

**INDIANA CONTINUING LEGAL EDUCATION FORUM**

**COAL PRODUCTION METHODS,  
CURRENT ISSUES AND TRENDS**

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## **BIOGRAPHICAL INFORMATION**

G. Michael Meighen is Vice President of Marshall Miller & Associates, Evansville, Indiana Branch office. Mr. Meighen has an extensive background in mining, which includes over 25 years of industry experience in management and engineering. Additionally, he has expertise in government research and the regulatory field. He has been an active member in numerous Illinois, Kentucky, Indiana, and Pennsylvania mining and academic institutions.

As General Manager of Alliance Coal's, White County Coal, LLC in Carmi, Illinois, Mr. Meighen was responsible for a multi-million dollar mine expansion project that included economic justification, permitting, and construction. Concurrently, he led the revitalization of Mt. Vernon Coal Transfer Terminal on the Ohio River in Mt. Vernon, Indiana. In the area of mineral law, Mr. Meighen fostered lobbying efforts for the 2001 "Coal Rights Act" in the State of Illinois.

When Mr. Meighen worked as a researcher with the National Institute of Occupational Safety and Health (NIOSH), in Pittsburgh, PA, he was involved in numerous ventilation, explosion, fire detection, and injury prevention projects. His research work included serving as a government liaison with industry in the development of new fire detection technologies for underground coal mines and leading an agency assignment as Principal Investigator in Mine Rescue and Emergency Response.

He has a variety of academic experience and continuing education with the Federal Executive Board Leadership Program, the E.J. Ourso College of Business at Louisiana State University and currently serves on Southern Illinois University's Mining Engineering Industrial Academic Advisory Board. Mr. Meighen holds degrees in Mining Engineering and Business Administration from the University of Kentucky, and a Master of Science in Management from Oakland City University.

## **ABSTRACT**

Energy resources drive the world economy and coal is an integral part of those resources. This paper will examine coal as a global energy source and the major coal-producing regions of the United States, specifically the Illinois Basin. Furthermore, the basis for reserve classification and mining methods to extract the resource will be defined. Lastly, current Illinois Basin production methods, issues, and industry trends will be briefly discussed.

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## **I. WORLD COAL RESERVES**

Coal is abundant and found in nearly every country in the world. Commercial mining of coal is occurring in approximately fifty countries around the globe today, with world coal reserves estimated at nearly 1 trillion tons. “Coal provides 25% of global primary energy needs and generates 40% of the world's electricity.”<sup>1</sup> Distribution of reserves, and thus control of this energy resource lies primarily with three countries, namely: The United States and former Soviet Union each having about 23% and China with 11%.<sup>2</sup>

The world coal market has been relatively stable over the years. Thus far, coal is mined, marketed, and transported around the globe without raising geopolitical issues. Overall, coal prices have historically been lower and more stable than other sources of energy, such as oil and natural gas. In contrast to other resources, coal is safe to transport and store. Coal does not require dedicated routes nor protected storage, which adds to the costs of competing fuels. At current rates of consumption, the United States has enough known reserves of coal to last approximately 250 years.<sup>3</sup>

## **II. COAL REGIONS OF THE UNITED STATES**

The United States Geological Survey (USGS) defines five major coal-producing regions within the continental United States of America. These regions are the Appalachian Basin, Illinois Basin, Gulf Coast, Northern Rocky Mountains and Northern Great Plains, and the Rocky Mountains and Colorado Plateau.

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<sup>1</sup> World Coal Institute

<sup>2</sup> Energy Minerals Division, A Division of the American Association of Petroleum Geologists

<sup>3</sup> Energy Information Administration

The Appalachian Basin stretches along the Appalachian mountain range and covers parts of Ohio, Pennsylvania, West Virginia, Maryland, Virginia, and eastern Kentucky. The Illinois Coal Basin covers nearly the entire state of Illinois, western Kentucky, and southwestern Indiana. The Gulf Coast region of coal production lies mainly in the state of Texas. The Northern Rocky Mountain and the Northern Great Plains Region includes northern and central Wyoming, Montana, and North Dakota. Within this region, in central Wyoming, the Powder River Basin contains vast amounts of surface minable coal with some coal deposits up to 140 feet thick. The Rocky Mountains and Colorado Plateau Region is essentially the southwestern portion of the United States and includes parts of Arizona, Colorado, New Mexico, Utah, and southwestern Wyoming.

