Coal: The Foundation of American Energy Security
Whether you are buying coal or producing it, you are exposed to lots of risk. Supply and demand changes. Price volatility. Transportation. Environmental regulations. The weather.

Evolution Markets is the largest broker of over-the-counter coal, emissions, and weather derivatives in the U.S. We understand risk, and how to manage it using the market. From facilitating trading strategies and executing financial swaps to hedging risk across energy and environmental markets, come to us when you need to reduce your exposure. We are the experts.

Reduce your exposure.

Coal: 914 323 0250  Emissions: 914 323 0255  Weather: 914 323 0260
visit www.evomarkets.com
CONTENTS

Message from ACC President ................................................. 3
Message from ACC Executive Director
and Communications Director ........................................... 5
ACC Events ........................................................................ 7
ACC Vision and Mission Statement ..................................... 8
2006 Board of Directors ...................................................... 8
ACC Member Companies .................................................... 9
ACC Champion & Patron Sponsors ....................................... 10

Why Do We Need Coal?
Using Coal to Reduce Foreign Threats to Energy .................. 11
Non-utility Demand for Coal Increasing ............................... 15
Our Growing Energy Dependence ...................................... 19

Can Coal Really Do That?
Outlook For America’s Coal Supply ........................................ 23
Railroads: Delivering Energy Security and Reliability .............. 28
New Life for an Aging Transmission System ......................... 33
Peer Review Ensures Research Integrity .................................. 39

How Can Coal Do That?
A Low Carb Diet for an Energy Hungry Nation ..................... 43
Coal-to-Liquids: A Solution to Energy Problems ..................... 47
Coal-to-Gas Conversion: Pipeline to Energy Security ............... 54
Carbon Dioxide: Poised for a Comeback ............................... 58

Index to Advertisers .............................................................. 60
2006 Buyers’ Guide ............................................................... Insert
Energy Security – the Next Frontier for Coal

John Ward, President, American Coal Council and Vice President Marketing and Government Affairs, Headwaters Incorporated

Coal has long been a pillar of America’s energy infrastructure—fueling more than half of the nation’s electricity generation. Indeed, 90 percent of American coal production goes to generating electric power.

Now coal may stand on the brink of becoming an even more important part of the energy picture. In numerous states and our nation’s capital, significant efforts are underway to start using coal as a raw material for producing synthetic natural gas and liquid transportation fuels. The reason can be expressed in just two words: energy security.

As world oil prices have soared above $70 a barrel this year and unrest in oil-producing regions has escalated, American policy-makers have begun to rediscover the potential of energy resources within our own borders. Resources like oil shale and tar sands hold enormous potential for the nation. But an even more immediate opportunity for reducing foreign energy dependence can be found in a familiar old friend—coal.

Coal is America’s most abundant energy resource. Proven technologies exist to economically convert coal into synthetic gas and ultra clean liquid fuels. These technologies can be employed in an environmentally responsible manner. And these technologies can be deployed now to produce fuel that works in today’s vehicles without modifications.

Reports issued this year by both the Secretary of Energy-appointed National Coal Council and the Southern States Energy Board have called strongly for creation of a new coal-fueled industry in America to produce gas and liquid fuels. States are stepping up to the plate by offering incentives for construction of facilities. And more than a dozen bills are currently before Congress seeking to help this new industry to its feet.

The reasons for this unprecedented interest in coal technologies are serious and immediate. Energy security think tanks point out several critical vulnerabilities our nation suffers from its dependence on imported oil. Among them:

• The vast infrastructure needed to extract, process, transport and store fuel presents tempting targets for terrorists. (For instance, 67% of all Saudi Arabian oil output is processed through one facility.)
• The world’s oil reserves are disproportionately controlled by unstable or undemocratic regimes.
• More than $7 trillion over last 30 years has flowed from the United States to countries where some of the money has funded terrorism.
• Competition for oil resources is growing rapidly. (For instance, China’s demand for oil is projected to increase eight-fold in the next 20 years.)

Creating a new coal-based energy industry for producing gas and liquid fuels will require enormous investment. But the expense pales in comparison to the risks and costs of continued dependence on imported oil. In testimony before Congress this year, the National Defense Council Foundation estimated that the true economic cost of fuel imported from the Persian Gulf—after all externalities are accounted for—is greater than $10 per gallon.

This edition of American Coal magazine tackles the timely and vital subject of energy security. The articles in this edition make it clear that American energy reserves are substantial and that the coal industry is well equipped to meet the challenge of decreasing dependence on energy imports.

Coal has lit and powered American lives for more than 200 years and that track record is something our industry can take pride in. Looking forward, our industry can play an even greater role in meeting the energy needs of our people.

It’s time to spend our energy dollars at home to develop American jobs utilizing American resources for producing environmentally responsible fuels that work in today’s vehicles. At the American Coal Council, we remain committed to supporting these developments that will benefit both our industry and Americans as a whole.
OVER 8,918,600 HOURS OF COAL ENGINEERING EXPERTISE.

For more than 100 years, Roberts & Schaefer has been the leader for quality engineering solutions in all phases of coal drying, coal preparation and material handling. From small, specialized projects, to total turnkey operations, we have the experience you need.

To learn more about Roberts & Schaefer, contact us today.

Full Service Engineering
- ENI Coal Dryer Systems
- State-of-the-Art Coal Prep Plants
- Plant Layout and Material Handling
- Architectural Design of Facility Shops and Offices
- PRB Handling Issues
- Civil, Structural, Mechanical, Piping, and HVAC
- Process Engineering
- Electrical Transmission and Distribution
- Process Control and Automation
- Coal Transportation and Delivery Solutions
- Project Management, Procurement, Expediting, and Construction Management

Roberts & Schaefer Company
5225 Wiley Post Way, Suite 300
Salt Lake City, UT 84116
801-364-0900 phone
801-364-0909 fax
www.r-s.com
stevec@eni.com
Identifying Key Industry Issues

Janet Gellici, Executive Director, American Coal Council.
Jason Hayes, Communications Director, American Coal Council

We always approach the preparation of American Coal magazine with mixed feelings. We combine excitement with a healthy dose of apprehension.

We’re excited, because while developing an issue we get to scan the energy industry and try to identify what are the timely and important issues for our readers. When we believe we have accomplished that task, we move on to selecting a group of authors, who can define and explain how those issues impact your every day activities. In each issue, we have the privilege of working with established and respected experts, as well as “up and comers,” people with ground breaking and important ideas. We also have the privilege of drawing from the collective wisdom of our diverse membership base and including the perspectives and challenges each sector faces on a regular basis.

We feel a healthy dose of apprehension, because we want to correctly identify the issues of interest and concern for you, our readers–energy experts, policy developers, industry associates, academicians, elected officials and the public at large. With each issue, we strive to raise the bar, or exceed the expectations set by previous editions. Given the excellent work completed by authors in past issues of this magazine, that’s not an easy task.

By focusing on “energy security” and the key role coal plays in our energy markets, we believe that we’ve provided you, our reader, with a valuable snapshot of a defining opportunity for our industry. We’re confident that our authors have presented ideas and concepts that illuminate a complex and critical issue. We hope that this edition of American Coal will leave you better educated, more informed and better able to respond to the challenges confronting your business.

The thoughts and opinions presented in this magazine represent those of our diverse membership base, including coal suppliers, transporters, ports and terminals, energy traders, support services and coal consumers (including utilities, industrial users and transportation fuel developers). We recognize that there may be some disagreements when ideas are openly discussed. For that reason, we encourage comments and contributions from all of our readers. If you feel an issue needs to be better developed or explained, please contact us; we might just ask you prepare an article for the next issue.

We’re convinced that encouraging an active dialogue in the industry will lead to a better overall understanding of varying opinions and will ensure a steady stream of new ideas. With that said, we invite you to examine those ideas in this edition of American Coal.

We are delighted to announce that the Coal Marketing Company, exclusive Marketers of Cerrejón coal from Colombia, has moved to:

1180 Peachtree St. N.E
Suite 2420
Atlanta, GA 30309
T: 678 608 2840
W: www.cmc-coal.com
Coal helps keep America moving. CIT Rail helps keep the coal moving. Find out what we can do for you.

At CIT Rail, we have the newest and most technologically advanced railcars in North America, including a state-of-the-art coal fleet that carries much of the fuel that powers this country’s homes and businesses. Combine all that with our innovative financing and leasing services – plus our long experience in the rail industry – and you’ve got a partner who’s got what it takes to help you drive your business wherever you need to go. Call Bill O’Brien today at 212.771.1085 to get things moving. Or learn more at www.citrail.com. We see what you see!
**Membership Coupon**

Join the 160 companies that recognize the importance of belonging to an Association that serves as the pre-eminent business voice of the American coal industry and advocates for coal as an economic, abundant/secure, and environmentally sound fuel source.

The American Coal Council (ACC) is an alliance of coal, utility, trading, transportation, terminal and coal support service companies, advocating a non-adversarial, partnering approach to business.

The ACC facilitates the lawful exchange of ideas and information regarding the American coal industry. It serves as an essential resource for companies that mine, sell, trade, transport or consume American coal. The ACC also serves as a resource for those wishing to expand or enhance business relationships in North American and international coal markets.

---

**Membership benefits include** educational programming and technical seminars, advocacy support, broad-based networking, web site, electronic and printed membership directory inclusion, newsletter and members-only electronic updates, database resources, policy input, referrals and discounts on events and industry publications.

---

**2006 and 2007 Event Dates**

**Coal Market Strategies Conference**
October 9-11, 2006 – San Antonio, TX

**Coal Trading Conference**
December 13-14, 2006 – New York, NY

**Mercury & Multi-Emissions Conference**
March 2007 – Pittsburgh, PA.

**Spring Coal Forum**
May 21-23, 2007 – Memphis, TN

**PRB Coal Use Seminar**
July 23-25, 2007 – St. Louis, MO

**Coal Market Strategies**
October 2007 – Tucson, AZ

**Coal Trading Conference**
December, 2007 – New York, NY

---

For additional information visit www.americancoalcouncil.org or call (602) 485-4737
American Coal Council
2006 Board of Directors

Coal Suppliers
Bob Pusateri
President
CONSOL Energy Sales
ACC Vice President Coal Suppliers

Andy Cox
Sales Director
Coal Marketing Company (USA), Inc.

Matt Levar
General Manager Sales & Marketing
Rio Tinto Energy America

Coal Consumers
Keith Drohan
Dominion Energy
President-Elect 2007/Treasurer

Ken Jenkins
Executive Director Fuel Services
Southern Company
ACC Vice President Coal Consumers

Bud Walker
Regional Vice President, Fuels
Midwest Generation EME, LLC

Energy Traders
Daniel Vaughn
Manager - Coal Services
United Power, Inc./Division of ICAP
ACC Vice President Energy Traders

Stephen Miller
President
COALTRADE, LLC

Transportation
Tom Vorholt
Vice President Utility Sales
Ingram Barge Company
ACC Vice President Transportation/
Membership Chair

Bill Rager
Vice President Operations
SCH Terminal Co., Inc.

Daniel D. Smith
Senior Vice President
Energy & Properties
Norfolk Southern Corporation

Coal Support Services
John Ward
Vice President Marketing
& Government Affairs
Headwaters Incorporated
ACC President 2006
ACC Vice President Coal Support Services

Kirk Weber
Vice President & General Manager
Norwest Corporation

Michael Durham
Ph.D., President
ADA Environmental Solutions, Inc.

Immediate Past President
Jim O’Neil
Senior Vice President
Headwaters Energy Services

Thank You Editorial Review Board
• Trygve Gaalaas, Pace Global Energy Services
• Janet Gellici, American Coal Council
• Jason Hayes, American Coal Council
• Rick James, We Energies
• Vic Svec, Peabody Energy

Vision Statement
The American Coal Council (ACC) strives to serve as the pre-eminent business voice of the American coal industry.

Mission Statement
The American Coal Council (ACC) is dedicated to advancing the development and utilization of coal as an economic, abundant/secure, and environmentally sound fuel source. The Association promotes the lawful exchange of ideas and information regarding the coal industry. It serves as an essential resource for companies that mine, sell, trade, transport, or consume coal. The ACC provides educational programs, advocacy support, peer-to-peer networking forums and market intelligence that allow members to advance their marketing and management capabilities.
American Coal Council Member Companies

ADA Environmental Solutions, Inc.
AEP Memco LLP
AEP/Cook Coal Terminal
Alliance Coal, LLC
Alliant Energy
Alpha Natural Resources, LLC
ALSTOM Power, Performance Projects
Ameren Energy Fuels & Services Co.
American Coal Ash Association
American Electric Power
ANDALEX Resources, Inc.
Arch Coal, Inc.
Argus Media, Inc.
Arizona Public Service
Basin Electric Power Cooperative
Benetech, Inc.
BHP Billiton
Black & Veatch
Boral Material Technologies
Burlington Northern Santa Fe Railway Co.
CAM Holdings LLC
Center for Energy & Economic Development (CEED)
Coal Marketing Company (USA), Inc.
CoalTek, Inc.
Commonwealth Coal Services, Inc.
CONSOL Energy, Inc.
Constellation Energy
Crounse Corporation
CSX Transportation
Dakota, Minnesota & Eastern Railroad Corp.
David J. Joseph Company
Diversified Energy Corporation
Dominion Energy
Drummond Company, Inc.
DTE Coal Services
DTE Rail Services
Duke Power Company
Dynegy Coal Trading & Transportation LLC
E.ON U.S. LLC
East Side River Transportation Entergy
Ernst & Young
Evolution Markets LLC
FirstEnergy Generation Corp.
Foundation Energy Sales, Inc.
FreightCar America
Fuel Tech, Inc.
Gainesville Regional Utilities
GE Rail Services
Glencore Ltd.
Global Energy Decisions
Golder Associates, Inc.
Grain Processing Corporation
Great River Energy
Hazen Research, Inc.
Headwaters Incorporated
Hellerwox, Inc.
Helm Financial Corporation
Hill & Associates, Inc.
Holcim (US) Inc./St. Lawrence Cement Co.
ICF Consulting
Ingram Barge Company
Interlake Steamship Company
Intermountain Power Agency
James River Coal Company
James River Coal Sales, Inc.
John T. Boyd Company
Kansas City Southern Railway
KCBX Terminals Company
KPx Inc.
Kiewit Mining Group, Inc.
Kinder Morgan Bulk Terminals, Inc.
Knott Floyd Land Company, Inc.
Koch Carbon LLC
Lafarge North America Inc.
Lakeland Electric
Lower Colorado River Authority
Marston & Marston, Inc.
Martin Engineering
McGuireWoods LLP
MidAmerican Energy Company
Midwest Energy Resources
Midwest Generation EME, LLC
Minnesota Power
Mitsui Rail Capital, LLC
Mon River Towing, Inc.
Natural Resource Partners L.P.
Newmont Mining Corporation
NexGen Coal Services Ltd.
Norfolk Southern Corporation
Norwest Corporation
NRG Energy, Inc.
Omaha Public Power District
Ontario Power Generation
Orlando Utilities Commission (OUC)
Pace Global Energy Services
Pacificorp
Paducah & Louisville Railway, Inc.
Peabody Energy
Pincock, Allen & Holt
Pittsburg & Midway Coal Mining Platts
PNC Bank N.A.
Portland General Electric
Powerspan
PPL Energy Plus
Pratt & Whitney
PricewaterhouseCoopers LLP
Progress Energy
Progress Fuels Corporation
Public Service Company of New Mexico
Rail Link Inc.
Railroad Financial Corporation
Rentech Inc.
Resource Technologies Corporation
Rio Tinto Energy America
Robert & Schaefer Company
Roundup Trading International, LLC
Salt River Project
Sampling Associates International
Savage Services
SCANA Corp.
SCH Terminal Co., Inc.
Sedgman
Separation Technologies LLC
SGS Minerals Services
SolArc, Inc.
Southern Company
SSM Coal Americas, LLC
Standard Laboratories, Inc.
TECO Coal Corp.
The C. Reiss Coal Company
The Coal Association of Canada
The North American Coal Corporation
The Karing Corporation
Thunder Bay Terminals Ltd.
TransAlta Utilities Corp.
Trinity Industries
Tritonman Sanders LLP
TTI Railroad, Inc.
Tucsan Electric Power Company
TXU Energy
Union Pacific Railroad Company
United Power - Division of ICAP
University of Kentucky - Center for Applied Energy Res.
University of North Dakota, Energy & Environmental Research Center
Upper Kanawha Valley Development Corporation
URS Corporation
Usibelli Coal Mine, Inc.
We Energies
Westar Energy
Western Fuels Association, Inc.
Western Region Ash Group (WRAG)
Western Research Institute
Westmoreland Coal Sales Co.
WPS Resource Corporation
WV University, Nat’l. Research Center for Coal & Energy
Xcel Energy
Xcoal Energy & Resources
Thank You ACC Champion & Patron Sponsors 2006!

