to alter the geopolitics of energy, promote innovation and entrepreneurialism, and engage rapidly developing countries in mitigation and adaptation efforts. U.S. international engagement should be designed to address domestic concerns over energy security and competitiveness, foster international cooperation, and facilitate development paths that are compatible with energy security and climate goals.

For the last eight years, the United States has been the single largest barrier to an effective international agreement on climate change. The new administration must engage effectively in international climate negotiations, and commit to a solution consistent with a long-term vision for a secure climate as agreed in the United Nations Framework Convention on Climate Change in 1992. The U.S. should work to ensure that a new agreement can successfully and seamlessly follow from the end of the first commitment period of the Kyoto Protocol in 2012. A successful agreement will need to include:

- significant commitments to GHG emission reductions from developed countries;
- nationally appropriate mitigation actions from emerging economies, including reducing emissions from deforestation; and
- developed country support for mitigation and adaptation in developing countries in the form of finance, technology transfer, and capacity building.

The new administration will need to start working with Congress early in its term to enable it to approach international negotiations with confidence about its ability to make domestic commitments to reduce emissions, promote international technology development and deployment, and provide funds for developing country adaptation measures.

We must redefine economic multilateralism beyond the traditional focus on finance and trade. The changing world economy demands that we think more broadly. Today, energy, climate change, and stabilizing fragile and post-conflict states are economic issues. They are already part of the international security and environmental dialogue. They must be the concern of economic multilateralism as well.

— **ROBERT ZOELLICK,** President of the World Bank

A new international climate change agreement, even if successfully negotiated, will not represent the totality of actions required to achieve an integrated global solution to climate and energy security. An adequate U.S. response to climate change will also require engagement on technology cooperation with developing and developed countries, and within key sectors such as energy, transport, and industry. A number of bilateral and multilateral agreements will be needed (see Box 7), as well as financial assistance programs to serve as supplements to any international treaty; these will help direct new technology investments as well as provide technical and financial assistance to ameliorate climate change impacts.

U.S. international energy policy currently focuses on supporting increased supplies, as well as promoting access to markets through improved global trading for energy goods and services. While environmental priorities are sometimes part of the discussion, climate change and the need for a

BOX 7. Opportunities for Strategic Partnerships

It is critical for the United States to engage the global community as it works to address energy security and climate change. No one country can address these global challenges alone; nations will need to work together to bring about needed technology and policy changes. The United States can leverage the strengths and leadership of other countries through strategic partnerships, including:

SECTORAL TARGETS: U.S. AND CHINA

Bilateral technology cooperation between two of the world's major economies and its two largest GHG emitters will be central to a globally successful international climate change agreement. In a world where emission reductions in the U.S. can easily be outstripped by emissions growth in China, technology cooperation is in everyone's interest. Technology can be jointly developed with appropriate attention given to shared intellectual property rights. New sectoral technology cooperation arrangements can provide a tool for sharing knowledge and technology experience, and support common action within potentially competitive sectors. Models like the Asia Pacific Partnership (APP) could serve as a starting point; these arrangements could usefully be broadened (e.g., to include Europe), and must be funded consistently and ambitiously to be fully effective. While rapidly emerging developing countries like China have opposed mandatory sectoral emissions reduction targets, they are active participants in the APP and have indicated their interest in continuing to participate in such learning and information-sharing mechanisms.

CARBON CAPTURE AND STORAGE: U.S. AND CANADA

Canada and the United States share an integrated energy market and infrastructure for natural gas, electricity, and oil. Canada is the largest supplier of energy to the United States and these supplies are an important source of U.S. energy security. The Canadian oil sands are a growing part of U.S. oil supplies. In an effort to reduce the high GHG emissions associated with oil sand production, Canada has instituted aggressive carbon capture and storage (CCS) goals.[i] These commitments suggest Canada could have large-scale CCS deployment before the United States. The United States should expand its partnerships with Canada to promote large-scale CCS and learn from Canada's experience addressing the technical, legal, and regulatory challenges. While sequestering the carbon dioxide associated with oil sands production is challenging (and does not address post-combustion/end use emissions), Canada's substantial oil sands resource and its commitment to address climate change give it a strong business case to find a way to sequester carbon dioxide. Other countries, such as the United Kingdom and Germany, are also investing heavily in CCS and should be viewed as possible partners for technology cooperation.