### **III. THE ILLINOIS BASIN**

The Illinois Basin is a vast area that covers some 34 million acres in Illinois, southwestern Indiana, and western Kentucky.<sup>4</sup> Today's remaining coal reserves in the Illinois Basin are approximately 51.0 billion tons of the total 263.8 billion tons in the United States.<sup>5</sup> Illinois Basin reserves tonnage is comprised of 38.0 billion tons in Illinois, 9.0 billion tons in western Kentucky and 4.0 billion tons in Indiana. The major coal seams currently being mined in the basin are the Springfield (Illinois No. 5, Indiana V, and Kentucky No. 9) and the Herrin (Illinois No. 6 and Kentucky No. 11) coals. To a lesser degree, mining is occurring in the Danville (Illinois No. 7, Indiana VII and Kentucky No. 14), Seelyville/Davis/ Dekoven (Kentucky No. 6 and 7) and several others in various areas across the region. Given the presently defined recoverable reserves at these production levels, coal in the Illinois Basin will last approximately 561 years.

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<sup>4</sup> Coalbed Methane Potential and Activity of the Illinois Basin; Tedesco, Steven; Search and Discovery Article #10058 (2004)

<sup>5</sup> Energy Information Administration

#### **IV. RESERVE CLASSIFICATION**

The standards for estimation and classification of reserves are defined in the United States Geological Survey (USGS) Circular 891. The document provides the following definitions:

- Reserve: Coal tonnage that can be economically extracted considering environmental, legal, and technological constraints. Reserve estimate is based on recoverable coal.
- Resource: Tonnage in a form or an amount that extraction is potentially feasible, but encumbrances exist that may render the deposit as uneconomical in today's market. Resources include inferred coal, which is too poorly explored and defined to allow for consideration as a reserve.

In addition to being economically viable, by further definition, a demonstrated reserve must be proven with data points (drill hole core points) to determine the coal seam thickness. Measured Areas of a reserve are defined with data points within a  $\frac{1}{4}$  mile radius of the adjacent core points, while Indicated Areas of reserve are within a  $\frac{3}{4}$  mile radius to the adjacent data points. Provided a series of adjacent data points or drilled exploration points, within the defined  $\frac{3}{4}$  mile radius, reveal an economically mineable coal seam, the area can be cumulatively classified as demonstrated reserve. Furthermore, data points from  $\frac{3}{4}$  to 3 mile radius, which exhibit economically mineable coal, are defined as inferred reserves and classified as a resource.

Tonnage estimates in a given area may be "roughly estimated" by assuming uniform coal seam thickness and continuity that approximate in-place tonnage is 1800 tons per acre-foot.

However, this is only an estimate. Reserve certification requires thorough review by qualified persons.<sup>6</sup>

## **V. MINING METHODS**

Mining to extract coal is conducted by either surface mining or underground deep mining. The exploration and planning needed before mining a deposit of coal can begin may take several years. Exploration includes determining the quality as well as quantity of the available coal to be mined, transported, and marketed. Land ownership and mineral rights are crucial parts of the exploration phase. Upon completion of exploration to identify details of a coal seam and the characteristics of the coal itself, engineering plans are developed to determine the best method to mine that deposit.

The selected mining method primarily depends on the depth of the coal seam from the surface and the character of the overlying terrain. Generally, the determination to surface mine is economically restricted by the strip ratio, which is calculated using the depth of coal seam (overburden thickness) to coal seam thickness. Illinois Basin mining companies are currently using an approximate economic cut off ratio of 20:1 for surface mining projects. In other words, extracting a coal seam at a depth of 100 feet would economically necessitate a seam thickness of 5 feet, hence the 20:1 ratio. Coal quality and overall marketability may change this economic ratio. Mining multiple coal seams in a given area will effectively increase the overall coal seam thickness and thus, the overall depth that can be economically mined to extract the deepest seam is increased.