**Champion Sponsors**

Andy Blumenfeld  
Vice President, Market Research  
City Place One Drive, Suite 300  
St. Louis, MO 63141  
www.archcoal.com  
(314) 994-2876

Matt Paul  
Vice President Coal & Emissions Trading  
414 S. Main St., Suite 200  
Ann Arbor, MI 48104  
www.dtecs.com  
(734) 887-2053

Charles O. Monroe, Jr.  
Sr. Vice President Coal Services Dev.  
6340 South 3000 East, Suite 600  
Salt Lake City, UT 84121  
www.savageservices.com  
(801) 944-6629

Marc Rademacher  
Vice President Business Development West  
4665 Paris St., B-200  
Denver, CO 80239-3117  
www.us.sgs.com/minerals  
(303) 373-4772

**Patron Sponsors**

Christopher Blazek  
Vice President Marketing  
1851 Albright Rd.  
Montgomery, IL 60538  
www.benetechusa.com  
blazekc@benetechusa.com  
(630) 844-1300 x214

Stevan Bobb  
Group Vice President-Coal Marketing  
PO Box 961051  
Ft. Worth, TX 76161-0051  
www.bnsf.com  
(817) 867-6242

John Ward  
Vice President Marketing & Government Affairs  
10653 S. Riverfront Parkway, Ste. 300  
South Jordan, UT 84095  
www.headwaters.com  
(801) 984-9400

---

**Mass Flow**

- Dual Bladed
- High Volume
- Variable Rate

Pebco® pioneered the development of the Mass Flow Feeder and invented the Dual Bladed Mass Flow Feeder. The Feeder eliminates vibration and helps solve asymmetric funnel flow problems in both existing and new silos. Blending with Pebco®’s Mass Flow Feeder is as simple as setting a rate. Contact us for a brochure and the industry’s most complete satisfied customer reference list.

Gates, Valves, Diverters, Automation, Controls

E-mail: sales@pebco.com  
(270) 442-1996 - www.pebco.com
Using Coal to Reduce Foreign Threats to Energy

By John Blaney, ICF Consulting

Over the past year, the world oil market has been roiled by a series of attacks on oil production, processing and distribution facilities. Because of the growing linkage between oil and natural gas prices, these attacks have also led to increased volatility in natural gas markets. In addition, the natural gas infrastructure has been directly interrupted and threatened. Not coincidentally, these sharp increases in oil and gas prices are occurring at a time of growing U.S. demand, diminishing domestic reserves, and increasing dependence on imports of oil and natural gas. In contrast, coal prices have been much less volatile. Given the volatility of oil and natural gas prices and the relative stability of coal prices, it is not surprising that there has been a surge in planned new coal-fueled electric generation builds and growing interest in coal-to-liquids (CTL) and coal-to-gas (CTG) facilities. At this critical time, with the U.S. painfully exposed to an increasingly uncertain and violent world energy market, it is imperative that we recognize the energy security value of our enormous domestic coal resources and continue to pursue an aggressive strategy to develop these resources in a sustainable way.

Energy Market Disruptions

On January 15, 2006, a rebel group attacked a Shell oil-pumping facility in the Nigerian Delta, killing 16. Other attacks followed forcing Shell to scale back its oil production by 450,000 barrels per day. Shortly after the January 15 attack, the rebel group's spokesman, Jomo Gbomo, e-mailed the Wall Street Journal with a list of demands, including the release of the group's leader. Crude oil prices rose by $2 per barrel that day in response to the group's actions.

A month later, security forces in Saudi Arabia thwarted an Al Qaeda suicide bomber attack on oil production facilities at Abqaiq, which handle about two-thirds of Saudi oil production. Oil prices increased by about $2 per barrel in the aftermath of the failed assault.

That same month, President Hugo Chavez threatened to cut off the 1.5 million barrels per day of oil shipments that Venezuela sends to the U.S. He reiterated that threat while visiting Iran in July. While the world oil market would likely rebalance with minimal impact if Venezuela were to redirect its oil exports to other countries, the threat illustrates the growing tendency of countries, as well as terrorist groups and guerilla fighters, to treat oil as an economic weapon.

In March of this year, Iran threatened to close the Strait of Hormuz in the Persian Gulf if the UN attempted to impose sanctions on its nuclear program. About 40 percent of the world's oil supply moves through the Gulf each year.

The most recent and perhaps most troubling development is the current hostilities in Lebanon between Israel and Iranian-backed Hezbollah guerillas. This fighting could expand and threaten the stability of the Middle East and the world's oil lifeline.

So in 2006, we have seen an alarming number of attacks and threatened attacks on the oil market infrastructure. These attacks have had a direct impact on oil prices. For context, every dollar increase in oil prices as a result of attacks on oil facilities adds about $7.5 billion to the U.S. oil bill. But the impact of these oil market disruptions on U.S. energy markets is broader than the direct effect on oil prices and the cost of petroleum products to U.S. consumers. As illustrated in Figure 1, natural gas prices have become increasingly linked to oil prices in recent years. In fact, natural gas prices have had

Figure 1: Natural Gas and Oil Prices are Highly Correlated
a correlation factor of 85 percent with petroleum product prices since the year 2000. This means that every 10 percent increase in oil prices translates on average to an 8.5 percent increase in natural gas prices.

Nor are the threats to world energy supply limited to oil. On January 1 of this year, Russia, the source of over 25 percent of the world’s proved natural gas reserves, cut off gas shipments to Ukraine. That action also disrupted shipments to Europe, highlighting the continent’s dependence on a potentially unreliable source for approximately one quarter of its natural gas needs. Adding to this year’s disruption is Jomo Gbomo’s rebel group. Not content with wreaking havoc on oil shipments, they are also threatening to attack Nigeria’s liquefied natural gas (LNG) facility, which accounts for about 10 percent of world LNG supplies. Thrown in on top of all of this is the fact that the Middle East accounts for 40 percent of the world’s natural gas reserves. The recent threatened disruptions to oil markets in the region mean that should the U.S. move to increase LNG shipments from the Persian Gulf they will be subject to the same risks that plague current and future oil markets.

Thus, we find ourselves in a situation where our major political and military rivals—aided by the Jomo Gbomos of the world—are using an American “addiction” to foreign energy sources as a means to hold us hostage.

Figure 2: U.S. Energy Consumption Since 1949

The Move Towards Coal

Figure 2 shows that, despite ups and downs, since the end of the Second World War, U.S. oil consumption has increased by 240 percent. Natural gas consumption has had smaller perturbations allowing it to grow at an even faster rate, realizing a total increase of 340 percent. However, over
January 31st & February 1st 2007
Ritz Carlton Key Biscayne
Miami, Florida, USA

The international networking event for the North and South American coal markets

- Meet over 250 key consumers and suppliers from the USA, Colombia, Venezuela, Canada and beyond
- Gather vital insights from a top-level faculty of international speakers
- Coaltrans returns to Miami – The paramount meeting point for the Americas


ACC members - To receive your $150 discount voucher please email gcooney@euromoneyplc.com

In 30 years of attending and participating in coal conferences - Coaltrans is the best, by far. Very professional & high quality, very organized, great agenda, well thought out, and professionally managed.
In addition, there is growing interest in using gasification processes to convert our vast coal resources into oil products and synthetic natural gas. The U.S. Energy Information Administration (EIA) projects that about 190 million tons of coal will be used in domestic CTL plants by 2030. Other sources such as the National Coal Council have projected much larger amounts of coal being used in CTL and CTG plants.

Thus, U.S. energy markets are reacting appropriately—to high and volatile oil and natural gas prices—by increasing coal use for electric generation and using conversion technologies to replace oil and natural gas. In addition, due in part to the energy security risks associated with our reliance on foreign energy sources, the U.S. Congress and the Bush Administration have also enacted the Energy Policy Act of 2005, which is channeling investment into clean coal technologies that will advance the use of our domestic coal resources in a sustainable way.

Given that each dollar increase in oil prices adds about $7.5 billion to the U.S. energy bill, the U.S. should seriously consider increasing our investment in sustainable coal development. By doing so, we can speed the development of an economic, abundant and secure, domestic energy source and minimize our growing vulnerability to the likes of Jomo Gbomo.◆

John Blaney is the Director of ICF Consulting’s Environment and Fuel Practice (www.icf.com).

2 Energy Velocity
The U.S. is standing at an energy crossroads. The easy path leads in a direction where the status quo is maintained—continued dependence on overseas energy sources, little technical innovation, and a genuine lack of long-term commitment. The second path, more likely a mountain climb, points to a radically new approach—a long-term, diverse, and committed plan of attack to secure the nation’s energy independence.

There should be little question as to the path the nation must undertake; it is one that should have been taken many years ago. While the details can be argued, there are unquestionable factual trends that point to a near-term U.S. (if not global) energy crisis, one that may very well be upon us now or very shortly. This challenge is prevalent in two areas that will prove especially burdensome to average Americans and business—transportation fuel and natural gas costs. It is in these areas that on-going issues with supply and demand, geopolitical instability, and the environment make coal particularly attractive.

According to the Energy Information Agency’s (EIA) Outlook 2006, global energy growth is expected to rise at a robust 3.8 percent/year through 2030 (the “projection period”). A central driver behind this growth is an expected tripling of energy demand in Asia during this period. Oil and natural gas demand growth are especially strong. Global oil consumption was recently up 3.4 percent, the fastest growth since 1978, and is expected to grow from 80 million barrels/day to 118 million barrels/day during the projection period. And, as surprising as it may seem, this is a slow-down from earlier projections because oil prices have jumped 35 percent since last year’s report. Beyond oil, natural gas continues to be one of the fastest growing energy sources—with demand expected to double over the projection period.

What’s Driving Demand?
The fundamental causes driving these demand projections, simply, can be attributed mostly to a continued boom in world population, an acceleration of growth in many of the less mature economies around the world, and China and India. According to the United Nations, the world is expected to grow in the range of 60—75 million persons annually from 2005—2030. More than 50 percent of this growth can be attributed to Asia (for example, China and India are expected to add roughly 8 and 16 million persons/year through 2010, respectively). To put this last fact in perspective, the combined annual population growth in China and India alone is greater than the entire population of Texas, by far the most populated state.

This global population expansion is being exacerbated by a solid trend in worldwide gross domestic product (GDP) growth. Over the projection period the global GDP is expected to double. It is easy to get buried in the numbers and lose site of the forest for the trees, so just a few more facts—one-third of the world’s population is still without electricity, the current worldwide per capita GDP is only $6,000, and China’s car ownership is expected to grow seven-fold.
over the next 25 years. Given all of these facts on economic growth potential, it is easy to see how the energy demand forecasts seem quite plausible.

These demands will put enormous new pressures on conventional fuels that can’t possibly be met entirely by traditional energy sources. The facts point to the very real possibility the world has reached (or is close to reaching) its pinnacle of crude oil production—much of the world’s major oil fields (like the North Sea, Kuwait’s Burgan Field, and Cantarell Mexico) are all on the decline. Most experts, including M. King Hubbert and his Peak Oil theory, agree the long-term trends look bleak for crude oil supplies. At home, the supply issues are similar—the U.S. has been a net importer of crude oil for over 50 years, continues to experience a dwindling of domestic production, and has not opened a new refinery in over three decades. How can industry ever expect to get past these supply constraints to meet a forecasted 40 percent increase in crude oil demand in the U.S. by 2030?

Beyond oil, the U.S. is also facing challenges meeting its natural gas demands.

This is demonstrated by new pressures to reopen deepwater drilling activities and a call to build a massive gas import infrastructure in the form of Liquid Natural Gas (LNG) terminals.

In addition to supply and demand challenges, the U.S. energy outlook is also being affected by on-going geopolitical instability and environmental concerns. Most of the world’s currently retrievable petroleum supplies are in regions ripe with conflict, tension, and future political and economic uncertainty. Last year 68 percent of U.S. imports of crude oil came from OPEC and the Persian Gulf region—these supply sources cannot be guaranteed. Coupled with this is continued evidence linking many of the older fossil fuel processing techniques with environmental damage. These forces—supply
and demand, geopolitical instability, and the environment—must drive a call to new energy approaches.

Coal and advanced processing technologies offer the U.S. one excellent near-term solution. With hundreds of years of proven coal reserves within the borders of the U.S., this abundance of supply enables commodity-like pricing with less volatility and more stability. The ability to extract coal has also improved by advancements in mining and reclamation techniques. One trip through the mined lignite fields in North Dakota will leave you thoroughly impressed with advanced reclamation processes. There have also been recent advancements in technologies to cleanly and efficiently turn coal into non-utility energy sources, like transportation fuels and natural gas.

Recently there have been a series of major technical advancements in the utilization of coal—building off the fundamentals that had lacked modernization for more than 60 years. The Department of Energy and industry have been pushing major advances in coal gasification, liquefaction, Fischer-Tropsch, and carbon dioxide sequestration technologies that deliver cleaner, more efficient, and less costly systems. These advances offer the opportunity to transform coal into a variety of useful transportation fuels (like gasoline, diesel, and jet fuel) or various gases and chemicals. It is quite possible that coal could someday soon provide a major portion of our petroleum import needs by providing an affordable source of transportation fuels and natural gas. In fact, the Department of Defense is already exploring the use of coal to take a bite out of their almost $10-billion annual fuel cost.