ENERGY EFFICIENCY: U.S. AND JAPAN

Japan is one of the most energy efficient countries in the world and has a proven track record of driving efficiency improvements year after year. The United States should work with Japan to craft a global energy efficiency partnership, based on the current Asia–Pacific Partnership on energy intensity improvements. Japanese leadership on energy efficiency, if appropriately mapped into U.S. policy, could drive significant energy efficiency improvements; jointly the two countries could help serve as a worldwide model of how to succeed in this arena through fora such as the G20, the UNFCCC, the Energy Charter, and other bilateral and multilateral processes. The International Partnership for Energy Efficiency Cooperation (IPEEC), announced at the 2008 G8 Summit, could provide an effective vehicle for this type of cooperation.[ii]

[i] *Environmental Challenges and Progress in Canada's Oil Sands,* Canadian Association of Petroleum Producers, p. 5, http://www.capp.ca/raw.asp?x=1&dt=NTV&e=PDF&dn=135721
[ii] Summit declaration, http://www.enecho.meti.go.jp/topics/g8/ipeecsta_eng.pdf

broad transformation of the current energy system are not. The new administration should highlight these issues.

On issues of energy supply and trade, the U.S. should work with others, including through the IEA, Asia Pacific Economic Cooperation (APEC), North Atlantic Treaty Organization (NATO), and other bilateral and multilateral arrangements, to ensure:

- the shared protection of sea lanes and critical energy infrastructure;
- investment-friendly regulatory and legal frameworks that also respect the development needs and sovereign rights of energy resource holders;
- regular producer–consumer country dialogues to discuss industry and government challenges and improve energy information sharing;
- better governance and transparency of energy-related revenues; and
- the incorporation of environmental sustainability principles – including climate change – into energy resource development.

In addition, the U.S. should work to ensure that all regional energy partnerships focus on energy security and climate change. The new administration should push international institutions dealing with energy or climate change, such as the International Energy Agency, to integrate both challenges and include major new consumers in ongoing dialogues. The administration should also renew support for regional energy organizations such as APEC, North American Energy Working Group (NAEWG), Latin American Energy Organization (OLADE), and many others, and work through them to find solutions that reflect the current geopolitical realities of energy production and trade.

FIRST STEPS – In bilateral discussions and international meetings, elaborate U.S. support for an international climate change agreement under the UNFCCC. Initiate discussions with the U.S. Congress on the links between domestic and international policies, including management of Congressional expectations for developing country actions to mitigate climate change; and build support for technical, financial, and capacity-building assistance (e.g., training and education) for developing country programs.

■ RECOMMENDATION 6:

Invest in infrastructure and technology necessary to transform the transportation system while promoting denser, more transit-friendly land use patterns.

Emissions from the transportation sector result from the combination of three factors: how much and how far people drive (or goods are driven), also known as vehicle miles traveled (VMT); the efficiency of the vehicle itself (fuel economy); and the carbon content of the fuel. Achieving significant GHG emissions reductions in the transportation sector will require addressing all three.[41]

The current U.S. transportation system is the product of decades of significant private and public sector investment. The public and private sector will need to make major new investments to ensure reliable and affordable transportation services while transforming the sector. The economy-wide price for carbon recommended earlier in the roadmap will not be sufficient for making the necessary transition in this sector,[42] and must be supplemented with complementary policies to drive greater efficiency, lower-carbon fuels, new technologies, smart growth strategies, and better consumer choices.

On the technology and fuels sides, there are clear pitfalls to avoid. In particular, the world must steer clear of pathways that move to unconventional liquid fuels (e.g., oil sands, coal-to-liquids, and corn-based ethanol), which while often touted as replacements for oil, do not offer the promise of long-term security and low emissions. Furthermore, while the new administration must recognize the need for near-term affordable and reliable transportation services, it should not let quick fixes for the current system (like increasing oil supply) delay investment in a more secure, low-carbon transportation system.

The history of federal promotion of alternative fuels and vehicles should provide a cautionary tale for recommending the big bet on one or another of the future technologies/fuels for the passenger car market. This approach has run from methanol twenty-five years ago, through electric vehicles, to hybrid-electrics, then fuel cells, to ethanol just two years ago, to plug-in hybrids today. This has been extremely disruptive and wasteful for the automakers and U.S. taxpayers.[43] Rather than pushing a single fuel or technology, policymakers should set time-bound performance objectives and requirements on a lifecycle basis, and give enough lead time to ensure quality and reliability. However, this does not mean waiting decades for performance improvement: there are advances in conventional gasoline and diesel technology now, as well as in regular hybrids and battery technology, that can yield benefits while more advanced technologies and systems go through product development and demonstration cycles.

