THE URGENCY OF SUSTAINABLE COAL

Executive Summary

The National Coal Council has laid out a coherent strategy.

Over the past five years, the NCC has submitted a series of reports to the Secretary of Energy delineating how the United States can use coal to solve some of our most pressing energy needs regarding electricity, liquid fuel, and natural gas (NG).

In 2004, the Council produced *Opportunities to Expedite the Construction of New Coal-based Power Plants*. This report emphasized: (1) the importance of streamlining the permitting process to meet increasing demand for electricity; (2) the strategic importance of integrated gasification combined cycle technology; and (3) the crucial need for continued R&D and technology demonstration projects—especially relating to clean coal technologies.

In 2006, the Council submitted *Coal: America’s Energy Future* and stressed five fundamental points: (1) coal is America’s greatest energy resource; (2) energy demand will continue to grow over the foreseeable decades; (3) coal is the only domestic fuel with the flexibility and reserve base to meet that demand; (4) coal conversion to electricity, liquid fuels, and synthetic natural gas would significantly increase supply and stabilize energy prices as well; and; (5) coal conversion would reinvigorate the industrial core of America, creating over 1.4 million new jobs and increasing the GDP by at least $3 trillion.

In 2007, the NCC built on the previous report by presenting *Technologies to Reduce or Capture and Store Carbon Dioxide Emissions*. That analysis presented a systematic suite of technologies to manage carbon dioxide (CO₂) emissions and pave the way for future generation, as well as coal gasification and liquefaction. The report concluded that to meet the Nation’s needs, technology for Carbon Capture and Storage (CCS), including storage sites and related infrastructure, must be developed within the next 10 years.

On October 12, 2007, the Secretary of Energy requested the NCC conduct an additional study to “focus on several technological options to increase coal use consistent with the environmental goals of the country.” Pursuant to this request, the NCC submits the current report, *The Urgency of Sustainable Coal*. Significant energy-related events have occurred in the past several years that have far reaching implications for the United States, and for the central role coal will play in the world’s future. The 2008 report follows the Secretary’s directive and refines and extends the findings and recommendations in the earlier reports, particularly in regard to: (1) carbon management technologies; (2) legal and regulatory issues; (3) hybrid electric vehicles; (4) in-situ coal gasification and; (5) converting coal to liquid fuel and SNG.
Energy related events since 2006 underline the urgency of sustainable coal.

In the 2006 report, the Council delineated the potential of coal and predicted that energy supply problems, coupled with rising demand everywhere in the world, would lead to higher prices, increased dependence on foreign countries and significant socioeconomic costs. There is no question that these projections have come to pass. Since the beginning of 2006, for example:

- Oil prices increased from $56 per barrel to over $85 in January of 2008 and breeched $120 by May. This headwind has significantly slowed economic growth and helped bankrupt six airlines in the past two years.
- LNG has reached $12-18/mcf in many parts of the world as rising demand from Asia and Europe has dramatically reduced U.S. import expectations.
- Oil production has stagnated as even more of the world’s top ten producers, Russia (2nd), Mexico (6th) and Norway (10th) now face the realities of depletion.
- Costs to produce energy have risen dramatically due to escalating prices for steel, materials, labor, equipment, transportation, and energy itself.
- Ethanol produced from corn has come under attack across the world as food prices rise and there are street riots in several countries.

Despite these untoward, but not unexpected, events since 2006, some aspects of energy remain stable. In 2006, coal produced 50% of our electricity at a cost of about one fourth that of NG. In 2008, coal produces about 50% of our electricity at a cost even less than one fourth that of NG.