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<sup>6</sup> Refer to Marshall Miller & Associates at [www.mmal.com](http://www.mmal.com)

Surface mining is essentially large-scale earthmoving, consisting of excavating the overburden above the coal seam(s) and then removal of the coal itself. Surface mining requires removal of the topsoil to store for proper reclamation upon completion of mining. Once the topsoil is removed, a series of vertical holes are drilled into the rock strata overlying the coal seam. Drilling is conducted to facilitate loading of explosive charges, namely ANFO, into the holes to dislodge the material. Two variations of surface mining are used to remove overburden material. The first method uses massive dragline machines to remove the overburden. Draglines typically move 115 cubic yards of material or 200 tons of material with a single pass. The motion of these machines is to drag and load the large bucket with the dislodged rock material, then lift and swing the bucket via cables connected to an outreaching boom arm and finally dumping the material into a waste pile. When overburden is removed by the bucket, a clear area of coal is exposed, ready to be mined. The second method of surface mining, which is now most prevalent in the Illinois Basin, is called the truck and shovel method. This method uses large off-road trucks, each capable of carrying up to 200 tons of excavated material, which have been filled by a hydraulic shovel. The hydraulic shovels can be powered by diesel engines or electric motors. A typical Illinois Basin shovel can load approximately 23 cubic yards of material or 35 tons in a single shovel lift. Surface mining may be supplemented by other less common variations, such as auger or highwall mining. These methods are used to increase extraction of the coal seam from the open surface pit area without removal of overburden and where underground mining may not be economically feasible.

In the Illinois Basin, underground mining methods are used to extract coal from seams normally deeper than 200 feet. Typically, underground mines in the basin are less than 1000 feet deep. Underground mines can have several different types of openings to access the coal seam,

and the mines are classified according to the type of opening used to reach the seam. A “drift” mine opening is one that is mined horizontally into the coal seam where the seam is naturally exposed or has been exposed through the above described surface methods. A “slope” mine is literally entered through an inclined opening constructed from the surface to the coal seam. Deeper coal seams are often accessed with direct vertical “shafts” equipped with elevators. Upon reaching the coal seam, networks of openings are mined within the coal for ventilation and passage of additional infrastructure necessary for optimal mining efficiency. Areas of the coal seam are sectioned off into “panels” or blocks, which are usually several hundred feet wide and several thousand feet long. Underground mining is predominantly accomplished by two methods of extraction. The first method, used in most underground coal, is called the “room and pillar” method. In this system, miners extract the coal by cutting a series of “rooms” or tunnels into the coal seam, leaving pillars or columns of coal to support the overlying mine rock. As mining advances, a square shaped honeycomb area is mined into the coal seam. The objective of this underground mining method is to mine only the coal seam with limited extraction of strata above or below the seam. Typical room and pillar mining will extract approximately 50% of the coal seam as the remainder is left intact to hold up the overlying strata and prevent the affects of subsidence on the surface. The second method, longwall mining, is also employed to extract underground coal. Longwall panels are set up for full or 100% extraction of the coal seam. To stage the longwall extraction method, mining by the room and pillar method is used to mine around the perimeter of a large rectangular panel or block of coal. The longwall mining machine is then set-up on the short end of the block. The cutting portion of the machine operates under a series of movable hydraulic supports, which hold up the strata above the coal seam as the coal is extracted in approximately 36 inch strips. As the cutting portion of the machine removes the

coal, the movable hydraulic supports are moved forward. The complete longwall system continues to cut and advance as the overlying rock strata falls in behind the machine. This full extraction method of mining inevitably creates mine subsidence on the surface. Mining companies using longwall mining systems must mitigate effects of the subsidence for property owners as well as the environmental regulatory agencies.

## **VI. CURRENT ISSUES**

Every day, news media headlines are filled with a host of issues that not only affect the coal industry, but our national and world economies as well. Some of the topics include Global Warming and the Greenhouse Gas Crisis; Scrubbing and Pollution Controls; Power Demands and Power Plant Projects; Alternative Fuels and Sources of Energy, to name a few.