Several fuel and technology options have potential as a long-term replacement for oil in light-duty vehicle fleets. However, the infrastructure barriers to adopting new fuels and technologies at a large scale are significant. For this reason, and given the urgency of our climate change and energy security concerns, the new administration should capitalize on opportunities to make infrastructure investments that support non-petroleum options. As recommended in other sections of this roadmap, one of the highest priorities for the U.S. is the creation of a *smart grid* – an upgraded and modernized electricity grid that can also facilitate and support electrified transport solutions. This kind of win-win infrastructure investment will be critical to long-term transformation of the transportation sector as well as supporting deployment of renewable energy sources.

Regarding land-use policy, stimulus or economic recovery plans should be screened for expected GHG emissions and energy-security performance. These two screens will ensure that intelligent transportation systems, smart growth, bike/pedestrian routes, transit system operations, and quality enhancement projects compete equally with construction projects.

There are signs that changes to the system are already occurring. Alternative fuels now make up 3 percent of the transportation fuel mix, compared to 1.3 percent in 2003.[44] The recent debut of plug-in hybrid electric vehicles suggests that while not yet commercial (the Chevy Volt is anticipated to sell for more than $40,000 when it is available in 2011), this technology could help facilitate a transition from petroleum to an electrified transportation system.[45] Cities all over the country are promoting mass transit options and smarter growth strategies.[46] Aggressive policies to transform the system – such as vehicle efficiency standards, low-carbon fuel standards, technology research and development, and incentives to buy more efficient vehicles – should be high priorities.

FIRST STEP – Ensure 2009 federal transportation bill adopts performance targets and post-project evaluation measures of oil consumption and GHG emissions, to hold federal, state, and local projects accountable for the impacts of transportation system projects on energy security and climate change.

PART 3

Manage the transition

Continue to meet U.S. energy demand while minimizing the tradeoffs between climate change and energy security that occur during the transition to a new energy system.

It will take time to build a secure, low-carbon energy system, and tensions between the goals of energy security and climate change may emerge along the way. The policies recommended below focus on these tensions. They can help the U.S. get past cost and technology hurdles that could divert policymakers from reaching long-term goals.

Over the long term, the federal government may not need to provide explicit support for secure, low-carbon technologies and infrastructure, if the price for carbon increases and the costs of these technologies fall. In the near term, however, targeted support for these technologies will be necessary to create a bridge to the future. Likewise, there are higher-carbon fuels and technologies in the energy mix now that will have to be sustained in the short term to maintain stable, affordable energy sources during the transition.

To manage the transition to a low-carbon energy, the administration should:

RECOMMENDATION 7:

Promote energy efficiency, renewable energy, and transmission infrastructure – measures that contribute to both security and climate change goals.

Energy efficiency and renewable energy technologies are the central components of the long-term vision, as they support both energy security and climate change goals. Both, however, will require active public support to overcome barriers to deployment. In the short term, efficiency and renewables will need an extra boost to enable them to compete with conventional fossil-fuel-based technologies.

Energy Efficiency

The new administration already has the authority to strengthen energy efficiency standards for appliances, buildings, and vehicles. The administration should regularly increase these standards and work with state-level organizations to do the same. It should launch a national home efficiency program supported by tax incentives and a public information campaign. The federal government should also lead by using its massive procurement system to purchase energy efficient products and renewable sources of energy. Other potential approaches are explored in Box 8.

BOX 8. Energy Efficiency

Energy experts often herald efficiency as the cheapest and easiest way to reduce demand, lower energy prices, and limit greenhouse gas emissions.[iii] Indeed, the technology already exists to improve efficiency and, in many cases, it can save money for both energy producers and consumers. In addition, efficiency can produce measurable savings quickly – no small benefit in hard times.

But there are many barriers to improving efficiency. Consumers often lack information about efficiency benefits. The technology can have high upfront capital costs. Government tax and regulatory policies – such as a lack of aggressive efficiency standards – can create disincentives for investing in efficiency. Congress and the new administration can remove these barriers by taking a number of actions, including:

- regularly tightening vehicle efficiency standards;
- setting more aggressive building energy codes;
- requiring home sellers to disclose the efficiency of a home;
- requiring regulatory analyses that lead to more aggressive energy efficiency standards for utilities and other players in the energy sector; and
- creating incentives for consumers to buy efficient vehicles and drive less.

[iii] For more information see studies by the American Council for an Energy Efficient Economy, the Alliance to Save Energy and *Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost?,* The McKinsey Global Institute, December 2007, http://www.mckinsey.com/clientservice/ccsi/pdf/US_ghg_final_report.pdf.