One of many examples of new technologies is an advanced molten metals gasifier being matured by Diversified Energy Corporation that could offer significant capital cost reductions and very high efficiencies.

In sum, coal could provide the U.S. a stable source of critical energy and a national security hedge against an over-dependence on international sources of crude oil and natural gas. The path the U.S. should choose is quite clear.

Jeff Hassannia is a Vice President at Diversified Energy Corporation (www.diversified-energy.com).
The United States has become increasingly reliant upon foreign oil suppliers and that dependence is projected to become overwhelming in the next several decades. As Figure 1 indicates, by 2035 we will rely on other countries for over 70 percent of our crude oil and more than 60 percent of all petroleum.

Furthermore, our dependence on foreign suppliers of natural gas (NG) is also scheduled to grow apace. Well into the 1980s, the United States was generally self-sufficient in terms of NG. Those days are long gone. The Energy Information Administration (EIA) projects that by 2030 NG imports will be 21 percent of supply—significantly increasing our vulnerability to supply disruption as well as the size of our trade deficit.

Our Growing Energy Dependence

By Dr. Frank Clemente, Penn State University

The Risks

1. **The cost of imports**, i.e., purchases of energy supplies, constitutes a substantial portion of our trade deficit. Each month we spend over $25 billion to bring energy from abroad. At today’s prices we will spend more than $2.6 trillion to import oil and NG over the next decade—at least $25,000 for every household in the U.S. Some of this money goes to fund terrorists, some to fund Madrass schools where young boys are taught to hate America. Imagine how we could improve our nation’s infrastructure with $2 trillion. Our grandchildren will not look kindly on this squandering of their heritage.

2. National security is at risk as our dependence on hostile and unstable suppliers grows. In his book *A Thousand Barrels a Day*, Richard Tertzakian paints a grim portrait of how oil dependence weakens national security. The risks to our nation are real:

   - We import over 10 percent of our oil from Venezuela. Hugo Chavez has loudly voiced his disdain for the United States while breaking contracts with American companies, making energy agreements with China and arms deals with Russia.
   - We plan to increase LNG imports by a factor of five over the next two decades. But 42 percent of all NG reserves are in either Russia or Iran. Russia has already used NG as a political weapon in the Ukraine and Iran has threatened to close the Strait of Hormuz—the most important energy shipping lane in the world. Are these the nations we want to rely upon for NG?

<table>
<thead>
<tr>
<th>Year</th>
<th>Crude</th>
<th>All Petroleum Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td>41%</td>
<td>36%</td>
</tr>
<tr>
<td>1995</td>
<td>52%</td>
<td>44%</td>
</tr>
<tr>
<td>2005</td>
<td>64%</td>
<td>57%</td>
</tr>
<tr>
<td>2025</td>
<td>71%</td>
<td>62%</td>
</tr>
</tbody>
</table>
3. **Competition** for energy supplies will grow increasingly intense. China, with a booming economy and 1.3 billion people, makes the headlines but the remainder of Asia, including India, is the rest of the story. Consider these facts:

- In 1990 Asia consumed 11 percent of the world’s oil. By 2025 it will use 28 percent.
- From 100 private vehicles in 1979 to 24 million today, China is projected to have over 120 million cars by 2020.
- With a population of 1 billion, India has oil reserves of only 5.7 barrels per person compared to 70 plus for U.S.
- No Asian country has reserves of more than 15 barrels per person. By 2025 there will be 4.3 billion Asians.

As Figure 2 demonstrates, the new “have-nots” of oil are former “haves.” In 2002 Indonesia, Malaysia and Vietnam all exported oil. By 2020 they will be part of the oil dole.

4. **Depletion** is the relentless foe of increased oil and NG production. The lowest fruit has been picked and new reservoirs of oil and NG are smaller, deeper, more difficult to reach and increasingly expensive to tap. Annual decline rates of various regions are stunning:

- Middle East variously estimated at three percent, six percent, and eight percent
- North Sea six to eight percent
- Gulf of Mexico 30 to 35 percent
- Barnett Fields (TX) 60 percent

These depletion issues increasingly face the largest fields in the world—Cantarell in Mexico, Burgan in Kuwait, Ghawar in Saudi Arabia and Daqing in China. Remember Spindletop?

5. **Domestic production** of oil and NG is on the ropes. Both oil and NG production peaked in the 1970s and have been declining ever since. In 1990, the United States produced 7.3 million barrels of oil per day. By 2000 this number was 5.8 million and in 2005 it was only 5.1 million. Natural gas production is not much better. We produced 19.2 trillion cubic feet (tcf) in 2000, 18.9 tcf in 2002 and only 18.2 tcf in 2005. Even our hopes in the Rockies are coming into question. The Director of the Wyoming Oil and Gas Conservation Commission recently warned that production in the Powder River Basin would drop 25 percent by the end of the year.
Yeah... coal can do that.

Today, coal fuels more than 50% of U.S. electricity. America has the largest coal reserves in the world... and greater use of this clean and affordable fuel can reduce our reliance on foreign oil and liquefied natural gas.

Peabody Energy (NYSE: BTU) is the world’s largest provider of coal to fuel 21st Century energy solutions.
6. Canada is not the answer to our NG problems either. Our northern neighbor has bailed us out in the past but with a 30 percent depletion rate in the Western basins, Canada is running on the treadmill next to us. In 2002, it took only 9,061 wells to produce 17.4 bcf/d. By 2004, however, 15,120 wells were needed to produce 17 bcf/d. A recent report by the Canadian government concluded the remaining NG resource will require significantly more wells than in the past. Canada will produce considerable oil from the oilsands. But heat is required for this process—a great deal of heat. Where will that heat come from? Natural gas, of course, leaving less and less to be exported as oilsands development proceeds.

**Concluding Comment**

Energy is the lifeblood of modern society. Our national security, economic prosperity, quality of life and the very future of our society depend upon an adequate energy supply. Yet, oil has become increasingly expensive with volatile supply and a questionable future. Natural gas may soon follow suit.

In a world of $70 per barrel of oil and $3 per gallon of gasoline, declining production, increasing demand, wars, terrorism and hurricanes, we must turn to other options. It is time for America to extensively deploy clean coal technologies to resolve our energy problems and stimulate the economy. In March 2006, a committee of the National Coal Council, chaired by Gregory Boyce of Peabody Energy, laid out an extensive plan of coal Btu conversion. Coal is abundant, affordable, secure and increasingly clean. Coal’s incredible versatility will produce electricity, liquid fuels and natural gas equivalents. We can use coal as the fuel source for ethanol and capture carbon dioxide for use in Enhanced Oil Recovery. We must count on the old workhorse to provide the energy we need to secure our socioeconomic destiny and sound a new clarion call to the future—Coal: Made in America.

---

Frank Clemente is Professor of Social Science and Energy Policy at Penn State University where his research specialization is energy policy. (Contact: fac226@psu.edu or 814-237-0787)

---

1 Spindletop was the world’s first “gusher” well. This well was located near Beaumont, TX and was drilled in 1901. The development of this well and oilfield played a key role in transforming oil production into the modern petroleum industry. However, speculation and high levels of drilling in the area caused rapid declines in production. Initial production from the well was 100,000 bbl/day. By 1904, production had dropped to 10,000 bbl/day.
The United States is blessed with abundant economic reserves of coal that will allow the nation to expand production rates for more than 100 years into the future. The U.S. demonstrated reserve base, as reported by the Energy Information Administration (EIA), totaled 494 billion tons in 2004. When adjusted for restrictions on mining due to land use, mining recovery factors and economics, the estimated recoverable U.S. reserve base stood at 267 billion tons in 2004, sufficient to sustain current production rates for well over 200 years.

Because all of America’s economic reserves are located within 2,000 to 3,000 feet of the surface and within easy reach of geotechnical data gathering techniques, the volume, quality and cost to extract America’s coal reserves are well understood. As Table 1 shows, with the exception of Central Appalachia, all of the active major supply regions contain abundant recoverable reserves that will sustain growing levels of production for the foreseeable future. These reserves are more than adequate to meet both the growing needs of the electrical generation sector as well as the emerging demand for coal as a feedstock for gas and liquid fuel production.

Current Production
A review of Table 2 demonstrates the diverse nature of current coal producing regions in the U.S. A total of 10 producing regions encompassing 20 states produced 1.13 billion tons of coal in 2005. The two most important supply regions, the Powder River Basin (430 million tons) and Central Appalachia (236 million tons), accounted for 58 percent of all production in 2005. Both of these basins produce low sulfur coal much sought after by the nation’s non-scrubbed generation fleet.

Regions
Following these two low-sulfur giants are the higher sulfur producing Northern Appalachia and the Illinois Basin, which combined accounted for 21 percent of 2005 U.S. coal production. The remaining U.S. production originates in the bituminous coalfields of the western U.S., and the lignite producing regions in North Dakota and the Gulf Coast.

### Table 2

<table>
<thead>
<tr>
<th>Mine Production 2005</th>
<th>Million tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal Region</td>
<td></td>
</tr>
<tr>
<td>Northern Appalachia</td>
<td>140</td>
</tr>
<tr>
<td>Central Appalachia</td>
<td>236</td>
</tr>
<tr>
<td>Southern Appalachia</td>
<td>22</td>
</tr>
<tr>
<td>Illinois Basin</td>
<td>93</td>
</tr>
<tr>
<td>Powder River Basin</td>
<td>430</td>
</tr>
<tr>
<td>Other Wyoming</td>
<td>16</td>
</tr>
<tr>
<td>Colorado</td>
<td>39</td>
</tr>
<tr>
<td>Utah</td>
<td>25</td>
</tr>
<tr>
<td>4 Corners (AZ-NM)</td>
<td>41</td>
</tr>
<tr>
<td>Other U.S.</td>
<td>93</td>
</tr>
<tr>
<td><strong>TOTAL U.S. PRODUCTION</strong></td>
<td><strong>1,135</strong></td>
</tr>
</tbody>
</table>

Source: EIA, Hill & Associates
Why Production Levels Will Change

A number of factors will combine to alter the existing supply-demand patterns that have characterized the nation’s coal markets since the late 1990s:

- tightening limits on emissions of SO$_2$, NO$_x$, and mercury;
- reserve depletion in Central Appalachia;
- transportation constraints; and
- coal quality issues.

Emission Limits

In 2005, the Environmental Protection Agency (EPA) finalized the Clean Air Interstate Rule (CAIR), which will effectively reduce emissions of SO$_2$ by 50 percent in 2010 and cut NO$_x$ emissions to 1.5 million tons during the same year. Another reduction of SO$_2$ emissions will occur in 2015. In addition, the Clean Air Mercury Rule (CAMR) sets a 38 ton hard cap on mercury emissions in 2010, with a reduction to 15 million tons in 2018. These tighter limits on emissions will trigger a significant increase in scrubber retrofits through the eastern half of the country. As a result, the sulfur premium currently enjoyed by Central Appalachian and PRB producers will diminish and the high sulfur coalfields of the Illinois Basin and Northern Appalachia will begin to gain market share.

A review of Table 1 shows that both of these regions have abundant recoverable reserves that will allow for significant production increases as the scrubber market develops. Although the value of coals produced in the PRB will diminish due to the lower sulfur premium, production from this key region will continue to grow as demand from new coal-fueled power plants will more than offset the loss of market share to high-sulfur regions in Eastern and Midwestern markets.

Central Appalachian Reserve Depletion

Central Appalachia has provided billions of tons of coal for use in domestic and foreign power plants, coke ovens and industrial facilities for well over 150 years. Production levels peaked in 1998 at 278 million tons as the region’s reserve base began to deplete. Although the region still has substantial reserves available for production, as the premium for low-sulfur coal diminishes, the lower cost, higher sulfur coals from Northern Appalachia and the Illinois Basin will continue to erode Central Appalachia’s market share at existing generation facilities. Thus, Central Appalachian reserve depletion will act to accelerate a shift to the higher sulfur eastern coals, as well as imported coals, primarily from Latin America.

Transportation Constraints

During the past several years, production levels in Central Appalachia and the Powder River Basin have been restrained due to the inability of the railroads to accommodate the increases in demand from coal-fueled generation plants. The railroads have responded by investing significant capital to overcome the delivery problems and these investments are beginning to result in marked improvement in car loadings and deliveries to utility customers. The railroads and barge companies will soon face new challenges as the shifting supply-demand patterns discussed previously will place new burdens on the existing rail and river infrastructure.

Future production levels among the various basins will be
There's a more reliable way to make decisions.

In today's volatile energy environment, you're under pressure to make multi-million-dollar decisions fast.

Coal industry executives, traders, risk managers, and analysts turn to Platts for the in-depth information they need to make decisions with confidence.

**Powerful Coal information conveniently delivered to your desktop or available online.**

Subscribe now and discover how you can . . .

- Get in-depth information on current and future coal markets—FAST.
- Improve forecasting and boost revenue.
- Stay up-to-the-minute on pricing, buyers, sellers, and news affecting the coal industry.

**Select from 5 information-packed reports and newsletters on Coal.**

- **Coal Outlook**
  Weekly update on who's buying, who's selling, and where the markets are heading

- **Coal Trader**
  The definitive daily news of the US coal markets

- **International Coal Report**
  Daily digest of essential news and analysis on the international steam coal and coking coal markets

- **Coal Trader International**
  Daily summaries of the news moving or hampering global coal markets

- **Historical Price Data**
  Historical price data archive of daily price reporting services in 60 categories

**Plus**—access today's most complete online energy resource.

**Platts Energy Advantage**
Highly accurate market fundamentals and more—available online 24/7.

**Rely on decades of experience.**
For more than 100 years, Platts has been delivering more depth and breadth of experience in energy markets than any other resource. Platts is the world’s leading provider of energy information serving over 10,000 customers across 150 countries.

**Start making your decisions with confidence.** To activate your subscription(s) now contact:

**Nancy Covey:** Tel: (202) 942-8719 • Email: nancy_covey@platts.com

www.platts.com
influenced by the nature and location of transportation investments. Additional capacity to transport higher sulfur coal to markets in the southeast will be required before significant production increases in these areas can be realized. If these investments are not made, it will result in higher production levels from Central Appalachia.

**Coal Quality Issues**

Many of the plants that will be installing scrubbers over the next decade were designed to consume low-sulfur coal from Central Appalachia. As a result, many may experience utilization difficulties when attempting to switch to higher sulfur coals from the Illinois Basin and/or Northern Appalachia. Differences in ash fusion temperatures, chlorine content, Btu levels and grindability may act to delay or even preempt fuel switching at many Central Appalachian-served plants. Although all of these quality issues can be overcome with investments in the plants and their coal handling systems, the timing and nature of these investments will ultimately determine the tonnage levels that will be produced among the various U.S. basins.