The Global Context of Energy Assures the Inevitability of Coal

Energy is the lifeblood of modern society as well as the means by which billions of women, men, and children across the world can escape the grip of poverty. Experience lights the way. In the 1930s, the United States employed the Rural Electrification Act to dramatically improve the quality of life of millions of Americans in small towns and villages, as well as those on farms and ranches. By 1949, two thirds (67%) of U.S. electricity came from coal. More recently, China has expanded access to electricity (87% generated from coal) to literally lift 400 million people out of poverty, leading the International Energy Agency (IEA) to state:

“Electrification in China is a remarkable success story [and] part of its poverty alleviation campaign… the most important lesson for other developing countries [is] that electrified countries reap great benefits, both in terms of economic growth and human welfare… China stands as an example.” IEA, 2007

Yet, despite these advances, much of the world remains in the energy backwater. Over 2 billion people live on less than two dollars a day, over two billion lack adequate access to electricity and another 1.6 billion have no electricity. Improved access to energy is the only hope the most
prominent victims of energy deprivation—women and children—have of lessening the burden of unrelenting toil in the dark. Indeed, as the Global Energy Network (2004) has pointed out:

“Every single one of the United Nations’ Millennium Development Goals requires access to electricity as a necessary prerequisite.”

The present report further delineates the pathway by which current and emerging “green coal” technologies can be utilized to reduce greenhouse gas (GHG) emissions while enabling both advanced and developing nations to expand their economies and improve the quality of life. The urgency of sustainable coal is increasingly apparent as policymakers grapple with the twin problems of protecting the environment while meeting the energy needs of a growing and dynamic world.

As a nation which is projected to import 62% of its liquid fuel, and 17% of its NG by 2015, the United States has an unremitting vested interest in the unfolding of the global energy drama. To set the conceptual framework of how the U.S., coal, and technology fit into the global picture, this report is based upon ten fundamental premises:

1. Global demand for energy, particularly electricity, is growing at an unprecedented rate that will continue for decades.
2. Over 75% of the new demand for energy will come from non-OECD nations, especially from the Middle East, China, India and other parts of Asia as they seek to modernize.
3. Fossil fuels provide about 85% of the world’s energy, and in 2030, that figure will be still be about 85%—oil (32%), coal (28%) and NG (24%).
4. Systematically optimistic forecasts of energy production and prices have dimmed our understanding of the energy supply problems facing the world.
5. There is increasing evidence that oil and natural gas production will not keep pace with the global demand.
6. Coal is irreplaceable as the cornerstone fuel of the future based on its strengths of supply, availability, versatility, affordability, and emerging receptivity to carbon capture.
7. Coal-based generation is on the rise as over 660,000 new megawatts of coal power stations are planned or under construction.
8. Coal conversion to liquid fuels and synthetic natural gas can alleviate emerging shortfalls in conventional production.
9. Clean coal technologies are continually evolving and allow for the consumption of more coal with greatly reduced criteria emissions.
10. CCS is the “game changer” for coal and will open up the full range of coal’s potential contribution to energy supply constraints across the world.

The United States has a unique opportunity to assume a leadership role in simultaneously reducing both GHG emissions and global poverty by making CCS and established clean coal technologies available, deployable, and affordable to developing nations. The world is inevitably turning to coal conversion to meet escalating energy demand. China and India have
only 4% of the world’s oil and NG. But with 2.5 billion people they have 37% of the population—and 23% of the world’s coal. It should be no surprise that coal is the fuel of choice for billions.

In short, coal will be an inevitable, essential, and productive part of the world’s energy future. The United States has the technology, resources and, as a global leader, the responsibility, to assure the process benefits both the environment and humankind.

**CCS will open the door even wider**

CCS consists of technology to capture CO₂ from a fossil fuel utilization facility, compress the gaseous CO₂ into a dense fluid form, transport the CO₂ to a suitable storage site and inject the CO₂ into a porous geological formation where it will remain permanently. Captured CO₂ can also be used as an injection fluid to recover crude oil from heretofore depleted oil reservoirs.

In terms of coal, CCS is a technically viable solution for controlling CO₂ emissions from coal-based power generation, coal-to-liquid production, and the production of synthetic natural gas.

At the present time, while there are no CCS applications at power plants, carbon capture is being implemented in oil and NG production, refining and industrial applications. Sequestration is being used for enhanced oil recovery.