■ *Renewables*

Renewable energy is a promising source of low-carbon energy, and can improve energy security by adding diversity and domestic supply to the energy mix. Promoting renewable energy technologies requires a mix of state and federal policies. There is no "one-size-fits-all" approach – each technology faces its own technical and economic hurdles. As a general rule, however, these technologies need long-term, predictable policies that reduce economic uncertainty for investors and developers.[47]

Governments can take a number of steps to reduce uncertainty, including:

- removing non-economic barriers, such as legal obstacles to grid access and financial rules that foster inefficient electricity markets;
- improving worker training;
- sponsoring education campaigns that promote acceptance of renewable technologies;
- creating a predictable and transparent investment framework; and
- offering incentives that are tied to a technology's maturity and promise.[48]

However, renewable energy also raises important – but not insurmountable – energy security concerns that will be discussed in the next section.

■ *Electricity Transmission*

Much of the U.S. transmission infrastructure is aging and congested, affecting the reliability of electricity supplies. To meet energy security and climate change needs, major new low-carbon power generation facilities, as well as smaller and more widely distributed sources, will have to be connected to the nation's electric grids. Plans for a "smart grid" envision a system that seeks out and overcomes reliability issues by digitally connecting energy consumers and producers and automating many of the grid functions that are currently manually operated.

The new administration should continue to streamline the process of siting and building new infrastructure.[49] It should provide incentives for distributed generation, ease congestion through improvements to energy efficiency and "demand response" measures, and pursue development of a "smart grid".

These improvements will not only improve reliability but enable other advances, such as the addition of smaller, widely-distributed low-carbon power sources, and greater use of plug-in hybrid electric vehicles.

FIRST STEPS – Implement more aggressive energy efficiency and renewable energy standards and programs under executive branch control and develop a prompt start to smart grid design. Work with Congress and states to advance new standards, long-term incentives, and support for private sector participation.

■ RECOMMENDATION 8:
Reduce GHG emissions from technologies that contribute to energy security and make low-carbon technologies more secure.

Some of the world's most plentiful and affordable fuels (e.g., coal, oil, and natural gas) also produce vast quantities of greenhouse gases. However, low-carbon energy sources cannot yet fully meet U.S. energy needs,[50] requiring conventional fuels to remain in the mix during the transition. To achieve climate change goals, emissions from these fuels must be managed.

Our push for new clean sources of energy, and greater energy efficiency, does not mean that we can ignore our existing major sources of energy. We must make the transition to an energy future where our reliance on traditional fossil fuels will be lessened. But that transition will not happen overnight. Our energy strategy has to make sure that we have adequate supplies of conventional fuels as we go through that transition.

— **SENATOR JEFF BINGAMAN**

Likewise, low-carbon energy sources – such as some renewables and nuclear power – raise a variety of energy security concerns. While they add diversity to the energy mix, low-carbon sources can have high prices, reliability issues, and complicated infrastructure. The new administration will have to address these security issues as it promotes the new technologies.

- ***Reducing GHG emissions from energy-secure technologies***
  - *Enable continued use of existing fossil fuel electricity infrastructure through carbon capture and storage (CCS)*

    The U.S. has abundant coal reserves and coal currently contributes 50 percent of U.S. electricity supply. It will take time to find scalable alternatives to coal in the United States. Therefore, the transition to low-carbon electricity requires the ability to capture and securely store the carbon dioxide produced by burning fossil fuels (especially coal, but also natural gas). CCS has the potential to preserve the use of coal and other fossil fuels in the electric power mix until low-carbon alternatives are available.

    Although CCS technologies are already in use around the globe, they have not yet been demonstrated at large-scale electricity generation plants, or in a diverse array of geological settings (rock characteristics can make a significant difference in the practicality of carbon storage). To deploy CCS at the required levels, the new administration should support commercial-scale demonstration of integrated CCS projects that employ all capture approaches (pre-combustion, post-combustion and oxy-fuel combustion). Efforts should include retrofitting existing plants, reducing CCS costs by continuing RD&D, and answering remaining technical questions about performance at commercial scales and in different geological settings.

  - *Expand sustainability requirements for biofuels*

    In the transportation sector, biofuels offer an opportunity to reduce the United States' heavy reliance on oil, which currently accounts for 97 percent of fuel use. Recent research, however, suggests that most of today's biofuels increase lifecycle GHG emissions compared to gasoline or diesel fuel.[51] These increases primarily result from direct and indirect land-use changes associated with using land to grow crops for biofuels. Likewise, the type of feedstock used to produce the fuel, its location, and the farming and fuel production methods all have a significant impact on the fuel's emissions. With proper land-use management, options such as cellulosic ethanol (produced from the non-edible woody material in plants) may offer emissions reductions relative to gasoline, but this technology is not yet available at a large scale.