**Conclusion**

There is no doubt that America has abundant supplies of economically viable coal in virtually all existing supply regions that will meet the growing demand from the electric generation sector for many years to come. Because of the investments being made by power generators in the technology required to reduce coal-fueled emissions, production levels in all major basins, with the exception of Central Appalachia, are forecast to increase over the next 20 years. In addition to these highly developed supply regions, there are significant low cost reserves of lignite and subbituminous coal resident in states such as Montana, North Dakota and the Gulf Coast region from Texas to Alabama that are available for conversion to gas or liquids in order to decrease the nation’s reliance on imported LNG and oil.

---

*Jeff Watkins is President at Hill & Associates (Annapolis Office)*

(www.hillandassoc.com).

---

**United Power**

United Power is the coal and emissions brokerage division of ICAP United, Inc., a subsidiary of ICAP plc, the world’s largest interdealer broker. United’s Coal Desk provides physical and financial brokering services for all U.S. coal markets. Our Emission’s Desk provides the same quality service in SO2, NOx, Reclaim and Emission Reduction Credits.

When you need to buy, sell, or simply have a question, contact Team United.

Coal Desk: Wilton, Connecticut 203-762-8493, website [www.upicoal.com](http://www.upicoal.com)

Emission Desk: Houston, Texas 281-340-8300, website [www.unitedpwr.com](http://www.unitedpwr.com)
Different name... 

Same people. 

Same company. 

Same commitment.

Rio Tinto Energy America’s Marketing and Customer Services Group has relocated to Denver, Colorado. Please contact our Marketing Department at the following numbers:

Duke, Chris (720) 377-2078
Houston, Steph (720) 377-2065
Levar, Matt (720) 377-2043
Lynn, Jim (720) 377-2052
Kelley, Michael (303) 886-5502
Maxey, Steven (720) 377-2048
Miller, Bruce (720) 377-2045
Newsum, Gail (720) 377-2073
Nus, Tara (720) 377-2088
Ochoa, Daniel (720) 377-2044
Orchard, Jim (720) 377-2058
Pieper, Rick (720) 377-2047
Price, Jeff (720) 377-2064
Read, Steve (720) 377-2060
Roberts, Mark (720) 377-2054
Stevermer, Michael (720) 377-7020
Thorn, Leslie (720) 377-2057
Wallace, Bill (720) 377-2072

8000 E. Maplewood Ave. 
Building 5, Suite 250 
Greenwood Village, CO 80111

Kennecott Energy Company is now:

RIO
TINTO

ENERGY
AMERICA

Headquarters Office: 
505 South Gillette Avenue 
PO Box 3009 
Gillette, WY 82717 
307.687.6000 
www.riotintoenergyamerica.com
The availability of coal as a primary energy source has been, and will continue to be, critical to U.S. economic development and energy security. Thanks to U.S. transportation providers, including railroads—which haul far more coal than any other mode—the nation’s coal consumers and producers enjoy the world’s most comprehensive and efficient coal transportation system.

**Railroads Hauling More Coal Than Ever**

In 2005, U.S. railroads moved more coal than ever before, and are on pace to significantly exceed their 2005 totals in 2006. Average weekly U.S. coal railcar loadings in May and June 2006 were the highest in history; January through April 2006 were among the highest ever. Coal car loadings through the rest of 2006 are expected to continue to be at record highs.

Railroads’ strong performance follows an extended period when many utilities were favoring natural gas over coal. This trend continues today, although recent gas price spikes are encouraging utilities to strongly reconsider coal. According to Energy Information Administration (EIA) data, 193 gigawatts of new natural gas-fired electricity generating capacity were added to the U.S. electricity grid from 2000 to 2005, versus just one gigawatt of coal-fueled capacity. Utilities choosing natural gas over coal was one reason why rail coal traffic was lower in 2002, 2003, and 2004 than it was in 2001. Utilities assumed that gas would remain cheap and plentiful. Instead, natural gas prices skyrocketed, making gas-fired generation less competitive and sparking sharply increased demand for electricity generated from coal. This turnaround has imposed an unanticipated strain on coal suppliers and transporters.

This unexpectedly strong increase in coal demand occurred at the same time that overall demand for rail transportation from other commodities was rising sharply and when weather-related problems seriously disrupted coal traffic.

For example, in May 2005, two coal trains derailed on a heavily used Powder River Basin (PRB) rail line in Wyoming. The derailments were caused by a weakening of the roadbed due to a combination of accumulated coal dust and heavy precipitation. The derailments and subsequent comprehensive repair program disrupted the flow of trains to and from the PRB. Other weather-related problems affecting coal in 2005 included track washouts in Kansas in October and, of course, Hurricanes Katrina and Rita.

**Rising Coal Stockpiles**

Railroads have come under attack recently for allegedly forcing some coal-fueled power plants to reduce their coal stockpiles to low levels and allegedly forcing the plants’ owners to generate electricity from natural gas or to import coal to replace domestic coal. In some cases, demand for coal has exceeded the capability of coal producers to supply coal and transporters to haul it. Even with temporary coal disruptions, however, the reliability of the U.S. electricity grid, and coal’s role in our energy security, was never impaired. Moreover, additional costs to utilities that resulted from rail issues in 2005 are minor compared to the tremendous savings utilities have enjoyed over the years due to railroads’ efficiency and cost effectiveness.

Despite the serious weather-related disruptions to coal movements in 2005, tight rail network capacity due to record overall demand for rail transportation, and periodic production disruptions at mines, the overwhelming majority of rail-served power plants received adequate coal supplies in 2005 and so far in 2006.
In 2006, coal stockpiles have been increasing rapidly. In mid-July, the EIA noted that “electric power sector coal inventories (in May 2006) reached their highest level since the middle of 2003, growing 6.4 percent from April 2006, and they were 11.1 percent ahead of May 2005.” While many factors influence stockpiles, fluid rail operations are clearly having a positive effect.

A central factor underlying the coal stockpile issue is the deliberate efforts some coal-fueled power plants have made since the early 1980s to reduce coal stockpiles in order to improve their financial profile. By intentionally reducing coal inventories, these utilities eliminated a traditional buffer to withstand supply disruptions like the May 2005 derailments.

Railroads Are Investing Heavily

To help ensure that adequate coal-carrying capacity will be available to meet current and future coal transportation needs, railroads are, among other things, making significant investments in infrastructure and equipment.

Railroading is a network business, meaning that operational improvements or investments in one location can affect rail traffic at distant locations. Therefore, even investments made on rail lines that do not carry substantial volumes of coal can have a positive impact on railroads’ coal-carrying operations.

From 1980 through 2005, Class I railroads invested nearly $360 billion (and non-Class I railroads spent additional billions) to
Air Pollution Control

The NOxOUT® process is a Selective Non-Catalytic Reduction (SNCR) process using urea-based chemicals to control nitrogen oxide emissions. The patented process typically achieves 30% to 60% NOx reduction. SNCR can be a cost-effective option compared to other technologies on a $ per ton of NOx removed basis, and is a lower cost and a lower risk approach than going short term to the NOx allowance market. For higher NOx reductions using SCR technology, the NOxOUT ULTRA® process uses urea to generate ammonia on-site as the reagent. NOxOUT ULTRA is currently being installed for large commercial SCR projects on coal fired boilers.
The FUEL CHEM® Group offers customized fuel and fireside treatment programs to keep your boilers running smoother longer. Our programs can be a complete package inclusive of Computational Fluid Dynamics (CFD) technical service, application equipment, and chemical reagent; or in-body fuel applications requiring only chemical reagent from our multifunctional product line. Our product line can reduce your concerns with opacity and plume abatement, slag control, corrosion, and enhance combustion.

The Results Are Clear...

For more details about our company, please visit www.fueltechnv.com or call 630.845.4500
maintain and improve infrastructure and equipment, with most of this spending either directly or indirectly benefiting coal movements. After accounting for depreciation, freight railroads typically spend $15 billion to $17 billion per year—equal, on average, to around 45 percent of their operating revenue—to provide the high quality assets they need to operate safely and efficiently.

Moreover, rail spending is expected to rise significantly in 2006 and beyond, demonstrating the diligence with which railroads are doing their part to ensure our energy security through expanded coal use.

Billions of dollars of rail investments will be directed specifically at coal, including scores of new locomotives and train sets; double-, triple-, or even quadruple-tracking heavily-used coal routes; bypasses, sidings, and terminals; and new operating employees—all aimed at enhancing coal-carrying capacity, reducing cycle times, improving asset utilization, and increasing velocity.

Of course, railroads do not have unlimited funds to invest in capacity expansion. Railroads cannot afford to keep spare capacity on hand “just in case,” because their customers are not willing to pay for it and railroads cannot force them to.

Before they enhance capacity, railroads must, of course, be confident that traffic and revenue will remain high enough in the long term to justify the investments. For example, in the past, when utilities showed their preference for natural gas as a fuel source, railroads’ capital investment plans reflected this. If rail customers want added capacity to improve rail “reliability,” it is reasonable to expect those customers to commit to that capacity and pay for it.

Reregulation Not the Answer

Railroads have been rebounding from the temporary coal delivery disruptions of 2005. Nevertheless, some rail critics, including some coal consumers, want the government to once again take a far more active role in rail operations. Reregulation is bad public policy and should be rejected.

The primary objective of those who call for rail reregulation is lower rail rates, even though railroads are not earning excessive profits (recent improvements in rail earnings notwithstanding), and, in fact, consistently lag other industries in terms of profitability. Lower rates would translate directly into lower rail earnings, which would mean lower rail investments, reduced rail capacity, and deteriorating service—outcomes that are contrary to our nation’s energy security.

The Congressional Budget Office summarized the situation appropriately when it noted in a January 2006 report that: “As demand increases, the railroads’ ability to generate profits from which to finance new investments will be critical. Profits are key to increasing capacity because they provide both the incentives and the means to make new investments.”

Conclusion

Railroads move hundreds of thousands of railcars and tens of millions of tons to and from thousands of origins and destinations every day, and no commodity accounts for more carloads and tons than coal. The vast majority of these shipments arrive in a timely manner at rates reflecting efficient rail operations.

Railroads work hard to keep their coal service responsive, reliable, and productive. They meet regularly with coal companies and coal consumers to help ensure that rail service conforms to customer needs. They invest billions of dollars each year in infrastructure and equipment. These investments, along with technological improvements that enable them to use their assets more productively, have increased railroads’ coal-carrying capacity and capability as coal demand has climbed. By doing so, railroads have created a highly reliable, efficient means for our nation to use our domestic coal resources productively and wisely.

Craig F. Rockey is Vice President - Policy & Economics for the Association of American Railroads (www.aar.org).
Americans are more plugged in than ever before. Plugged in, that is, to electricity. In the past few decades our reliance on automated technology and electricity has significantly increased demand for power—demand that has strained the nation’s electric system.

Think about a few examples: electronic signs in major cities relate expected commuting times, possible detours and traffic conditions to drivers; in our buildings, heating, lighting, cooling, security, and sprinkler systems are controlled by a network of electronic monitoring devices; farmers use acoustic pest sensors in grain storage and remote imaging to monitor crop health; health care depends on electricity to monitor vital signs, detect disease and perform many types of surgery; screen readers and touchless computer keyboards help individuals with disabilities to access information and communicate; and even recreation depends on rechargeable batteries for cell phones, GPS units, cameras and flashlights.

Underlying the technology that improves the quality of our lives is the need for an uninterrupted supply of electricity. Unfortunately, due to lagging investment in our nation’s electric infrastructure over the past several decades there is great potential for people to become unplugged. Regional energy markets are developing to reduce costs and bolster reliability, but our aging transmission grid was not designed to handle this increased volume of power that is now flowing across its power lines. Clearly, investments in the electric system are necessary to meet modern needs.

Growth Is Substantial

The average U.S. household is using 21 percent more electricity than it did in 1978. Nationally, electricity usage is projected to rise another 45 percent by 2030, and a new generation of base load power plants will be needed to accommodate electricity usage today and in the future.

Annual investment in transmission
nationally declined in the decades following 1975, and the Department of Energy’s (DOE) Grid 2030 Report, issued in 2002, reported that the nation’s aging transmission system cannot keep pace with innovations in the digital information and telecommunications network. Reliance on automated systems to power new technologies and innovations has expanded public expectation for an uninterrupted supply of electricity, yet the DOE report states, “Power outages and power quality disturbances cost the economy from $25 billion to $180 billion annually. Even with adequate electric generation, bottlenecks in the transmission system interfere with the reliable, efficient and affordable delivery of electric power.”

Today’s grid congestion can mean higher electricity costs, not only because more costly generation must at times be relied on in constrained areas for reliability reasons, but also because of line losses related to how heavily the system is loaded. A revamped grid will reduce line losses and the potential for low voltages, which can dim lights, stall motors and harm computers and other sensitive electrical equipment.

**Investments Planned**

Over the next five to 10 years, new transmission investments will help meet three primary objectives:

- maintain reliable service
- connect new power plants to the grid, including large baseload and remotely sited renewable generators
- reduce congestion and foster
In April 2007, DTE Coal Services will open the DTE Chicago Fuels Terminal located on the Calumet River in Chicago, IL. When open, this new terminal will offer:

- **Solid fuel blending** – state-of-the-art facilities blending up to four different fuels at greater than 99% accuracy.
- **Storage** – will hold 1.5 million tons of various coal and petroleum coke supplies with more storage planned for a phase 2 expansion.
- **Transportation** – a wide range of rail, vessel, barge and truck transportation options for inbound and outbound deliveries, providing access to coal supplies in the Powder River, Colorado, Utah, Montana and Illinois Basins by way of the Great Lakes and the Mississippi and Illinois rivers.

DTE Coal Services is the one-stop coal solutions provider for utilities and industrials across the United States. It’s one of the largest marketers of coal in the country, and transports and markets more that 40 million tons annually to utility and industrial customers.

DTE Coal Services – your partner in managing costs and maximizing reliability of your fuel supply

dtecs.com
To meet these objectives, utilities are expanding their transmission investments substantially. The Edison Electric Institute (EEI) shows in its May 2005 survey that investor owned utilities have spent or plan to spend $29 billion on transmission infrastructure improvements from 2004 to 2008—a 60 percent increase over the previous five years.

EEI survey respondents also indicated that, on average, only a small portion of this total planned transmission investment, 6.5 percent, is attributed to direct generator interconnections. This means much of the projected investments in the nation’s transmission infrastructure will enhance the system downstream through better transfer capability between regions, improved grid reliability, and enhanced local, regional, and inter-regional markets.¹

Challenges to Transmission Improvements

Despite a clear need for a stronger grid, transmission upgrades have numerous challenges and are often considered the “hard part” of the energy facilities siting equation. The long, linear nature of a transmission line footprint means that many communities and jurisdictions can be impacted. Because the local benefit is not readily perceived by the communities through which transmission lines pass, public acceptance is more difficult to achieve.