The United States Department of Environmental Protection Agency policy states: “The United States is committed to reducing the greenhouse gas intensity of the American economy by 18 percent over the 10-year period from 2002 to 2012. This initiative puts America on a path to slow the growth of greenhouse gas emissions, and -- as the science supports -- to stop, and then reverse that growth.” “The policy focuses on reducing emissions through technology improvements and dissemination, improving the efficiency of energy use, voluntary programs with industry and shifts to cleaner fuels.”<sup>7</sup> Clearly, the agency does have a plan to reduce CO<sub>2</sub> emissions in the near and long term through voluntary programs and innovative technology. The United States has officially signed the Kyoto Protocol Agreement but, without ratification by the Senate, mandatory reductions are not required. “The Kyoto Protocol is an agreement under which industrialized countries will reduce their collective emissions of greenhouse gases.” The

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<sup>7</sup> <http://www.epa.gov/climatechange/policy/intensitygoal.html>, United States Environmental Protection Agency

United Nations Framework Convention on Climate Change agreed to a set of “common but differentiated responsibilities”. The agreement states: “The parties agreed that: The largest share of historical and current global emissions of greenhouse gases has originated in developed countries.” In other words, China, India, and other developing countries were not included in any numerical limitation of the Kyoto Protocol because they were not the main contributors to the greenhouse gas emissions during the pre-treaty industrialization period and thus; do not directly share in the burden to reduce emissions. The current Bush and former Clinton administrations were opposed to moving forward with ratification due to the unfair economic burden that would be placed on the United States’ economy versus that of the developing countries.

“Historically, industry has developed and implemented control technologies in incremental steps to mitigate emissions of sulfur dioxide (SO<sub>2</sub>), oxides of nitrogen (NO<sub>x</sub>), particulate matter (PM), and other pollutants, as driven by air pollution requirements. Control technologies that are capable of simultaneously reducing emissions of multiple pollutants may offer the potential to achieve this at lower cost and reduced footprint when compared to conventional controls.” “Multi-emission control technologies are those capable of simultaneously controlling emissions of at least two of these three pollutants, NO<sub>x</sub>, SO<sub>2</sub>, and mercury, from electric utility sources.”<sup>8</sup> Essentially, pollution controls continue to be progressively added to power plants. Utility companies often refer to the modifications as “bolt on chemical plants” that cost multi-millions of dollars with every upgrade. Because public utilities are regulated, the costs are passed on to the customers. A review of emissions and power generation data reveals that, over the past two decades, power generation has steadily

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<sup>8</sup> <http://www.epa.gov/airmarkets/resource/docs/multipreport2005.pdf> , United States Environmental Protection Agency

increased, while emissions have steadily decreased. The exception is the emission of CO<sub>2</sub> which simply mirrors the increase in power generation. The United States Department of Energy has initiated programs to deal with carbon emissions. The department defines the issue as follows: “Carbon sequestration refers to the provision of long-term storage of carbon in the terrestrial biosphere, underground, or the oceans so that the buildup of carbon dioxide (the principal greenhouse gas) concentration in the atmosphere will reduce or slow.”<sup>9</sup> Large scale testing of carbon sequestration is planned, whereby the CO<sub>2</sub> may be pumped underground via deep wells and forced into permeable rock strata.

The demand for coal and mining is predicted to grow. Coupled with the growth in mining, is promise of new power generation facilities. The headlines were full of information regarding the “Future Gen” power plant, which promised near zero emissions. However, the Department of Energy has recently announced the department’s portion of funding will now be diverted to several other projects versus this single endeavor. “The proposed Cash Creek Generation power plant planned for Henderson County, Kentucky has received the final air quality permit from the state of Kentucky.”<sup>10</sup> The Indiana Department of Environmental Management has approved the construction permit for a \$2 billion coal-fired power plant to be built by Duke Energy in Knox County near Edwardsport. The 630-megawatt station would use a new technology known as integrated gasification combined cycle, or IGCC. The process does not involve burning coal directly, but rather converting it to a synthetic gas used to power the turbines that generate electricity. Supporters say the process uses coal in an environmentally friendly manner.