    Instead of seeking to aggressively increase biofuel production through subsidies and tax credits, the new administration should pursue efforts to:

    - clarify the sustainability impacts of different biofuels;
    - develop methods for forecasting biofuel costs and benefits and evaluating long-term sustainability; and
    - identify actions – such as land-use management and processing strategies – that could reduce GHG emissions and other environmental impacts associated with biofuels production.

    In addition, the United States should continue to encourage development and commercial deployment of next generation biofuels that avoid the pitfalls of current biofuels.

- ***Improving energy security characteristics of low-carbon technologies***
  - *Renewable energy*

    The intermittent nature of some renewable energy sources (e.g., wind and solar power) as currently used raises concerns about their reliability. In the context of electric power, finding a way to provide consistent and reliable renewable energy sources (those that can provide baseload power) is the main obstacle to overcoming this energy security concern. Policymakers should link support for renewable energy to modernization of the transmission grid, policies and technologies that improve the intermittency of renewable energy (e.g., energy storage), and support for plug-in hybrid electric vehicles (which provide electricity storage).

  - *Improve the safety, waste management, cost, and proliferation risks currently hindering expansion of nuclear power*

    Nuclear power offers a source of low-carbon electricity that is available at large scale. But a variety of obstacles currently stand in the way of its expansion in the United States. These include the security of facilities, the lack of a long-term solution for waste management, the cost and shortages of materials and labor, and public concerns about safety. There are also serious concerns about the proliferation of materials that could be used to construct nuclear weapons. Many factors affect proliferation, including the technical difficulty of extracting fissile material and the adequacy of safeguards against tampering.[52] Such concerns have focused renewed attention on perceived shortcomings of the international Nuclear Nonproliferation Treaty.

    If nuclear power is to play a major role in the future, the new administration must develop policies to address proliferation and other concerns. Specific needs include:

    - an RD&D commitment to more cost-effective fuel-recycling technologies;
    - establishment of strong, verifiable interim waste-solution guidelines;
    - a commitment to finding a long-term waste storage option that respects the rights of communities located near storage sites;
    - support for deployment of "Generation IV" nuclear reactor technologies that have the potential to make nuclear proliferation more challenging;[53]
    - continued efforts to reform the international system for transporting and recycling spent nuclear fuel; and
    - increased efforts to improve public understanding of nuclear energy technology, safety, costs, and benefits.

FIRST STEP – Within the federal budgeting process, evaluate energy technologies and programs to see how they contribute to economic, climate, and security goals. Ensure that federal funds used to promote these technologies seek to maximize opportunities for both climate change and energy security.

RECOMMENDATION 9:
Support domestic oil production during the transition to low-carbon fuels.

Energy security concerns often produce calls for "energy independence," an effort to reduce U.S. reliance on foreign sources of oil, especially those viewed as hostile to U.S. interests or politically unstable. While the recent economic crisis has dampened demand, over the past several decades U.S. dependence on imported oil has grown as the vehicle fleet has become heavier and larger, the average distance traveled per vehicle has increased, and domestic oil production has declined. A combination of two factors – surging domestic oil demand and reduced domestic production – creates potential conflicts between climate change and security goals: satisfying energy security concerns in a period of declining domestic oil production could lead the U.S. to support high-emission alternatives. This is a false choice – the opportunity to achieve both climate change and energy security goals ultimately lies in reduced reliance on oil as the dominant transport fuel. However, a transition away from oil as the primary transportation fuel will take time: oil currently makes up 95% of U.S. transportation fuels. A successful transition requires policymakers to avoid policies that jeopardize the current fuel system before a viable replacement is in place. Previous recommendations in this roadmap focus on increasing vehicle efficiency, improving land-use planning, and supporting a shift to an electrified transportation system. Coupling improved demand measures (for example, through improved vehicle efficiency, reduced VMT, and mass transit alternatives) and aggressive supply-side actions to promote alternative low-carbon fuels with efforts to maintain domestic petroleum supply doubly enhances energy security.