In fact, transmission lines often have even longer planning and outreach lead times than power plants due to the challenge of developing acceptable route options; transmission lines typically take five to 10 years to place in service.

Key milestones in siting new transmission lines include: planning (needs analysis and system solution), routing (local official, environmental and public outreach and route selection), permitting (review by state utility commissions), environmental permitting of approved route, easement negotiation and acquisition, engineering and line design, construction, and restoration. Lastly, in areas where the transmission system is heavily loaded, construction efforts can be complicated when transmission lines cannot be taken out of service for necessary upgrades because doing so would cause lengthy or widespread outages for consumers. Therefore, utilities must bear the expense and safety issues associated with working on the lines while they are energized.

Transmission Supports Fuel Diversity

The EEI report also looked at the effect of generators’ fuel choices on transmission investments. The shift away from gas-fired generation to large, baseload, coal-fueled and nuclear generation and renewable generation increases the demand for new lines.

Over the last 15 years, much of the new generation capacity added in the United States has been gas-fired capacity. Coal, currently used to generate half of all electricity in the U.S. and growing, comprises a significant share of new generation under development. Most of this new coal-fueled capacity will be distant from population centers for environmental and/or fuel supply reasons. This reality will entail the construction of more long-distance transmission capability. Similarly, wind farms are often located at remote locations with site-specific wind resources. Thus, the increase in natural gas prices is driving the mix of new generating capacity to a configuration that is likely to require significant new network capacity to deliver this power from distant resources to population centers.²

The incremental cost associated with this transmission capacity appears significant. As an example, the Western Governors Association concluded that a generation expansion plan in the western United States including coal, wind, and geothermal generation would require about $8 billion to $12 billion in transmission investment over the next 10 years. Alternately, a generation expansion plan featuring gas-fired generation would require only about $2 billion of transmission investment. However, the EEI report also recognizes that natural gas, which accounts for 20 percent of all generation, saw price increases of 100 percent since 2003. Oil and coal saw price increases of 50 and 20 percent respectively.³

INTERNATIONAL CONSULTANTS PROVIDING:
- Geological & Engineering Services
- Geophysical Logging Services
- Mine Engineering Services
- Operations Analysis
- Environmental & Permitting
- Financial/Economic Modeling
- Environmental Services
- Coalbed Methane
- Project Management
- Mine Planning & Feasibility Studies

HEADQUARTERS
P.O. Box 848 • Bluefield, VA 24605
(phone) 276.322.5467 • (fax) 276.322.5460

OFFICE LOCATIONS: VA • WV • KY • NC • PA • KS • LA • TN

AFFILIATED OFFICE LOCATION: Shanxi Province, PRC
Benefits of a Strong Network

A modern, robust transmission grid benefits the nation’s electricity supply in a number of ways:

- **Reliability**—Modernizing the grid helps meet demand growth, delivers power and gives operational flexibilities to manage power flows and avoid blackouts.
- **Regional efficiencies**—Transmission grids facilitate energy markets that dispatch economic generation first and allow broad geographic areas (including states that are generation-deficient) to rely on regional reserves.
- **Rates**—Transmission, the smallest component of an electric bill at roughly six percent, is a good investment because a strong network can access electricity from diverse fuel sources, helping to insulate consumers from price spikes. A strong grid also reduces energy losses and congestion costs.
- **Renewable energy**—As more states enact renewable energy requirements, the transmission grid must transport “green” power to consumers, often from remote locations.
- **Technology**—Because today’s world relies on automation to perform many necessary functions, the consequences of momentary power outages have increased. A strong transmission system helps meet modern expectations of power supply and quality.

According to the North American Electric Reliability Council, more than 12,484 miles of transmission line will be added over the 2005 to 2014 time frame, a nearly six percent increase over the total number of extra-high voltage transmission lines in existence today. Nearly 1,200 miles of new or upgraded transmission lines will be added in 2006 alone. These improvements will bring the economic benefits of a high quality supply of electric power to communities across the nation.

### About ATC

American Transmission Co. owns and operates the high-voltage electric transmission system in portions of Wisconsin, Michigan, Minnesota and Illinois. It has nearly 8,900 miles of transmission line and 480 substations, and plans to invest more than $3.5 billion over the next 10 years to improve the reliability of its transmission network.

Mark Williamson is Vice President, Major Projects for American Transmission Co. (www.atcllc.com)

---

2. The Brattle Group.
3. Ibid.
4. Ibid.
Ameren Energy Fuels and Services Company (AFS) provides a full range of fuel-related services to the Ameren group of companies. However, AFS also works with some unaffiliated businesses, assisting with specific fuels and emission related issues.

AFS procures over 37 million tons of coal from the Powder River and Illinois Basins for use in the Ameren generation fleet. In addition to procurement, AFS provides transportation services related to negotiating and administration of rail, barge and truck contracts, as well as the management of over 5000 system railcars.

Management and marketing of three river terminals on the Mississippi River is another responsibility for AFS. These terminals provide blending and rail to water trans-loading services for both in-house and third party users.

Combustion by-product services for beneficial use such as flowable fill projects as well as ash disposal options are additional services provided by the AFS team.

AFS provides all procurement of natural gas on both the wholesale and retail level to over 925,000 customers in the Ameren UE, Ameren Energy Generating Company, Ameren CILCO and AmerenIP territories. AFS is also currently working to develop coal bed methane (CBM) projects as well.

Market research is an additional function of AFS, providing senior management as well as plant operations with the necessary information required to keep on top of the ever-changing fuel and transportation markets.

Renewable energy resources and the development of “green generation projects” is yet another area of responsibility for the AFS group.

Peer Review Ensures Research Integrity

By Josie Gaskey, The Annapolis Center for Science-Based Public Policy

Peer review. The mere mention of the term can elicit yawns of indifference, but its importance cannot be overstated. “Peer review” implies that whatever you’re reading is high-quality science and somewhat sacred. It represents not just the thinking of one scientist, but rather a group of scientists, bent on ensuring that their research is correct and beyond reproach.

Enter South Korean stem cell scientist Hwang Woo Suk. When Hwang’s claim, published in a 2004 article in the journal Science, announced the dramatic possibility of using embryonic stem cell therapy for human cloning and for treating incurable diseases, the world’s excitement was inevitable. But then came the findings of an investigation into Hwang’s results by an eight-member peer review panel at Seoul National University. Their findings indicated that his studies were fakes…and the issue of peer review became a hot topic around the world.

But is it really appropriate to question the peer review process for a calculated deception? Every day, the issue of peer review plays a role in the medical, environmental, scientific and the legal arena. Even Wikipedia—the online free encyclopedia—now devotes a section to peer review.

Why is Peer Review so Important?

Let’s take a step back for a moment. Merriam Webster indicates that peer review is “a process by which something proposed (as for research or publication) is evaluated by a group of experts in the appropriate field.” This process is thought to have become standard in the late 1700s when the Secretary of the Royal Society of London’s Philosophical Transactions began sending manuscripts to established scientists for review prior to publication. However, popular writings indicate that the peer review process has really only been around since the middle of the twentieth century. With wider applications of science to guide public policy making, “peer reviews” of other sorts have developed. These include processes to (1) assure data integrity (through audits to detect error and/or misconduct) and (2) assure data utility (through advisories on the applicability of scientific findings to regulatory decisions). However, more novel forms of peer review have emerged. The newer arrivals may be distinguished by their political objectives rather than scientific goals.

Complaints surrounding peer review indicate that it is an elitist process, as well as being slow and time consuming. With respect to being slow and time consuming, however, one could make the argument that the opposite is now true due to the speed and efficiency of the electronic world and that this speed acts to the detriment of the peer review process. Other complaints have to do with lack of transparency and how associated issues, such as defining consensus and assuring balance, are handled within the process.

Executive Order 12866, issued in 1993 by President Clinton, granted the Office of Management and Budget (OMB) the authority and responsibility to address agency peer review practices. In 2003, as part of an ongoing effort to “improve the quality, objectivity, utility and integrity of information disseminated by the federal government to the public,” OMB proposed to issue new guidance on meaningful peer review...
of the most important scientific federal government regulatory topics. On December 16, 2004, OMB issued its “Final Information Quality Bulletin for Peer Review.” Under this Bulletin, agencies are granted discretionary powers with respect to formulation of a peer review mechanism. To ensure that the process is cost effective, the requirements for more intensive peer review apply only to the most important federal scientific assessments. According to the Bulletin, agencies “must ensure that the peer review process is transparent by making available to the public the charge to the peer reviewers, the peer reviewers’ names, the peer reviewers’ report(s) and the agency’s response to the peer reviewers’ report(s).”

But there are gaps, i.e., unresolved issues and controversies, regarding this Bulletin. Many groups expressed concerns over unaddressed issues in the Bulletin with respect to topics such as openness requirements and who has final say over whether peer review is adequate. Questions arose about the actual data that forms the backbone of these reports and studies. Shouldn’t the actual data be part of a “transparent” process? And what about the models used to make predictions? Shouldn’t the models and the input to the models also be available to allow an independent reviewer to replicate the results? Should the same peer review process be used for scientific journal articles as for regulatory policies requiring expenditures of billions of dollars?

Many scientists, academics, elected officials and taxpayers believe these important issues must be addressed. The House Energy and Commerce Committee (HECC) recently released a report that critiqued and assessed the validity of the so-called “hockey stick” theory of global temperature change authored by paleoclimatologist Michael Mann in 1998. The conclusions in the HECC report noted that this research contained basic statistical errors that led one to question the papers’ conclusions. The report also raised the issue of “social-network analysis” where the network of researchers is so incestuous that it affects their ability or desires to “…reassess their positions without losing credibility.”

The Annapolis Center for Science-Based Public Policy is dedicated to promoting responsible energy, environmental, health and safety decision-making. The Center has developed three sets of “Annapolis Accords,” providing vehicles to assist a nonscientist or economist in evaluating the quality of science. These Accords (or principles) include: Risk Analysis, Cost-Benefit Analysis and Toxicology.

Because the issue of peer review is so vital, the Center is currently developing a fourth accord—Peer Review. We are approaching this project in three major phases in an attempt to fill a need for consensus on the best means and methods to achieve the full potential of peer review. This project includes identifying the “best practices,” comparing those practices to the OMB guidelines, addressing outstanding issues not covered by OMB, developing a template for the most comprehensive and rigorous peer review, establishing a “grading system” and applying the guidelines to specific regulatory and scientific journal processes.

The project’s first phase examines the different areas where peer review is currently being utilized—scientific, legal, medical and regulatory—and how peer review is applied within those areas. Potential groups to be examined include, but are not limited to, IRIS, NAS, FDA, OMB, CASAC, JAMA, TERA, etc.

As part of the second phase of this
project, the Center will hold a workshop to develop the “gold standard” for peer review and establish a grading system that would judge when a scientific study, report or article can be used as the basis for setting regulatory programs. This workshop will be completely transparent and have four concurrent paths along each of the four major areas–environmental, medical, scientific and legal journals. The goal is to develop a template for the most comprehensive and rigorous peer review process. Results of the workshop will be published.

The third phase will use a grading system to apply the guidelines to specific regulatory, legal, medical and scientific processes to judge the adequacy of scientific reports, journals or studies to be used as the basis for regulation.

The Annapolis Center is interested in receiving thoughts and comments on this project, as well as input as to which experts should be involved. Contact The Annapolis Center at info@annctr.org with your comments.◆

Josie Gaskey is Sr. Vice President of The Annapolis Center for Science-Based Public Policy (www.annapoliscenter.org).
CONNECTING A NATION

For over 140 years, we’ve been carrying the materials and finished goods that America needs. Each day, we deliver the coal that powers America’s homes, schools and workplaces. The 48,000 men and women of Union Pacific are proud to serve the coal industry, yesterday, today and well into the future.

PROVIDING AUDIT, TAX AND RELATED FINANCIAL SERVICES TO US COAL MINERS AND THE MINING INDUSTRY AROUND THE WORLD

We’re on the ground where you're in the ground.

Contact Steve Ralbovsky, US Mining Leader
(602) 364-8193
steve.ralbovsky@us.pwc.com
pwc.com/schoolofmines

©2003 PricewaterhouseCoopers. PricewaterhouseCoopers refers to the individual member firms of the worldwide PricewaterhouseCoopers organization. All rights reserved.
The U.S. is energy hungry. We have an ever increasing appetite for new affordable, reliable and clean sources of power. At best, aggressive demand-side energy conservation programs might slightly curb this growing appetite. Therefore, an economic, abundant, secure and environmentally sound domestic energy source, like coal, is essential to maintaining our energy supply.

Our growing energy appetite requires continued improvement to the existing coal-fueled energy infrastructure, along with a commitment to developing new sources of energy. As energy efficiency expands its role as a key market driver, there will be greater attention given to cleaner and more efficient use of coal. To meet this challenge, competing coal technologies will be pushed to achieve near-zero emissions performance, while also being held to the traditional standards of supplying affordable and reliable energy. This means that future demands on clean coal developments will pose technology challenges and opportunities for both new and existing coal-fueled energy.

Today, coal satisfies more than 50 percent of the U.S. energy needs and even with an increased emphasis on cleaner more efficient new power, the U.S. can expect to continue its heavy reliance on nearly 330 gigawatts (GW) of power produced at existing and upgraded coal-fueled power plants. Recognizing this fact, even the best performing emission control technologies for new power generation will need to be compatible with existing coal-fueled generation, and across the range of different coal types.

While the U.S. energy portfolio is seeing a wider acceptance of energy from nuclear, natural gas, oil and a growing list of renewables—most notably wind power—the demand for coal-fueled energy is expected to continue to grow beyond the capacity of the existing power fleet. It should come as no surprise, therefore, that to satisfy this expanding energy appetite, a number of clean coal technologies have re-emerged around the globe. Driven by new market

A Low-Carb Diet for an Energy Hungry Nation

By David Foerter, Institute of Clean Air Companies
CONVEX MIRROR SYSTEMS FOR LARGE OFF-ROAD TRUCKS

Let E.S. & S. equip your trucks with the best mirrors available!

- **DECREASE**
  - DOWNTIME
  - INJURIES
  - EQUIPMENT DAMAGE

![Convex Mirror]

Visibility Aids... Because sometimes what you can't see, can hurt you!

— E.S. & S.

P.O. Box 742 • Pleasanton, CA 94566-0074
(925) 462-4393 • Fax (925) 484-5173
incentives and reductions in social and regulatory barriers, these technologies are primarily focused on the creation of new power generation capacity.

As a result, the clean coal arena is abounding with coal-fueled combustion acronyms such as PC (pulverized coal), CFB and its younger sibling PFB (circulating and pressurized fluidized bed), as well as IGCC (integrated gasification combined cycle, which is a power plant option using synthetic natural gas, or syngas, a fuel derived from coal).

While much is changing in the energy world, the contribution and improving performance of traditional coal-fueled energy options is still valued. As alluded to above, existing technology will continue to play a key role in our energy generation future. By continuing its successful evolution from subcritical boilers—recognized as the reliable work horse for industrial and utility applications—into highly advanced, efficient, clean and affordable super- and ultra super-critical boilers, PC technologies are expected to maintain their commanding share of the market for new coal-fueled power.