Long term geologic storage of CO₂ is safe and there is sufficient storage capacity in the U.S. for the volumes of CO₂ released by power generation and other applications. Further, CCS
technology is evolving to further improve capture capability, lower energy consumption, and reduce costs. As pointed out in the NCC reports of 2004, 2006, and 2007, R&D programs, demonstration projects, and reasonable financial incentives should be implemented to spur commercial-scale demonstrations by 2015.

The United States Needs Additional Coal-Based Generation

The United States must come to grips with the reality that, like many of the countries discussed here, we are a growing nation with increasing electricity requirements:

- Population is growing by about three million people per year and will exceed 365 million by 2030—an increase of 75 million in only three decades.
- Economic expansion: The GDP will rise from $11 trillion in 2006 to over $20 trillion in 2030—an 82 % increase.
- Advances in electro-technologies will place substantial demands upon the electricity infrastructure as increased precision and reliability become even more crucial to productivity.

The implications of these demographic, economic and technological trends for America’s electric supply system are reflected in EIA’s projections of electricity demand through 2030:

Source: EIA, 2008

Figure ES.2. The Rising Tide of Electricity Demand in the U.S.
The EIA has projected that at least 230,000 megawatts of new generation capacity will be needed by 2030 and that about 100,000 MW (43%) will be coal-based.

Unfortunately, the National Electric Reliability Corporation (NERC) recently warned that the continuing short term focus on the construction of new NG-based generation has increasingly adverse implications for reliability:

“Long-term capacity margins are still inadequate…inadequate capacity margins [reflect] the industry’s relatively recent shorter-term approach …short–term planning can’t preclude long-range strategies for modernization and expansion…dependence on short term natural gas generation…overlooks the need to integrate other necessary resources.”

Along these lines, the continuing forced cancellation of planned coal generation, coupled with the development of even more NG plants, in such states as Texas, Florida, Kansas and Oklahoma, is setting the stage not only for reliability problems but higher electricity prices as well.

From 1993 to 2007, the amount of NG used for electricity grew 92%

Source: Adapted from EIA data, 2008

Figure ES.3. Using More NG to Produce Electric Power Increases the Price of Both NG and Electricity
The EIA has projected that about 75% of new NG supply will come from LNG. If even more NG generation continues to be built to replace cancelled coal generation, the amount of LNG required in the next 20 years will be even greater than predicted. Hence, de facto, LNG would become the default fuel for generation and other uses. NERC has warned about such a situation:

“Importing LNG from abroad opens the U.S. fuel supply to the global market and all the economic and political risks associated with it” (NERC, 2007)

Thus, for the first time in history, the reliability of the U.S. electricity supply system would be dependent upon decisions made in other countries. Europe, of course, has already gone down that path, with all the attendant risks to energy security and economic stability.

In order to meet the growing demand for electricity, additional coal-based generation is essential. Coal is the only major energy source which can meet projected electricity demand in a timely, reliable, affordable, and increasingly clean manner.

**The scale required to replace new coal-based generation is beyond the scope of other fuels.**

The EIA has projected that coal-based generation will increase by over 820 billion kwh by 2030. This increase alone is as much as the combined current generation of France and Italy. Figure ES.4 demonstrates the magnitude of alternative fuels needed to (1) meet existing EIA projections for each fuel and (2) replace projected increases in coal generation:

![Figure ES.4. The Scale of Alternative Generation Needed To Meet EIA Projections and Replace Projected Coal](source)

Source: Adapted from EIA data, 2008
The over 820 billion kwh needed to replace projected new coal generation, coupled with the expectations for the respective fuels would require the general equivalent of:

- 7 Tcf of NG - almost as much as the annual production of Texas plus Louisiana
- 110 nuclear plants (we have 104) at a construction cost of $385 billion
- 250 or more hydroelectric facilities the size of Hoover Dam

A series of logical steps

The series of NCC reports over the past five years provides a systematic technological and regulatory pathway to cleanly and efficiently realize the full potential of our domestic coal resources.