Over the near term as we transition to a more sustainable energy system, a stable energy regime will require local resources to hedge against import-related risks. Expanded domestic production would increase U.S. and global energy security by increasing global supply, moderating prices, and reducing dependence on imports from a limited number of suppliers.[54] To this end, in 2008 Congress moved forward with expanded domestic oil production to reduce the vulnerability of the U.S energy system to foreign interference and manipulation by suppliers. Over the next decade or so, there are no supply alternatives able to replace liquid fuels at scale. And to the extent U.S. demand for oil continues, U.S.-sourced production comes with the most stringent environmental regulations and does not require long-distance tanker transport.

While energy security analysts have noted the near-term security benefits of unconventional sources of oil (many of which are abundant in the U.S. and western hemisphere),[55] oil shale and coal-to-liquids production[56] result in extremely high GHG emissions.[57] The climate change impacts associated with such liquid fuel choices lead to a recommendation in this report against such options absent significant environmental improvement.

Recognizing the near-term energy security benefits of domestic oil production and the difficulties in making a quick transition to a low-carbon transport infrastructure, the administration should support policies that improve the recovery rates and productivity of wells in areas open for production. Such policies can, during this transition period, help manage energy prices and avoid a shift to high-carbon non-conventional fuels. However, in determining production policies, decision makers should balance resource potential with environmental sensitivity. In all cases it will be essential to assure strong and comprehensive monitoring for human health and the environment as well as compliance with environmental law.

It will be critical that increased production not undermine other priorities to shift the transportation sector toward a more diversified and decidedly cleaner fuel mix and away from one dominated by petroleum-based fuels. Including domestic production as a recommendation is thus part of a package, not to be taken in isolation as a stand-alone proposal. Efforts to promote other technologies and fuels must be sustained. In the near term, as the world's third largest oil producer,[58] it will be critical for the U.S. to combine domestic production with improved end-use efficiency and the promotion of low-carbon transportation choices. Doing so can enhance domestic security, reduce import dependence, and avoid a turn to high-carbon alternatives that will only make meeting climate change goals more challenging.

FIRST STEP – Develop and implement policies to improve production technology, increase recovery rates (e.g., enhanced oil recovery), and prioritize production in areas that have the greatest production potential and are the least environmentally sensitive.

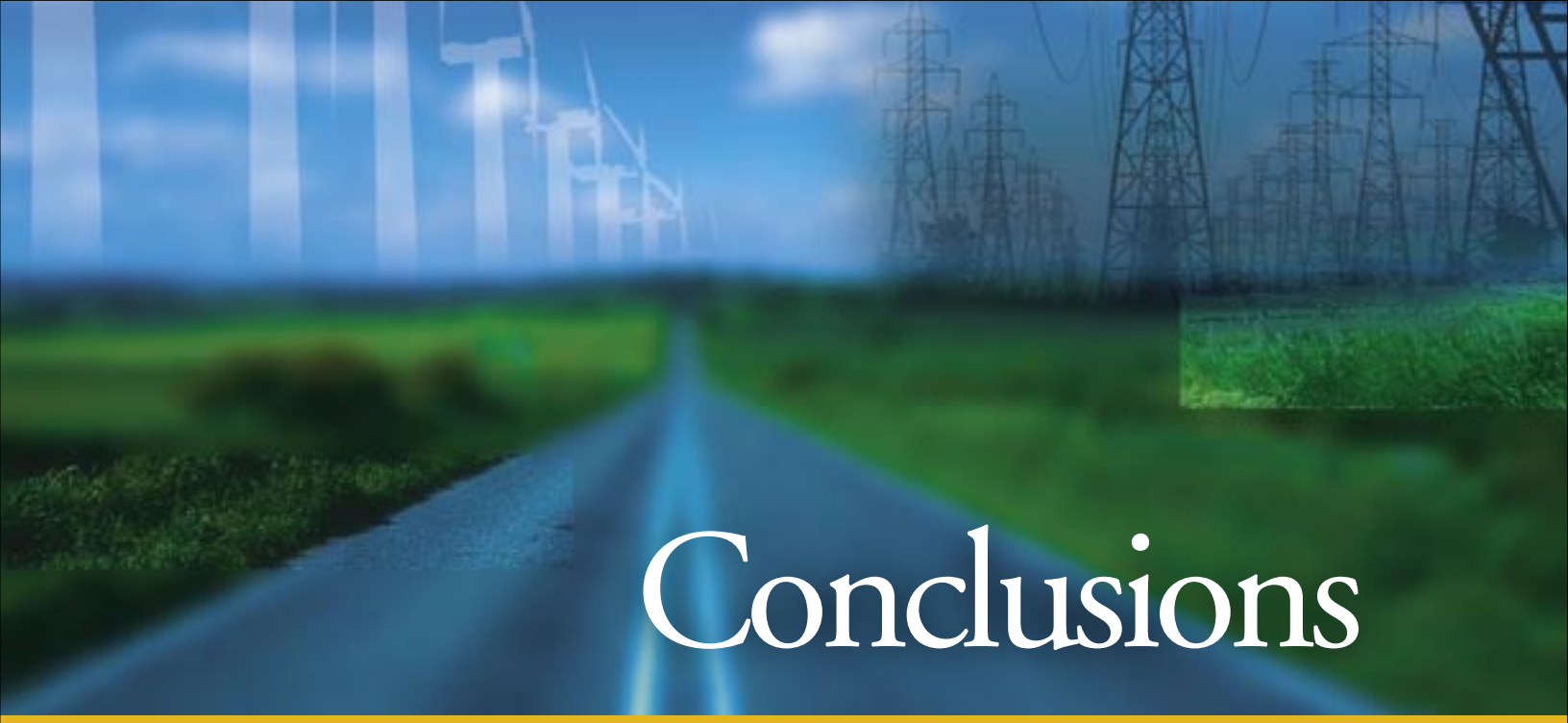
■ RECOMMENDATION 10:

Develop a natural gas strategy with appropriate environmental safeguards to meet short-term demand and ensure availability of alternatives in the longer-term.

In the absence of large-scale alternatives, natural gas (the least carbon-intensive fossil fuel) is an obvious near-term option for power generation. However, a rapid global increase in natural gas demand could pose energy security and climate change challenges. From an energy security perspective, a near-term and widespread switch to natural gas could yield greater competition for gas resources. This could rapidly increase prices and force greater dependence on a small group of suppliers that emerge in a more global market. Moreover, models show that over a longer timeframe, GHG emissions from natural gas will ultimately need to be captured and stored or natural gas will need to be removed from the electricity mix to aggressively reduce emissions.[59] Likewise, it has been proposed that natural gas serve as a transition fuel for the transport sector; as with oil, post-combustion capture and storage problems in the vehicle fleet suggest that this is not likely to be a long-term solution.

The new administration should develop a strategy to use natural gas efficiently in the near term while addressing its energy security concerns. It should avoid investments in infrastructure that may have to be retired prematurely due to carbon constraints. This strategy requires a domestic climate change policy that is sufficiently stringent to encourage investment and development of alternatives to fossil fuels; demonstration of carbon capture and storage technologies; and domestic production of natural gas resources to ensure adequate gas supply, consistent with existing infrastructure and right-of-ways.

FIRST STEP – The new administration should develop a natural gas strategy to address the strategic implications of natural gas in a carbon-constrained environment. This strategy should include an assessment of the potential domestic natural gas resources available, and the associated lifecycle emissions and other environmental impacts of their development.



Conclusions

During his election campaign, President Obama consistently recognized the role that energy plays in the U.S. economy and in its foreign affairs. He noted that a concerted U.S. effort to deploy low-carbon energy sources and energy-efficient technologies can reduce costs to consumers in the long term and create new jobs, mitigate the worst impacts of climate change, and ensure a stable supply of energy to support future economic growth and development.

Achieving these goals will not be easy. It will require a complete transformation of the energy system upon which the U.S. has relied for a century. The technologies and infrastructures that must replace it are largely theoretical and potentially expensive. However, this transition must occur. At a time when budgets are tight, energy spending should be seen as a long-term investment and a key component of economic stimulus efforts. It should be done judiciously and in ways that leverage the resources available to the private sector. Most importantly, it must be recognized that increased spending alone will not solve energy security and climate change problems. These challenges require long-term planning, a resetting of the system of mandates and incentives that have led to today's challenges, and careful management of the tradeoffs that will inevitably emerge along the way. President Obama will not be able to solve all of these problems by the end of his term, but wise choices now will allow him to put the United States on the path to a secure, low-carbon future.

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[3] There are countless other environmental and national security concerns critical to policymakers in the U.S. and globally, including biodiversity, water scarcity, conventional air pollution, climate change impacts, weapons proliferation, and military energy needs. While the authors note specific examples of policies that intersect with these other concerns, they are not at the heart of this discussion. The recommendations in this roadmap focus on ways to address both energy security and climate change, and should be considered in the context of other policy priorities.

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[5] Ibid.

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[7] See UN population statistics at: http://esa.un.org/unpp/p2k0data.asp

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[10] Energy Information Administration, *Short Term Energy Outlook,* December 9, 2008,.Available at: http://www.eia.doe.gov/emeu/steo/pub/contents.html

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[13] For additional supply, demand, and price outlooks see the International Energy Agency, Organization of Petroleum Exporting Countries, Energy Information Administration, and Deutsche Bank Global Markets Research.