First generation supercritical PC boilers emerged in the 1960s, as did CFB coal applications, although significant market drivers for this advanced PC technology would lag for another 40 years, particularly in the U.S. Similarly hampered by lack of strong market conditions, IGCC took root and has been under development since the 1970s. All of these technologies represent clean coal due to higher energy efficiencies and the application of air pollution control technology in pre-combustion, combustion or post-combustion. With new power markets increasingly driven by the need for cleaner more efficient power, comparisons of these clean coal technologies must recognize the real-life successes of the newest units.

Issues of energy efficiency—closely coupled with reducing CO₂ emissions—are driving the market incentives for, and the development of, these advanced clean coal technologies. For example, globally, energy efficiency and CO₂ reductions are commonly accepted considerations for new power. Locally, they also play a role through state permitting and initiatives such as RGGI (regional greenhouse gas initiative). So if the barriers are being stripped away and markets should favor energy efficiency and lower CO₂ emissions options, what is the best way to promote the penetration of coal-based options into the market? What are some challenges we might need to address in our quest to secure an affordable low-carbon energy future?

**Challenges**

Markets, markets, markets... customer and client needs drive markets and market competition drives innovation. In this environment, single option solutions increase the risk of failure; stranding investments, time and effort. Government’s role is to regulate and require a minimum performance standard and then allow independent, fact-based and informed decisions to guide development of the markets. Market participants let the market weigh the value of various fuel choices, energy reliability and the economics of technologies. Just as with any other competition among technologies, allowing governments to pick and choose a winner is a mistake. Take away competition, and an entirely different future is created. Invest too heavily in one option, and you become technology stranded. Properly understood, it is the role of government to establish and monitor the regulatory requirements, and then technologies need to compete, relying on market decisions to make final selections.

As energy efficiency and CO₂ reduction take on a greater importance, we must consider those technologies that augment existing coal-fueled power systems, not just those that require a new fuel source. We cannot afford to replace all of our existing power generation with a new technology. The criteria for market-ready clean coal technologies will necessarily include: the ability to work with existing systems, reliability, lower cost, increased efficiency, the ability to reduce CO₂ emissions, and (perhaps) flexibility in using different coal types.

**Carb Counting**

Energy efficiency improvements translate to reduced CO₂ emissions and can account for as much as 20 percent of overall CO₂ reductions. It is a basic scientific fact that all technologies, operating at the same
efficiency, produce the same amount of CO$_2$ per megawatt-hour (MWh). Increase efficiency and CO$_2$ production per unit of energy consumed is decreased. Today, PC is not only promising further advancements, but can already guarantee thermal efficiency rates greater than 40 percent. Further advancements promise practical thermal efficiency limits near 50 percent.

Carbon dioxide storage is a point of common interest for all technologies. As with similarities in CO$_2$ production, it is a fact that once captured and compressed, the costs of CO$_2$ sequestration will be the same regardless of the technology option from which they were generated. Carbon dioxide can be captured from all coal generation technologies. The costs of doing so differ based on concentrations in gas stream and pressure. This results in higher initial capital cost for IGCC (cost of water-gas shift reactors) and higher cost per ton of CO$_2$ capture for PC combustion. However, suppliers are competing to develop lower cost, lower power solvents that can be applied to combustion, both for existing and new power generation. Competition drives innovation and is the most likely the path to lower cost options.

**Tightening the Belt**

Clearly, all new power generation benefits from and requires integration of new technologies during design. In addition, all technologies for new coal are reaching ultra-low levels of emissions, with CO$_2$ reductions extending beyond efficiency improvements remaining as the single biggest challenge. Today, there are multiple paths for CO$_2$ reduction innovations for future applications including advanced supercritical boilers with MEA (monoethanolamine), advanced amines, ammonia scrubbing, and oxyfiring to concentrate CO$_2$; IGCC and advance turbines; and ultra supercritical boilers with advanced CO$_2$ capture. Some possible paths to carbon-free power include, ultra supercritical PC and CFB striving for greater than 48 percent HHV (higher heating value), co-firing of biomass for partial replacement of fossil fuels, and post-combustion capture of greater than 90 percent CO$_2$.

The American economy is energy hungry and it thrives on innovation as well as economic, abundant, secure and clean power. Markets are needed to create incentives for innovation and as a pathway to lowering costs. Entry into these markets can be encouraged by promoting research and development, demonstrations, and commercialization of CO$_2$ capture technologies—with a sober understanding that a low-carbon energy diet will require technologies that can be applied to both new and existing power generation.

Coal has been a very valuable natural resource since our nation’s founding. Coal is and will continue to be an essential part of our energy diet, simply because it is abundant, has proven reliability, is relatively inexpensive and can be made clean. Clean coal can be tomorrow’s extraordinary, even complete natural resource.

David Foerter is Executive Director for the Institute of Clean Air Companies (www.icac.com).
Coal-to-Liquids: A Solution to Energy Problems

By Ken Frailey, Theo Lee, Jim Lepinski and Sam Tam, Headwaters Energy Services Corp.

It’s easy to see why coal-to-liquids (CTL) is attracting significant attention these days. In the president’s words, the United States is addicted to oil. U.S. petroleum imports in 2005 exceeded $250 billion. Natural disasters have disrupted oil production and refining on the U.S. Gulf Coast. Political instability in the Middle East is a constant threat. Fuel prices have rapidly escalated along with world oil prices that are reaching levels unseen since the 1970s energy crisis.

The situation is not likely to get much better in the future. Global oil demand was 84.3 million barrels per day in 2005. The United States consumed 20.7 million barrels per day (24.5 percent) and imported 13.5 million barrels per day of petroleum products. Worldwide demand for petroleum products is expected to increase 40 percent by 2025, largely due to growing demand in China and India. World oil production could peak before 2025. Most of the remaining conventional world oil reserves are located in politically unstable countries.

In contrast, coal remains the most abundant fossil fuel in the world and the U.S. has more coal reserves than any other country. With CTL technology, the U.S. can take control of its energy destiny. Any product made from oil can be made from coal.

At today’s oil prices, CTL is economical and has the power to enhance energy security, create jobs here at home, lessen the U.S. trade deficit, and provide environmentally superior fuels that work in today’s vehicles. By building even a few CTL plants, the U.S. would increase and diversify its domestic production and refining base—adding spare capacity to provide a shock absorber for price volatility.

What’s behind this technology? And what will it take to deploy it in the United States? This article is intended to address both questions.

What is CTL?

CTL is the process of converting solid coal into liquid fuels. Coal typically contains only five percent hydrogen, while distillable liquid fuels such as petroleum typically contain 14 percent hydrogen. The hydrogen deficit can be made up in two different ways:

**Direct Coal Liquefaction (DCL)**
Coal + Catalyst + Hydrogen ($H_2$) $\rightarrow$ Hydrocarbons ($C_xH_y$), or

**Indirect Coal Liquefaction (ICL)**

1. Gasification: Coal + Oxygen + Steam $\rightarrow$ Syngas ($H_2$ + CO)
2. FT Synthesis: $H_2$ + CO + Catalyst $\rightarrow$ Hydrocarbons ($C_xH_y$)
The Shairzal Emergency Refuge Station, used extensively in Australian and Mexican mines, is now available in the United States. **Strata Products (USA) Inc.** is the exclusive distributor in the United States.

These stations provide an immediate safe haven for miners in the event of life threatening emergencies underground. They also provide a storage area for essential supplies such as SCSRs, drinking water, food and first aid kits. Fresh, breathable air is fed into the chamber either through a permanent connection to the mine’s main air line, or from the Shairzal Refresh 48 Breathing Air System.

This air system consists of medical grade oxygen cylinders and a CO₂ scrubber. Oxygen is released into the chamber at rates controlled by an oxygen flow meter. Soda lime chemicals, used in the scrubber, remove the CO₂ from the air. The standard supplies last 48 hours but this is fully scalable up or down.

---

**Conveyor Accessories for the Coal Industry**

- **Conveyor Belt Cleaning**
  - Precleaners
  - Primary & Secondary Belt Cleaners

- **Conveyor Sealing**
  - Skirtboard Clamps
  - Skirtboard Rubber

- **Conveyor Impact Protection**
  - Impact Saddles
  - Impact Idlers

- **Pulley Lagging & Wear Liners**
  - Ceramic & Rubber Pulley Lagging
  - Ceramic/Rubber & Rubber Wear Liners

---

**SAI**
SAMPLING ASSOCIATES INTERNATIONAL, L.L.C.
P.O. Box 338
Newport News, VA 23607-0338
Phone (757) 928-0484
Mobile (757) 876-5217
Fax (757) 244-5697
Email preagan@samplingassociates.com

---

**RICHWOOD**
Toll Free: 800-237-6951
www.richwood.com

---

**Strata Products (USA) Inc.**
3939 Roswell Rd Suite 100
Marietta, GA 30062
1.800.691.6601
info@strataproducts.com

---

**EMERGENCY REFUGE CHAMBER**

**Top:** Emergency Refuge Station
**Right:** Interior view of Station including the back-up air supply system
Direct coal liquefaction involves mixing dry, pulverized coal with recycled process oil and heating the mixture under pressure in the presence of a catalyst and hydrogen. Under these conditions, the coal transforms into a liquid. The large coal molecules (containing hundreds or thousands of atoms) are broken down into smaller molecules (containing dozens of atoms). Hydrogen attaches to the broken ends of the molecules, resulting in hydrogen content similar to that of petroleum. The process simultaneously removes sulfur, nitrogen and ash, resulting in a synthetic crude oil (syncrude) which can be refined just like petroleum-derived crude oil into a wide range of ultra-clean finished products.

Indirect coal liquefaction is a two-step process consisting of coal gasification and Fischer-Tropsch (FT) synthesis. Coal is gasified with oxygen and steam to produce a synthesis gas (syngas) containing hydrogen and carbon monoxide. The raw syngas is cooled and cleaned of carbon dioxide and impurities. In the FT synthesis reactor, the cleaned syngas comes in contact with a catalyst that transforms the diatomic hydrogen and carbon monoxide molecules into long-chained hydrocarbons (containing dozens of atoms). The FT products can be refined just like petroleum-derived crude oil into a wide range of ultra-clean finished products.

**DCL Historical Development and Status**

DCL originated in Germany in 1913, based on work by Friedrich Bergius. It was used extensively by the Germans in the Second World War to produce high-octane aviation fuel. Since that time, tremendous advancements have been made in product yields, purity and ease of product upgrading.

From 1976 to 2000, the US government invested approximately $3.6 billion in DCL facilities. As of 2000, there were no commercial DCL facilities operating in the US.

**Sketch of Shenhua’s DCL Facility in Inner Mongolia, China**

**Sasol’s ICL Facility at Secunda, South Africa**

**Leading the U.S. Market in Engineered Performance Improvements**

- Optimized plant retrofits with demonstrated performance improvements
- PRB conversions that have maintained original nameplate steam flow
- Economizer exit gas temperature control modifications for SCR applications
- State of the art firing systems for NOx control
- Cost effective mercury reduction solutions

**“Your Boiler Solutions Company”**

Visit us at www.power.alstom.com or contact your local ALSTOM sales representative.
(1999 dollars) in improving and scaling up DCL. During this time, pilot and demonstration facilities ranging from 30 to 1800 barrels per day of liquid fuel were built and operated in the U.S. The end result of this effort is the HTI DCL process developed by Hydrocarbon Technologies Incorporated (HTI), a subsidiary of Headwaters, Incorporated.

In June 2002, the largest coal company in China (Shenhua Group) agreed to apply HTI’s technology for the first phase of a three-phase multibillion-dollar DCL project. The Shenhua DCL facility in Inner Mongolia is currently under construction and is scheduled to startup in late 2007 or early 2008. The first phase, as currently configured, has a capacity of 20,000 barrels per day.

Additional DCL projects are currently being studied or planned in India, the Philippines, Mongolia and Indonesia. The Philippines project is based on hybrid DCL/ICL technology.

ICL Historical Development and Status

ICL was developed in Germany in 1923 based on work by Drs. Franz Fischer and Hans Tropsch. During the Second World War, the technology was used by Germany to produce 17,000 barrels per day of liquid fuels from coal.

In 1955, Sasol constructed an ICL plant at Sasolburg, South Africa. Additional ICL plants were constructed by Sasol in Secunda, South Africa. Today, Sasol produces the equivalent of 150,000 barrels per day of fuels and petrochemicals using its ICL technology. Technologies for ICL are also being developed by Shell, Syntroleum and Rentech.

ICL projects are currently being studied or planned in China, Philippines, Germany, Netherlands, India, Indonesia, Australia, Mongolia, Pakistan and Canada. In the United States, ICL projects are being considered in Alaska, Arizona, Colorado, Illinois, Kentucky, Louisiana, Mississippi, Montana, North Dakota, Ohio, Pennsylvania, Texas, West Virginia and Wyoming.

Comparison of DCL and ICL

One of the main differences between DCL and ICL is the quality of the raw liquid products. DCL raw products contain more ring structure. Therefore DCL naphtha is an excellent feedstock for production of high-octane gasoline, while DCL distillate requires considerable ring opening (mild hydrocracking) to generate on spec diesel fuel. On the other hand, the straight-chain structure hydrocarbons produced by ICL technology result in high-cetane diesel fuel but ICL naphtha needs substantial refining (isomerization and alkylation) to produce on spec gasoline. Both processes produce low-sulfur, low-aromatic fuels after the refining step. DCL and ICL can be combined into a hybrid DCL/ICL plant that produces both types of products that can be blended into premium quality gasoline, jet fuel and diesel with minimum refining.

ICL plants usually include combined-cycle electric power plants because they produce a substantial amount of steam and fuel gas that can be used to generate electricity. DCL plants produce less steam and fuel gas, so they can be designed to purchase electricity, be self-sufficient in electricity generation or generate excess power depending on the local market conditions.

DCL plants produce more liquid fuel per ton of coal than ICL plants. However, ICL plants are better suited for polygeneration of fuels, chemicals and electricity than DCL plants.
The preferred feedstock for DCL plants is low-ash, sulfur-bearing, sub-bituminous or bituminous coal. ICL plants have greater feedstock flexibility and can be designed for almost any type of coal ranging from lignite to anthracite.

**Environmental Characteristics of CTL Fuels**

Fuels produced by CTL processes can be used in existing engines without modifications and can be distributed through existing pipelines and distribution systems. Nevertheless, they are exceptionally clean when compared to today’s petroleum-derived transportation fuels.

ICL fuels derived from the Fischer-Tropsch process, in particular, contain substantially less sulfur and also exhibit lower particulate and carbon monoxide emissions. These fuels also contribute less to the formation of nitrous oxides and they are readily biodegradable.