A Multi-Step Process to Near-Zero Emissions

**A Long-Term Approach to a Long-Term Challenge**

- Efficiency improvements at existing Plants. The NSR process should not be triggered for plant efficiency improvements that reduce emissions.
- Building New, Efficient Supercritical & IGCC Coal Plants 15% Lower CO₂ Emissions
- Demonstrating IGCC and Carbon Capture/Sequestration Up to 90% Lower CO₂ Emissions
- Retrofitting Existing Coal-Based Generation with Carbon Capture/Sequestration Up to 90% Lower CO₂ Emissions

The Goal: Near-Zero Emissions

0 20 Years

Figure ES.5. A Multi-Step Process to Near-Zero Emissions

FINDINGS AND RECOMMENDATIONS
The present report provides a series of findings and recommendations, supported by technical analyses, that give the Secretary a detailed overview of how coal can be further utilized to meet the energy needs of the Nation.

**Chapter Two: Carbon Management Technology Options**

**FINDINGS**

1. Reducing CO$_2$ emissions from coal-fired power plants is an enormous challenge. However, the electric power industry, technology producers, equipment manufacturers, academic and research organizations, and the federal government are rapidly developing solutions that will secure coal’s place as an important fuel source, even in a carbon constrained world.

2. Improvements in supply side efficiency must play an important role in both near and longer-term CO$_2$ emissions reductions.

3. Wholesale replacement of existing generating units cannot be accomplished in the near future. Besides daunting economic consideration, small subcritical units, with their high responsiveness to load demand fluctuation, contribute significantly to a robust portfolio of reliable generation technologies.

4. Advanced coal power plant technologies with integrated CO$_2$ capture and storage (CCS) will be crucial to lowering U.S. electric power sector CO$_2$ emissions. They will also be crucial to substantially lowering world CO$_2$ emissions, if the technology is supported in rapidly growing Asia.

5. RD&D pathways have been identified to demonstrate, by 2025, a full portfolio of economically attractive, commercial-scale advanced coal power and integrated CCS technologies suitable for use with the broad range of U.S. coal types. Some technologies will be ready for some fuels sooner, but the economic benefits of competition will not be realized until the full portfolio is developed.

**RECOMMENDATIONS**

It is important to avoid choosing between clean coal technology options. Therefore, the Secretary of Energy should coordinate with other Federal and Stage funding groups to support and help advance a full portfolio of technology options for the electric power industry.

1. The Secretary of Energy, EPA and Congress must work together to remove the regulatory hurdles that impede the implementation of supply efficiency enhancements, including a more workable New Source Review. 

2. The key to proving CCS capability is the demonstration of CCS at large-scale (on the order of 1 million tons CO$_2$/year) for both pre- and post-combustion capture with storage in a variety of geologies. Therefore, the Secretary should solicit from Congress funding for large combined capture and storage demonstrations to be conducted in different regions and with different coals and technologies.

3. The United States is a leading developer of clean coal technology. Since carbon management and climate change is a global issue, the Secretary of Energy should support efforts by international trade associations and Federal Agencies to enable the transfer of technology to countries such as India and China which are responsible for much of the growth in carbon emissions.

**Chapter Three: Legal and Regulatory Dimensions of CCS**
FINDINGS

1. If atmospheric CO$_2$ emissions are to be controlled, carbon capture and storage (CCS) is the only means available to address very large quantities of CO$_2$ emissions from coal-fired facilities. However, it is a tool that requires significant additional research and the definition of a stable legal regime.

2. If carbon constraints are applied at the state or federal level, CCS may need to develop very quickly in order to maintain reliable and secure energy supplies. The legal regime applicable to CCS is very important, both to encourage its development and to speed the appropriately considered approval of needed projects.