[14] IEA, WEO 2008, p. 333

[15] More information can be found at: http://www.encharter.org/

[16] More information can be found at: http://www.cslforum.org/

[17] United Nations Framework Convention on Climate Change. Available at: http://unfccc.int/2860.php

[18] European Council Communication, January 10, 2007, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2007:0002:FIN:EN:HTML Note: there remains a degree of uncertainty about climate sensitivity that makes it difficult to pinpoint stabilization targets and expected temperature rise.

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[22] IEA, WEO 2008

[23] Under both Bush and Clinton administrations, interagency processes often convened by the White House were responsible for coordinating policy among and between agencies. Under the Bush administration, the working group was called the CCPPR committee. An organization chart for the existing interagency working group is available online: http://www.climatescience.gov/images/cccst-orgchart.jpg

[24] A number of studies (e.g., Grubb et al. 2006. *Technological Change for Atmospheric Stabilization: Introductory Overview to the Innovation Modeling Comparison Project*, or the IPCC Special Report on Technology Transfer, IPCC, 2000) review technological change. Lawrence H. Goulder demonstrates the cost savings by combining these two types of policy mechanisms. (*Induced Technological Change and Climate Policy,* Pew Center on Global Climate Change, Arlington, Virginia, October 2004.)

[25] McKinsey Global Institute. 2007. *Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost?,* The McKinsey Global Institute, December 2007, http://www.mckinsey.com/clientservice/ccsi/pdf/US_ghg_final_report.pdf

[26] Additional incentives and policies such as tax credits, technology investments, etc., may be used to make up the difference between a carbon price and the incremental cost of low-carbon technologies.

[27] A number of analysts have looked at the relative merits of cap-and-trade programs vs carbon taxes. (See Aldy J. and B. Pizer. 2008. *Issues in Defining U.S. Climate Change Policy* Washington, DC: Resources for the Future.) The former appears to be the policy with political momentum. Congress has moved forward with several bills proposing cap-and-trade programs for greenhouse gases, and during his campaign, President Obama expressed support for this approach.

[28] A patchwork of regional cap-and-trade programs are taking shape throughout the United States. Most of them expand the coverage and stringency of the cap over time to allow the program to ramp up without being too far-reaching or draconian at the outset. A federal program establishing a cost for carbon can usefully learn from the experience of the states (as well as the European Union, which also has spent the past several years planning and now implementing a cap-and-trade regime), and find ways to incorporate or reconcile these regional programs with a more comprehensive national plan.

[29] The "negative cost" of efficiency investment is refuted by some organizations, most notably Larry Makovich at Cambridge Energy Research Associates. Despite a difference of views over the negative cost of efficiency investment, analysts generally agree that efficiency investments are among the lowest-cost ways to reduce emissions. McKinsey & Company, 2007. *Reducing Greenhouse Gas Emissions: How Much at What Cost?.* Online at: http://www.mckinsey.com/clientservice/ccsi/greenhousegas.asp

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[31] See opinion piece by Larry Summers in the New York Times, November 6, 2008.

[32] This is USD$45 trillion more investment than in the IEA's business as usual scenario, spent between 2010-2050. The IEA predicts this investment would be comfortably offset by fuel savings at a 3 percent discount rate. IEA Energy Technology Prospectus 2008. Paris, France: OECD/IEA.

[33] Note: This is not a net increase in jobs. United States Conference of Mayors and Mayors Climate Protection Center. 2008. "U.S. Metro Economies: Current and Potential Green Jobs in the U.S. Economy," United States Conference of Mayors and Mayors Climate Protection Center, Global Insight.

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[46] See U.S. Conference of Mayors Climate Protection Agreement at: http://www.usmayors.org/climateprotection/agreement.htm

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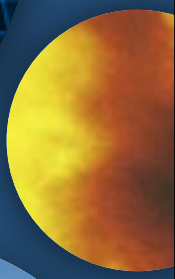

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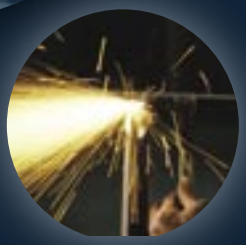

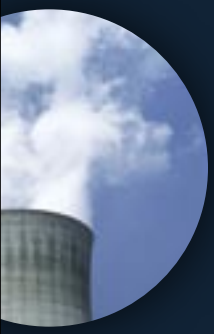

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