The production of CTL fuels is also environmentally responsible. Because CTL processes remove contaminants from coal prior to combustion, process emissions from CTL plants are much lower than

### Global oil demand was 84.3 million barrels per day in 2005. The United States consumed 20.7 million barrels per day (24.5 percent) and imported 13.5 million barrels per day of petroleum products.
traditional coal-fueled power plants. Both DCL and ICL plants generate carbon dioxide in a highly concentrated form, allowing capture and sequestration. Without CO₂ capture, DCL plants emit half as much CO₂ as ICL plants of the same capacity. CTL plants with carbon dioxide capture and sequestration can produce fuels with life-cycle greenhouse-gas emission profiles that are as good as or better than that of petroleum-derived products.

### CTL Project Opportunities and Challenges

CTL projects are capital intensive. DCL costs slightly less than ICL ($50,000-$60,000/bpd versus $60,000-$80,000/bpd). Escalating capital costs related to raw materials prices and equipment availability make small CTL projects less economical and may force some developers to look at larger capacity projects on the order of 30,000 to 80,000 barrels per day to take advantage of economies-of-scale.

High capital costs ($2.5 billion to $6 billion per project) and large project size (30,000 to 80,000 barrels per day) will dictate where and how viable CTL projects can be built. Multiple partners will likely be required to spread the risks and costs. These partners may include coal suppliers, technology providers, product users, operators, or private equity providers.

Large, low-cost coal reserves (from 500 million tons to over 1 billion tons) will be needed; preferably dedicated to the project. CTL can be adapted to handle any kind of coal through proper selection of the coal gasification technology.

The accompanying graph indicates the impact of plant size on project economics. Large CTL plants (30,000 to 80,000 barrels per day) can compete with petroleum-derived products when crude oil prices exceed $35 to $45 per barrel. In this case the debt to equity ratio was assumed to be 70:30 and did not include any volumetric excise tax credit (VETC) on product sales. This graph is only for discussion purposes. Economic analysis should be based on site-specific conditions for each project.

Projects in the eastern United States will favor locations on inland water ways to facilitate delivery of large equipment and coal, supply of water and distribution of finished products. Projects in the western United States will favor mine-mouth locations with pipelines for product distribution.
Although larger scale CTL projects appear to be economically viable in today’s oil price environment, there are still significant hurdles to getting projects built. There are no CTL plants operating in the U.S. that would serve as commercially proven models. Until that happens, financial institutions will be reluctant to fund multibillion-dollar CTL projects without significant technology and market performance guarantees. This includes some assurance that plants will not be rendered uneconomical by oil-producing nations that may seek to artificially reduce oil prices just long enough to prevent the formation of this competitive new industry.

Federal and state governments have begun devising incentives to help push CTL projects forward. Some of the federal incentives currently under discussion include:

1. Loans or grants to fund front-end engineering and design for CTL projects. (This represents high-risk, up-front money that can amount to $50 million or more per project.)
2. Extension of the 50 cents per gallon volumetric excise tax credit for CTL fuels from 2009 to 2020 or beyond.
3. Loan guarantees for the first few CTL plants.
4. Investment tax credits for CTL plant construction.
5. Accelerated depreciation of CTL plant investments.
6. Authorization for the Department of Defense to contract up to 25 years for fuel purchases. (The Department of Defense consumes 370,000 barrels per day of liquid fuels that could be supplied by CTL plants.)

Support for CTL development incentives is growing in many sectors. Reports this year by both the Secretary of Energy’s appointed National Coal Council and the Southern States Energy Board have called for significant public investments in developing an American CTL capability to enhance the nation’s energy security. The National Mining Association has created a coal conversion working group that is striving to support all levels of the growing CTL movement. Numerous bills supporting CTL have been filed in both houses of Congress.

As energy security continues to increase its profile as an issue of paramount importance for our nation, CTL stands out as a vital, near-term solution. Instead of sending hundreds of billions of dollars to politically unstable oil-producing nations, the United States can invest in an industry that will employ American workers using American resources to produce fuel for its own use. That fuel can be used in today’s existing cars, trucks, buses, trains and airplanes. And it can be produced using demonstrated technology in an environmentally responsible manner.

Breaking the national addiction to oil will require finding new sources of energy to rely on. To do that, America needs to look no further than its own abundant coal reserves. ◆
Coal-to-Gas Conversion: Pipeline to Energy Security

By Martin Considine and Richard Weissman, Ph.D., Peabody Energy

High natural gas costs for most of this decade threatened U.S. industries and family budgets. During the 1990s, seemingly abundant natural gas supplies led to a surge in construction of gas-fired power plants.

But the gas bubble burst dramatically in 2000, leaving consumers and industry with heavy price tags. Natural gas supplies became scarce and prices soared. For instance, in 2005 the delivered price of coal to electricity generators was $1.54 per million Btu, compared with $8.20 per million Btu for natural gas.

And there is no end in sight. Even during the summer season, when natural gas is usually being stored for winter use, we have seen unprecedented withdrawals of gas from storage to be used in electricity generation. Forward natural gas prices are ranging from $7 to $11 per MMBtu through 2011.

Prices for liquefied natural gas, viewed as a major source of new U.S. gas supply, are being increasingly linked to costly global oil prices. LNG supplies into the U.S. market have fallen short of projections as shipments are diverted away from the U.S. to higher-paying countries.

There is a solution for driving down energy costs and improving energy security: transforming the energy in coal—our most abundant domestic fuel—into other valuable forms of energy through “Btu Conversion.” Technology is available to turn coal into pipeline quality synthetic natural gas in addition to transportation fuels and hydrogen.

Consider that a long-standing and proven industrial chemical process that produces “Town Gas” can be used to convert coal into gas. This process has been used for illumination and heating since the 19th century, prior to the availability of relatively plentiful and inexpensive natural gas in the early 20th century.

Modern coal gasification can fill a number of cost-effective natural gas uses and applications. The technology can be used to convert coal to:

- Synthetic (or Substitute) Natural Gas (SNG): Since it meets or exceeds pipeline natural gas specifications, SNG can also take advantage of the existing natural gas distribution and infrastructure network.
- Fuel Syngas: While syngas makes an excellent fuel, it has disadvantages for long distance transport and distribution compared to natural gas due to its relatively low volumetric energy density. However, it can be produced more cost effectively than SNG and makes a good substitute for natural gas in distributed fuel applications for industrial customers.
- Chemical Feedstock Syngas: The use of coal gasification to produce syngas for use in chemical feedstocks has the advantage of removing natural gas from the cost equation and can also produce a syngas composition that is better suited for certain processes, providing additional cost savings.

Peabody Supports Coal Gasification

For more than a decade, Peabody has supported coal gasification projects:
- Peabody is a participant in the Power Systems Development Facility gasification project in Wilsonville, Alabama. PSDF is a national center for testing cleaner, more efficient and more cost-effective coal-fueled technologies for commercial use.
- Peabody is pursuing development of a large coal to natural gas facility, working with ArcLight Capital Partners LLC to choose a site and develop the plant in Illinois using ConocoPhillips technology. The project would require at least three million tons of coal per year to fuel two gasifier trains that could produce more than 35 billion cubic feet of synthetic natural gas.
- Peabody purchased a 30-percent interest in Econo-Power International Corp., which owns and markets modular coal gasifiers for industrial-based applications.
- Peabody and Rentech are evaluating sites for coal-to-liquids projects that would transform coal into diesel and jet fuel.
- Peabody is a founding member of the FutureGen Industrial Alliance, a coalition of energy companies and electric utilities that is working with the U.S. Department of Energy to design and build the world’s first coal-fueled “zero emissions” power plant.

Coal Gasification and BTU Conversion

Unlike combustion, gasification is the controlled and partial oxidation of fuels such as coal in a reducing environment to primarily produce carbon monoxide (CO) and hydrogen (H₂), which is called synthesis gas, or syngas. This process contrasts the complete combustion to carbon dioxide (CO₂) and water (H₂O).

\[
\text{Gasification} \quad (\text{C}_m \text{H}_n + \frac{1}{2} \text{O}_2 \rightarrow m \text{CO} + n \text{H}_2) \\
\text{Combustion} \quad (\text{C}_m \text{H}_n + \text{O}_2 \rightarrow m \text{CO}_2 + n \text{H}_2\text{O})
\]

In gasification, the amount of oxygen is strictly controlled to prevent over-combustion of the fuel.

Gasification is a clean way to convert coal into fuel and energy since the gasification process occurs in an oxygen-depleted state. In this reducing environment, constituents such as sulfur are converted to compounds that can be treated and removed from the syngas prior to combustion in fuel applications.

Due to the high reaction temperature and reduced oxygen environment in gasification, organic waste materials such as tars, oils, PCBs and other wastes generally do not form or...
There are a number of different configurations and technology providers of gasification, but there are three major gasifier groups:

- **Moving bed:** Coal is fed at the top of a gasifier and moves down through the reactor by gravity while the syngas moves to the top of the gasifier. In general, these gasifiers are operated in a “non-slagging” mode, in which the temperature is below the slagging temperature of the inorganic components of the feed.

- **Fluid bed:** Coal particles are fluidized by the produced syngas, and are subsequently separated from the syngas.

- **Entrained flow:** The syngas and the coal particles flow together in an “entrained flow.” These gasifiers operate in a high temperature mode, generally with very short residence times, and use either a dry or slurry feed system to introduce the coal into the gasifier.

Oxygen can be added to the gasifiers as either air or a purified oxygen stream. Steam or water for slurry feed gasifiers is also introduced into the system as both a chemical reactant in the gasification and to moderate the gasifier’s temperature.

Natural gas has a volumetric energy density of approximately 1000 Btu per standard cubic foot (scf); syngas generally has an energy density of between 200 to 320 Btu/scf based on the specifics of the gasification process used to produce it. Therefore, fuel applications for syngas are favored when end use can be in relatively close proximity to the gasifier, such as in distributed fuel applications where there are industrial customers, or clusters of customers, that can substitute syngas for natural gas.

Syngas also is used as a feedstock for the production of hydrogen and as a building block for certain chemicals. While natural gas has historically been used to produce syngas for chemical applications in the United States by means of the catalytic Steam Methane Reaction (SMR) process: The Dakota Gasification plant in Beulah, North Dakota, produces SNG from lignite coal and recovers and sells pure CO₂ for EOR usage.
Reforming, or SMR reaction, coal-derived syngas can easily be substituted, and in many instances is preferable due to its composition. The optimum ratio of H\textsubscript{2} to CO in the syngas is dictated by the particular chemical to be produced from it. Syngas that is deficient in hydrogen can be adjusted by a catalytic reaction known as the “water-gas-shift” (or shift). In this process, CO reacts with steam (H\textsubscript{2}O) and is converted to CO\textsubscript{2} and hydrogen.

\[ \text{Water-Gas-Shift CO + H}_2\text{O} \rightarrow \text{CO}_2 + \text{H}_2 \]

In many chemical applications the carbon dioxide (CO\textsubscript{2}) is removed to facilitate further chemical processing. The removed CO\textsubscript{2} can be recovered as a relatively pure stream, which can be used either in beneficial applications, such as Enhanced Oil Recovery (EOR) or sequestered in geological formations. This same process step (water-gas-shift) can also optionally be used for carbon removal from syngas in fuel applications, producing a hydrogen-rich fuel whose combustion product is only water vapor (H\textsubscript{2}O). The gasification-shift reactions are the basis for carbon footprint reduction of coal fuel in the Integrated Gasification Combined Cycle (IGCC) power production process.

Coal-derived syngas can also be chemically converted into pipeline quality natural gas, which is composed primarily of methane (CH\textsubscript{4}). Methanization is a catalytic and highly exothermic reaction usually carried out in stages in several reactor vessels.

\[ \text{Methanization CO + 3H}_2 \rightarrow \text{CH}_4 + \text{H}_2\text{O} \]

The produced Synthetic, or Substitute Natural Gas (SNG) is chemically identical to natural gas, and can be transported and distributed by natural gas pipelines and utilized in all natural gas markets. The Dakota Gasification plant in Beulah, North Dakota, produces SNG from lignite coal and recovers and sells a pure CO\textsubscript{2} stream by pipeline to the Wayburn oil field in Canada for EOR usage.

**Economics**

The technology for converting coal into marketable gas products is well established and can be an economically viable alternative to natural gas. Industrial fuel syngas can be the lowest cost fuel conversion option for natural industrial customers or clusters of natural gas fuel users when a coal gasification facility can be built nearby. Likewise, SNG can be produced price competitively with natural gas and take advantage of the existing natural gas infrastructure.

The cost of industrial syngas is estimated to be in the $4 to $5 per Mcf range, and the cost of pipeline-quality synthetic natural gas is projected as low as $6 per Mcf.

Btu conversion of coal to fuel gas applications can be both economic and competitive and can reduce the dependence on scarce domestic natural gas resources and imported LNG. Likewise, the use of coal-derived syngas for chemicals applications rather than natural gas can help improve the competitiveness of the U.S. chemicals industry and keep it from moving offshore.

There is a growing chorus of support for greater use of coal and Btu Conversion to drive down costs and build energy independence. A recent study by the National Coal Council, “Coal: America’s Energy Future” sets forth an ambitious plan to add 1.3 billion tons per year of U.S. coal production, more than double today’s annual production, to meet the nation’s growing energy needs using clean coal technologies. The study calls for using coal to produce four trillion cubic feet per year of natural gas, 2.6 million barrels per year of transportation fuels and an additional 100 gigawatts of clean electricity. It also calls for increasing coal for heat and electricity in the production of ethanol, coal-to-hydrogen and enhanced oil and gas recovery utilizing carbon dioxide emissions from coal combustion.

Supporting research from Penn State University also found that increasing annual coal production for Btu Conversion would reduce energy prices by one-third; grow the annual GDP more than $600 billion per year by 2025, with a gain of $3 trillion net-present-value, increasing to $4 trillion with enhanced oil recovery; and create 1.4 million jobs per year by 2025.

Even at this increased level of coal use, U.S. reserves are sufficient to power these energy needs for more than a century.

**Gasification is a clean way to convert coal into fuel and energy since the gasification process occurs in an oxygen depleted state.**

Martin Considine is Vice President Technology and Richard Weissman, Ph.D., is Director Coal Conversion Technology, at Peabody Energy. (www.peabodyenergy.com)
FOR MORE THAN 30 YEARS, WE’VE MADE SOME REMARKABLE ADVANCES IN CLEAN COAL TECHNOLOGY.
WE LIKE TO THINK OF IT AS THE ULTIMATE IN BLUE SKY THINKING.

It may surprise you to know that, for more than 30 years, America’s air quality has been improving. Thanks in part to advances in clean coal technology, emissions of the major pollutants regulated by the Clean Air Act are nearly half of what they were in 1970—despite the fact that our usage of coal to generate electricity tripled during the same time. As this trend continues, EPA projections show that by 2015, emissions from America’s coal-based power plants will be 75% less than they were in 1970. And, best of all, according to Department of Energy and private-sector experts, coal-based power plants capable of zero emissions will begin to enter the marketplace as soon as 2020. To find out more about how affordable, abundant and increasingly clean electricity from coal is powering our future, visit www.balancedenergy.org.