RECOMMENDATIONS

The National Coal Council recommends that the Secretary of Energy work with various parties, most particularly the states and other federal agencies, to promote a legal framework for CCS that will encourage rather than discourage its development. A legal framework to encourage development of CCS would include the following elements:

1. A single clear regulatory scheme administered by as few government agencies as possible, rather than multiple potentially applicable regulatory regimes with inconsistent or conflicting requirements.

2. Clear definition and assignment of risks under a single liability regime, rather than unclear, vague liabilities potentially posed under a variety of State and federal statutes.

Chapter Four: Plug-In Hybrid Electric Vehicles and Coal-Fueled Power Plants with CCS

FINDINGS

1. The combination of Plug-in Hybrid Electric Vehicles (PHEV) and coal-fueled electricity with carbon capture and storage (CCS) is an attractive way to use coal as a transportation fuel from economic, energy security, and environmental perspectives. If the electricity were generated in coal-fueled power plants with CCS, total fuel greenhouse gas emissions (per mile driven) for a PHEV would be reduced by 60%, compared to a conventional vehicle (spark-ignition gasoline or diesel) or 37% compared to Hybrid Electric Vehicle (HEV). Even without CCS, CO$_2$ emissions for the combination of a PHEV and coal-fueled electricity generated in a state-of-the art power plant are about equivalent to those of an HEV, and less than for a conventional vehicle.

2. A PHEV charged with coal-based electricity displaces petroleum (two-thirds of which now imported) with domestic coal as a transportation fuel. Replacing ~60% of the light- and medium-duty vehicle miles with PHEV miles by 2050 would reduce petroleum consumption by 3.7 million barrels per day.

3. PHEVs are not commercially available at present. GM announced its “Volt” PHEV concept car with a “market introduction date” of 2010, and Toyota, Chrysler, Nissan, and Ford also have PHEVs under development. EPRI expects PHEVs to enter the commercial marketplace in 2010. The principal technical issue is the cost and performance of the PHEV battery, which is the subject of considerable federal and private R&D.

4. A major impediment to the commercial acceptance of the PHEV will be its initial purchase price, projected to be $2000-3000 above the HEV price when introduced into the commercial market,
principally because of the battery cost. This is offset to some extent by lower fuel costs, but the payback period might be 10 years or longer, depending on fuel, electricity, and vehicle purchase prices.

5. During its initial introduction, the electricity requirements for the fleet of PHEVs would be low and could be met by the existing generating capacity, in part because PHEVs would be charged most frequently at night when excess capacity is available. To put this in context, a single 600 MW power plant would generate enough electricity to supply two million PHEV40s. Various studies conclude that even with significant PHEV penetration, the incremental electricity demand is modest. For example, EPRI found from its modeling that replacing ~60% of the total light-and medium-duty vehicle fleet by 2050 would result in only a 7.8% increase in electricity demand.

6. Since its introduction in 1999 (through 2006) about 650,000 HEVs were sold in the U.S., and a similar pace of introduction of PHEVs would suggest that they would not create substantial electricity demand for a decade. The timeframes for the deployment of PHEVs in sufficient number to create the demand for new coal-fueled power plants, and the deployment of CCS-equipped coal plants are relatively consistent within the 2020-2030 period. Because of the technical and economic difficulties in reducing CO₂ emissions from the transportation fleet, incentives for broad scale PHEV adoption can be highly cost-effective, on the order of $3-5/tonne on an avoided-CO₂ cost basis.

RECOMMENDATIONS

1. The Secretary should conduct research and development on coal-based electricity generating technologies, including CCS, to ensure adequate supplies of electricity to support the broad commercial implementation of PHEVs or other electric vehicles.

2. The Secretary should conduct research to reduce the cost and improve the performance of PHEVs, with particular emphasis on the cost, performance, durability, safety, and environmental impact of batteries.

3. The Secretary, working with other agencies and Congress as appropriate, should promote incentives for the deployment of advanced coal-based electricity generating technologies coordinated with the substantial market penetration of PHEVs or other electric vehicles, recognizing the economic, energy security, and environmental benefits of electrification of the transportation fleet.