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<sup>9</sup> <http://cdiac2.esd.ornl.gov/>, United States Department of Energy/Office of Science

<sup>10</sup> Evansville Courier and Press

A host of regulatory standards has historically affected the mining industry. Currently, more than three dozen federal environmental laws and regulations cover all aspects of mining.<sup>11</sup> Additionally, mining in the United States is conducted with significant health and safety regulatory oversight from Federal and State agencies. Federal standards for mining are promulgated by the Mine Safety and Health Administration (MSHA). The agency's authority was first set forth by congress in The Federal Coal Mine Health and Safety Act of 1969. Subsequently, the law was updated in The Federal Mine Safety and Health Act of 1977, and most recently with the Mine Improvement and New Emergency Response Act of 2006, known as the "2006 Miner Act". Unfortunately, many health and safety regulations are legislated due to serious accidents that result in loss of life. Additional health and safety legislation is being drafted this year by congress and several state legislatures. The overall impact of more legislation has yet to be determined.

## **VII. REGIONAL PRODUCTION TRENDS**

In 2006, the Illinois Basin experienced an increase in coal production of 2.1 million short tons, or 2.2 percent, to achieve a total of 95.0 million short tons produced. This increase in coal production was primarily due to the increased coal production in Indiana and Western Kentucky, which accounted for almost two-thirds of the total regional increase. Indiana coal production rose 0.7 million short tons in 2006, ending the year at 35.1 million short tons, an increase of 1.9 percent.

Many market analysts are predicting continued strong market growth for Illinois Basin coal. "The developing scrubber market and renewed interest in coal gasification and coal-to-liquids has allowed the Illinois Basin to experience a tremendous resurgence of interest similar to

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<sup>11</sup> National Mining Association

that experienced in the 1970s. Existing producers are all planning expansions, but many newcomers are also entering the market with plans to develop a multitude of mines. If markets develop, the Basin's production is poised to expand two-fold in the next years.”<sup>12</sup>

## **VIII. INDIANA PRODUCTION STATISTICS**

Indiana officially has twenty coal producing counties with twenty active surface mines and eight active underground mines. Surface production of coal in 2006 was nearly 24 million tons, with an additional 11 million tons of underground production, for a total combined production of approximately 35 million tons.<sup>13</sup> Overall, Indiana production from 1998-2006 has remained relatively constant.

According to demonstration plots developed by Purdue University’s “Indiana Coal Report 2006”, coal production in the state of Indiana is expected to increase between 61 and 145 percent by 2020, depending upon trend assumptions. The base case, which indicates a 61% increase, is derived from the following assumption: “It is assumed that the 3.05% annual growth rate experienced during the interval 1995-2004 were to hold during the forecast period. As the figure indicates, if history repeats itself, Indiana coal use will grow to 56.78 million tons by 2020, an increase of 61% during the interval.”<sup>14</sup> Provided the most conservative trend, base case, becomes a reality for Indiana, there will be significant business activity associated with the growth of coal mining. The growth will require support from a host of professional businesses throughout the region.

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<sup>12</sup> Hill & Associates - <http://www.hillandassoc.com/illinoisbasin.htm>

<sup>13</sup> [http://www.in.gov/dnr/reclamation/pdf/Annual\\_Coal\\_Tonnage\\_Report.pdf](http://www.in.gov/dnr/reclamation/pdf/Annual_Coal_Tonnage_Report.pdf)

<sup>14</sup> <http://www.purdue.edu/dp/energy/pdfs/CCTR/CoalReport-2006-3-14-06-Final.pdf>

## **IX. CONCLUSIONS**

Coal is and will continue to be an abundant natural resource and source of energy to power the economy for many decades into the future. The United States will continue to control a significant portion of this coal resource, energy, and power while issues with mining and the utilization of coal will continue. The demand for coal will increase, but the desired quantity and quality will become more difficult to extract and market. Economically, markets will shift in true supply and demand terms. Environmental standards will become more stringent, resulting in cleaner and more efficient technologies that will make coal a more accepted source of energy. Alternate fuels technologies will be developed, over the long term, to reduce dependence and use of all fossil fuels. In the short term, coal will not readily be replaced as a primary energy source.