AMERICANS FOR BALANCED ENERGY CHOICES
www.BalancedEnergy.org 1-877-358-6699
Carbon Dioxide Poised for a Comeback

By Kipp Coddington, Esq., The Coalition for Commodity CO₂ / Alston & Bird, LLP and Bob Reynolds, Esq., Alston & Bird, LLP.

It’s tough being carbon dioxide (CO₂) these days. Long gone is the time when textbooks touted the molecule’s role as a critical component of the carbon cycle, and thus life itself. Today, it is the focus of derision and abuse because global climate change has been hung around the molecule’s neck like an albatross. Environmentalists want to treat anthropogenic emissions of CO₂ as a criteria pollutant under the federal Clean Air Act, a designation that carries with it significant regulatory baggage. Even companies that oppose carbon regulation frequently mouth an “out-of-sight, out-of-mind” theory. In the words of Rodney Dangerfield, it’s a molecule that gets no respect.

The good news for America—and thus the coal industry—is that CO₂ is now poised for a comeback. How can this be? Simple. Carbon dioxide is uniquely equipped to extract and recover America’s untapped hydrocarbon resources—a role that it has played in places such as the Permian Basin of West Texas since the 1970s—thereby alleviating our increasing dependence on foreign sources of oil. With oil prices forecast to stay well north of $50 per barrel in the years ahead, CO₂’s energy recovery role will only increase.

We envision a day in the near future in which that humble molecule links coal-fueled CTL and IGCC plants, which are seeking markets for their carbon, and hydrocarbon-rich geologic sinks, which need CO₂ for energy recovery purposes. Coal-combustion and processing facilities have an abundance of CO₂; while energy companies engaged in extractive practices such as enhanced oil recovery (EOR) need all the CO₂ that they can get. You don’t need the economic insight of Adam Smith to perceive the commercial opportunities facing sellers and buyers of carbon dioxide.

Demand for Coal-Derived CO₂

Carbon dioxide’s chemical properties make it uniquely suited to recover hydrocarbon resources. CO₂ currently enjoys widespread use for EOR. The molecule enters the reservoir as a super-critical fluid and literally scrubs large volumes of otherwise unrecoverable oil from the injection zone. In 2005, the Permian Basin, in West Texas, produced its billionth barrel of oil from injected carbon dioxide. The Oil & Gas Journal most recent survey documents the production of approximately 237,000 barrels per day of domestic oil production in 2006 from the application of CO₂-EOR. Another 110,000 barrels per day of domestic oil is produced using nitrogen, hydrocarbon miscible and flue gas immiscible enhanced oil recovery from fields that would be amenable to CO₂-EOR should affordable supplies of carbon dioxide become available through the deployment of CTL and similar coal-intensive technologies.

Recent basin studies conducted by the U.S. Department of Energy (DOE) estimate that 89 billion barrels of additional oil from currently “stranded” oil sources in 10 U.S. regions are technically recoverable by applying state-of-the-art CO₂-EOR technologies. DOE separately has documented the presence of an oil bearing transition zone beneath the traditionally defined base of many existing reservoirs that, under certain geologic and hydrodynamic conditions, could add another 100 billion barrels of oil resource in place in the United States, an estimated 20 billion barrels of which could be recoverable with state-of-the-art CO₂-EOR technologies. Suitable fields are geographically disposed, too, from North Dakota to Illinois to California to Texas.

The amount of CO₂ needed to lift this oil is significant. DOE has estimated the EOR-driven demand for anthropogenic CO₂ at 10,500 trillion cubic feet, or 151 gigatons, of anthropogenic emissions of carbon dioxide. We anticipate that these numbers will prove to be conservative in the years ahead.

Demand for anthropogenic CO₂ is not limited to EOR, either. Enhanced coal bed methane production is another commercial opportunity for the gas which exists today. New technologies suggest that the molecule could be used to recover oil from shale, too. Injection of carbon dioxide into geologic reservoirs is environmentally safe. In Texas alone, there are 10,000 permitted carbon dioxide injection wells, 8,000 of which inject carbon dioxide exclusively. Those wells safely inject over 1 billion cubic feet of CO₂ daily.

Challenges Ahead

Although commodity CO₂ has a bright future, there are obstacles ahead to its full deployment. One critical hurdle is the manner in which CO₂ injection and storage will be regulated. No federal or state law directly governs the practice, although there are potential models such as: (1) State natural gas storage laws; (2) CO₂-EOR regulations; and (3) the Underground Injection Control Program under the Safe Drinking Water Act. Decisions regarding how CO₂ will be regulated are critical because over-regulation, i.e., designating CO₂ as a waste or pollutant, will cripple its future use as a commodity. Senator Jeffords (VT) recently introduced a bill that would place all carbon dioxide geologic injection activities under the supervision of the U.S. Environmental Protection Agency (EPA), an outcome that we believe to be potentially problematic for permitting and related reasons. Entities such as the Interstate Oil & Gas Compact Commission, Groundwater Protect Council, and EPA are currently weighing these issues. The coal industry is engaged in the debates, but more work is needed.
Another issue is overcoming the perception that the extractive use of CO$_2$ is a niche opportunity. This position is frequently advanced by R&D interests seeking federal monies to investigate the molecule’s dynamics in deep saline aquifers. While deep saline aquifer injection research may be important in the long-term, it must not be allowed to overshadow the commercial opportunities that exist today for carbon dioxide.

We do not mean to suggest that hydrocarbon extraction activities are a panacea for coal-burning facilities seeking to outsource their carbon dioxide. Costs associated with CO$_2$-EOR are non-trivial, for example, and include capture, pipeline transport, compression, injection, recovery and recycling. Capture from flue-gas may be uneconomic for some time, too. The devil is in the details, but published data suggest that projects are comfortably profitable as long as crude oil prices stay above $40 per barrel. Those forecasts may turn out to inaccurate, however. The oil industry is no stranger to boom-and-bust cycles.

A final hurdle is deciding what label CO$_2$ should wear. We fear that if CO$_2$ is deemed a pollutant, its commodity use will be hindered because no commercial enterprise will be able to bear the potential environmental liabilities associated with its use. The government and R&D community are in their third decade of conducting environmental assessments on the suitability of Yucca Mountain as a repository of radioactive waste. We do not believe that Americans should wait until 2040 to decide if it is safe to inject and store CO$_2$ into geologic reservoirs that have safely held both liquid and gaseous hydrocarbons for millennia.

**Conclusion**

We’re bullish on CO$_2$ and believe that the coal industry should be, too. We believe that coalmines produce two valuable commodities, not one: coal and CO$_2$. Carbon dioxide is an asset, not a liability. We are advising our project development and infrastructure clients to hold long positions on CO$_2$ because we believe that the molecule's short-sellers are going to get burned—and not because the Earth's climate is warming, but because the market value of CO$_2$ is rising, not falling.

Critical decisions about the future potential of CO$_2$ will be made in the months and years ahead. The outcome of those decisions will depend in great part on the coal, gasification and unconventional fuel industries. It is insufficient for the coal industry to merely oppose carbon regulation; the industry also must explain to legislators, regulators and judges why carbon dioxide is important for American's energy security.

---

*Kipp Coddington and Bob Reynolds are partners in Alston & Bird, LLP’s Strategic Energy Team (www.alston.com).*

---

1 To put this into context, daily U.S. domestic crude oil production was 5.1 MMb/day in May 2006.

2 Eighty-nine billion barrels of technically recoverable oil is a significant amount. Total proven producing Saudi reserves are approximately 260 billion barrels. Although it’s mixing apples and oranges to compare “technically recoverable” and “proven producing” reserves, it is fair to assert that America is blessed with ample reserves of both coal and oil, with carbon dioxide being the bridge that binds those assets together.
# Index to Advertisers

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alliance Coal, LLC</td>
<td>2</td>
</tr>
<tr>
<td>Alstom Power</td>
<td>49</td>
</tr>
<tr>
<td>Ameren Energy Fuels &amp; Services Co.</td>
<td>38</td>
</tr>
<tr>
<td>BHP Billiton Marketing Inc</td>
<td>12</td>
</tr>
<tr>
<td>CIT Rail</td>
<td>6</td>
</tr>
<tr>
<td>CMC USA Inc</td>
<td>5</td>
</tr>
<tr>
<td>Coal Trans Conferences</td>
<td>13</td>
</tr>
<tr>
<td>Consol Energy Inc.</td>
<td>14</td>
</tr>
<tr>
<td>CSX Transportation</td>
<td>50</td>
</tr>
<tr>
<td>Damascus Corporation</td>
<td>16</td>
</tr>
<tr>
<td>Dings Company / Advanced Detection Systems</td>
<td>18</td>
</tr>
<tr>
<td>DTE Coal Services</td>
<td>35</td>
</tr>
<tr>
<td>E S &amp; S Company</td>
<td>44</td>
</tr>
<tr>
<td>Evolution Markets Inc</td>
<td>IFC</td>
</tr>
<tr>
<td>Fuel Tech, Inc</td>
<td>30</td>
</tr>
<tr>
<td>Great River Energy</td>
<td>22</td>
</tr>
<tr>
<td>Hagby USA, Inc</td>
<td>53</td>
</tr>
<tr>
<td>Hard Steel, Inc</td>
<td>59</td>
</tr>
<tr>
<td>Headwaters Incorporated</td>
<td>OBC</td>
</tr>
<tr>
<td>Helm Financial Corporation</td>
<td>46</td>
</tr>
<tr>
<td>Hill &amp; Associates, Inc</td>
<td>37</td>
</tr>
<tr>
<td>The Hilliard Corporation</td>
<td>53</td>
</tr>
<tr>
<td>Hoss Equipment</td>
<td>24</td>
</tr>
<tr>
<td>Ingram Barge Company</td>
<td>IBC</td>
</tr>
<tr>
<td>J.K. Hydraulics, Inc</td>
<td>44</td>
</tr>
<tr>
<td>Jennmar</td>
<td>17</td>
</tr>
<tr>
<td>John T. Boyd Company</td>
<td>50</td>
</tr>
<tr>
<td>KCBX Terminals Co.</td>
<td>52</td>
</tr>
<tr>
<td>Kiewit Mining Group</td>
<td>29</td>
</tr>
<tr>
<td>Liberty Mining Consulting, Inc.</td>
<td>52</td>
</tr>
<tr>
<td>Marshall Miller</td>
<td>36</td>
</tr>
<tr>
<td>Marston</td>
<td>46</td>
</tr>
<tr>
<td>Midwest Generation</td>
<td>20</td>
</tr>
<tr>
<td>Millenium Broadway Hotel</td>
<td>44</td>
</tr>
<tr>
<td>NexGen Coal Services Ltd</td>
<td>51</td>
</tr>
<tr>
<td>Norwest Corp</td>
<td>44</td>
</tr>
<tr>
<td>Peabody Energy</td>
<td>21</td>
</tr>
<tr>
<td>PEBCO®, Incorporated</td>
<td>10</td>
</tr>
<tr>
<td>PICOR</td>
<td>48</td>
</tr>
<tr>
<td>Platts</td>
<td>25</td>
</tr>
<tr>
<td>PricewaterhouseCoopers</td>
<td>42</td>
</tr>
<tr>
<td>Railworks</td>
<td>38</td>
</tr>
<tr>
<td>Richwood</td>
<td>48</td>
</tr>
<tr>
<td>Rio Tinto Energy America</td>
<td>27</td>
</tr>
<tr>
<td>Roberts &amp; Schaefer Company</td>
<td>4</td>
</tr>
<tr>
<td>Sampling Associates International</td>
<td>48</td>
</tr>
<tr>
<td>SCH Terminal Company</td>
<td>38</td>
</tr>
<tr>
<td>Strata Products (USA) Inc</td>
<td>48</td>
</tr>
<tr>
<td>The David J. Joseph Company Rail Equipment Group</td>
<td>60</td>
</tr>
<tr>
<td>Trinity Industries, Inc.</td>
<td>40</td>
</tr>
<tr>
<td>Union Pacific Railroad</td>
<td>42</td>
</tr>
<tr>
<td>United Power, a division of ICAP-United, Inc</td>
<td>26</td>
</tr>
<tr>
<td>Weir International, Inc</td>
<td>34</td>
</tr>
<tr>
<td>Wiley Consulting, LLC</td>
<td>53</td>
</tr>
</tbody>
</table>

---

**Expertly interpreting lease and finance options in the railcar industry. This is what we do...everyday.**

**The David J. Joseph Company**

**Rail Equipment Group**

Contact one of our Rail Equipment Group experts today for your railcar leasing and marketing needs at **513.419.6200.**

300 Pike Street, Cincinnati, Ohio 45202 • info@djj.com • www.djj.com
Ingram Barge Company
Dry and liquid transportation service throughout the entire Mississippi River and Gulf Intracoastal Waterway System

Custom Fuel Services
Midstream fuel service at New Orleans, Baton Rouge, Columbus (Cairo), Paducah, Hartford, Davenport, Catlettsburg and Point Pleasant

Huntington Terminal
Coal transfer from rail (CSX) to barge at Mile 306.5 Ohio River

Ingram Materials Company
Sand producer and distributor in Tennessee, Kentucky and Alabama

Triangle Fleet / Triangle Anchorage Services
Barge fleeting and ship anchorage at Reserve, LA

St.Louis Fleet
Barge fleeting at St. Louis Harbor

INGRAM BARGE COMPANY
P.O. Box 23049 • Nashville, TN 37202-3049
615-298-8200 Phone • 615-298-8213 Fax
Website: www.ingrambarge.com

Photo by Gregory Thorp
Headwaters offers the industry’s most diverse portfolio of services and technologies that make coal cleaner and more valuable for our nation’s dynamic energy future.

Adding Value to Energy™

Pre-combustion Clean Coal Technologies for Power Generation

- Leading supplier of technology and chemical reagents to the coal-based synfuel industry
- Deploying dry coal cleaning process
- Commercializing low rank fuel enhancement technology (coal drying)
- Applying nanocatalyst technology for creation of emissions reducing coal treatments
- Ethanol production utilizing waste heat from coal fueled power stations

Coal Conversion for Ultra Clean Transportation Fuels

- Only technology provider with footprint in all coal conversion methods:
  - Direct Coal Liquefaction
  - Indirect (Fischer Tropsch) Coal Liquefaction
  - Heavy Oil / Coal Co-processing
- Leading developer of America’s first coal-to-liquids projects

Post-Combustion Resources Management

- Largest manager and marketer of coal combustion products:
  - Marketing nearly 7 million tons of coal fly ash annually
  - Expertise in FGD systems installation and operation
  - Comprehensive utility and industrial services
  - Technologies for controlling ammonia and carbon in ash
- Leading manufacturer of building products containing coal ash:
  - Regional market leader in concrete blocks, mortars and stuccos
  - National market leader in architectural stone veneer and siding accessories
  - Developer of innovative FlexCrete™ aerated concrete