Chapter Five: Liquids From Coal

FINDINGS

1. Financial: The Safe, Accountable, Flexible, Efficient, Transportation Equity Act: A Legacy for Users, SAFETEA-LU 2005 extension, provides a $0.50 per gallon excise tax credit for certain alternative liquid fuels, including CTL products. This incentive is scheduled to expire in 2009, before any major new CTL plants can be built. Its extension through 2020 will provide critically needed market incentives for CTL development. CTL plants, especially the first ones to be built, often face difficulty in raising the required private capital investment.

2. Research and Development: The robust research programs undertaken in earlier years to improve the chemistry of syngas production and the preparation of new products in downstream processes have been inhibited by the lack of federal programs to support research in coal chemistry. The nation has experienced a sharp decline in the number of researchers in this area as a result of the elimination of industrial coal research labs and the elimination of federal research
support. Investments in research would bring about improved yields and products from coal-syngas processes.

3. **Institutional and Regulatory**: A clearly defined permitting process for CTL facilities will reduce the uncertainty, time, and cost required for permitting, while retaining regulatory process and oversight. In order to facilitate the rapid scale-up of CTL production capabilities in the U.S., regulatory changes are necessary, and standardizing, simplifying, and expediting the permitting process is crucial. The “not in my back yard” mentality, often accompanied by costly time-consuming litigation and obstructionism, needs to be countered with legislation and leadership.

4. **DOD Policies and Incentives**: Total oil consumption by U.S. military forces is approximately 300,000 bpd, and through the development of BUFF specifications a substantial portion of this requirement can be met with domestically produced CTL fuels. DOD desires to enter into long-term contracts for the purchase of alternative fuels made in the U.S. from domestic resources. This is part of DOD’s Total Energy Development (TED) Program, the stated mission of which is to “catalyze industry development and investment in alternative energy resources.” DOD fuels purchases under long-term contract can help establish a foundation on which to build a CTL industry, and can secure the high quality U.S. made CTL fuels desired by DOD.

**RECOMMENDATIONS**

1. **Financial**: Congress should extend the $0.50 per gallon alternative liquid fuels excise tax credit. Also, the federal government should provide assistance to industry to attracting private capital for new facilities by:
   - Providing for 100% expensing in the year of outlay for any CTL plant that begins commercial operation by 2020
   - Providing for a federal loan facility of $100 billion with the ability to provide loan guarantees for the initial commercial scale CTL plants (see EPAct2005, Title XVII)
   - Extending the CTL excise tax exemption to 2020 (Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users SAFETEA-LU 2005 extension)
   - Extending the temporary expensing for equipment used in refining to 100 percent of any required additions to existing refineries needed to handle CTL products (EPAct2005, § 1323)

2. **Research and Development**: The federal government should increase its support of syngas chemistry, and research should be directed towards improved conversion processes for CTL and CBTL in bench and pilot studies of catalysis, processes to minimize CO₂ production, and of different coal types. Research should also focus on the development of alternative products from syngas chemistry, such as SNG, chemicals, and carbon products, the use computational chemistry to model catalysts, and assessment of the economics of emerging research.

3. **Institutional and Regulatory**: The federal government should develop clearly-defined permitting processes for siting, constructing and operating CTL plants. Federal agencies should work with local, state, and tribal agencies to establish a well-defined permitting process for the siting, construction, and operations of CTL plants. This should include all environmental impact documentation and permits related to air, water, land, product transport, mining, community impact, and safety and health. The federal and state governments should provide regulatory streamlining for the production of CTL fuels and should:
   - Standardize, simplify, and expedite permitting and siting with joint federal, state, and local processes, policies, and initiatives.
   - Make appropriate federal, state, and local government sites available for CTL plants, including Base Realignment and Closure (BRAC) military sites and
disused heavy industry sites for which industries have foundered and the sites are now abandoned but could be reinstated as CTL sites.

- Encourage local leadership to modify approaches to zoning and other land use and business regulations to accommodate CTL activities.

4. **DOD Policies and Incentives**: The federal government should authorize and fund military purchases of CTL fuels under long-term contract. Congress should support DOD’s TED program, including extending its long-term contracting capabilities from five years to as long as 25 years. Appropriations and necessary authorizations and funding for these programs should be given high priority.

**Chapter Six: Underground Coal Gasification**

**FINDINGS**

1. Underground coal gasification (UCG) converts coal in-situ into a gaseous product, commonly known as synthesis gas or syngas through the same chemical reactions that occur in surface gasifiers.
2. Gasification converts hydrocarbons into a synthesis gas (syngas) at elevated pressures and temperatures, and can be used to create many products including electric power, chemical feedstock, liquid fuels, hydrogen, synthetic gas.
3. Gasification provides numerous opportunities for pollution control, especially with respect to emissions of sulfur, nitrous oxides, and mercury.
4. UCG could increase the coal resource available for utilization enormously by gasifying otherwise unmineable deep or thin coals under many different geological settings. A 300-400% increase in recoverable coal reserves in the U.S. is possible.
5. For developing countries undergoing rapid economic expansion, including India and China, UCG also may be a particularly compelling technology.

**RECOMMENDATIONS**

1. A renewed research program is needed. The U.S. disbanded its research program in 1989. Since then, no government agency has sponsored scientific research into UCG processes or products. A number of outstanding technical issues, including improved simulation, costs and economics, process engineering, subsurface process monitoring and control, risks and hazards, and synergies with carbon management remain unexplored. A substantial research program (>55M) is recommended that includes participation of research institutions, universities, and companies.
2. Field demonstrations are essential to development. The two existing and rapidly emerging field programs in the U.S. and China provide near-term opportunities for investigating key technical and non-technical concerns. These are platforms to test subsurface monitoring equipment, validate simulators and models, and understand potential environmental concerns. Some projects might be pursued through the Asian Pacific Partnership given the needs in developing countries around pollution abatement and clean coal technology development. Others could be pursued through public-private partnerships. The DOE should assess these pilots and investigate their current status and goals in considering which ones provide the best opportunities to meet key goals. Additional funds beyond a core R&D program should be brought forward for field testing, monitoring, and validation.
3. As present, there are no broadly accepted standards for siting and operation of UCG projects and facilities; the development of such standards is needed. To help commercialization in North America, we recommend a 3- to 5- year research program aimed at providing key industries,
regulators, and decision makers with the technical basis needed to screen out problem sites and encourage sound investment.

4. In-situ gasification has the potential to dramatically reduce the costs of syngas production and thereby CCS, but a greater understanding must be reached. However, these two enterprises are fundamentally distinct and have their own technical, commercial, and environmental needs. We recommend a formal program to investigate how UCG might enable or hinder CCS development and deployment. And to identify potential synergies that will enhance economics and site performance.

5. Materials on UCG are needed for outreach and education programs. Few decision makers in the U.S. are familiar with UCG as an energy technology option. The DOE should engage its own expertise and knowledge to develop briefing materials and public outreach documents to be used to engage stakeholders.

Chapter Seven: Turning Coal into Pipeline Quality Natural Gas

FINDINGS

1. The United States’ growing demand for natural gas is forecast to continue to exceed our capacity to produce natural gas domestically. This presents an energy security problem, as the broadly proposed alternative is imports of LNG from countries that may be politically unstable.

2. The production of natural gas from abundant, domestically produced coal provides a clean, competitive and secure alternative.

3. Technologies exist to convert coal into 4 trillion cubic feet of natural gas annually by 2025.

RECOMMENDATIONS

1. The U.S. must take steps now to remove the key barriers to implementation of projects to produce natural gas from coal, namely: environmental permit approval, financing risk, and carbon sequestration solutions.

2. Some incentives should be made available to the first group of projects to overcome the increasing capital costs. These incentives should include investment tax credits and Federal loan guarantees.

3. Additional funding should be utilized to accelerate demonstration of carbon sequestration.