"Energy Research at WVU - Exploring West Virginia's Future"

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Man has long desired to know the future. Examples of fortune tellers, astrologers, religious prophets of various sorts, and even "women's intuition" fill the pages of history.

Today, things are not much different. Millions check the astrology column in the morning newspaper to prepare for the day ahead. In some respects we have become more sophisticated. Governments and businesses who desire to plan for the future hire an "out-of-town expert" called a consultant. The possession of a Ph.D., a long list of publications with exotic titles and a set of professional organization memberships apparently qualifies a person to predict the future for a group of strangers.

If all this sounds a bit cynical, it is intended. We have all read so many predictions for coal, synthetic fuels and export markets that have not been accurate, it is no wonder that the coal industry is a bit skeptical of efforts to anticipate the future. What bothers me about this subject is our willingness to look to someone else to make the predictions. I believe that we each must make an effort to anticipate the future. In this paper I will address a subject that I believe provides one window on the future for the coal industry in West Virginia.

While we obviously will never predict future events with great detail there are signs of trends and directions that suggest where we are headed. Activity in research laboratories is one indicator. to expand the title of my talk beyond that which you requested. As we discuss energy research at WVU, we are also exploring part of West Virginia's future.

Coal and energy research has been a vital part of West Virginia University for many years. Since 1977 substantial State funding has made possible the development of research capabilities in a variety of areas important to West Virginia. In 1978 the Energy Research Center was founded to coordinate energy research projects on campus. In 1979 WVU was designated the Mining and Mineral Resources Research Institute (MMRRI) for West Virginia. This program is funded equally by federal and state allocations and was initially focused on solving problems associated with the environmental effects of mining in West Virginia. By 1980 energy research at WVU was being steered strongly toward specific problems and issues important to the State.

During the past few years, progress in several research areas has been significant. However, it has been only this year that specific practical results are being realized due to the increased levels of funding and new policies instituted in the 1977 to 1980 time period. Professor Stiller's work is probably the most dramatic example. The continued progress of Professor Sencindiver and his colleagues in the College of Agriculture and Forestry has been aided by our program, but also owes much to the long term support of the mining Industry.

During the past year, an evaluation of the past four years of experience led to a refinement and focusing of the program as expressed in a new "Research Plan" which is outlined below.

The overall objective of energy research at WVU is to develop new knowledge, processes and technology that can be used to maximize the safe and environmentally acceptable production, utilization and marketability of West Virginia's energy resources.

Research will be focused in the following ways:

By Industrial Application	and for each	By Area Of Concern
Coal Mining		Production
Coal Processing		Occupational Safety
Coal Combustion		Occupational Health
Coal Conversion		Environmental Protection
Petroleum and Natural Gas Extraction		Market Issues

Also, special issues important to West Virginia will be the subject of research from time to time. For example, policy issues, regulatory impacts, economic concerns and alternative energy topics can be addressed as required. The areas listed will involve specific research efforts directed toward solving existing or anticipated problems.

Each research area is discussed below. Note that some topics are based on current efforts while others are planned for future implementation.

1. Coal Mining

The process of removing coal from the earth is complex. A variety of technologies contribute to the efficiency and safety of that process. The conditions under which coal is mined in West Virginia are expected to become increasingly difficult. New mines will be deeper with thinner coal seams, and coal that is now viewed as uneconomical for mining will be that on which the State's future economy must depend. Thus, the plan focuses primarily on searching for ways to improve mine productivity in safe and environmentally acceptable ways.

Coal Mining research will be focused on the following areas:

A. Increased productivity and safety of presently used mining methods
B. Improved mining systems for future mining conditions
C. New methods of surface mining to improve recovery and environmental protection
D. Supporting research

2. Coal Processing

A key factor in the competitiveness of West Virginia coal is the quality of the product. Because of the increased concern for environmental protection, the amount of sulfur, ash and trace metals present in coal has become an important issue in coal acceptability. With low-sulfur surface mined coal available from Western states, economical methods for removing

undesirable matter from West Virginia coal have become a key competitive factor. Physical methods for separating ash and sulfur from coal are now standard procedures in preparing coal for sale. Although physical coal cleaning methods may have been developed nearly to their full potential, processes which utilize chemical reactions to remove undesirable constituents are only in the earliest stages of development. Also, the cleanup of effluents from all types of processing, such as the processing of coal for slurry transport and the dewatering of slurry at the receiving end of a transport system, all need continued research. Fundamental to coal processing research is the characterization of coal -- especially the development of new methods that aid the of understanding reaction processes. Focal topics in this area are as follows:

A. Chemical and physical processing
B. Coal slurry related processing
C. Dewatering of waste fines
D. Processing plant effluent cleanup
E. Coal characterization and other supporting research

3. Coal Combustion

The primary value of coal is derived from its direct or indirect use as a fuel. Because of coal's variable heterogeneous composition, combustion and conversion processes must be controlled to meet environmentally related constraints while achieving high efficiency and reliability. Combustion processes that are likely to be applied to electric power generation and industrial heating are candidates for concern. Studies of the most fundamental properties of coal combustion are revealing new information that are expected to lead to new combustor designs. The priority topics for this research are as follows:

A. Exploratory research with new combustion processes
B. Combustion of coal-water mixtures
C. Hot gas cleanup for direct combustion systems
D. Fluidized bed combustion of high sulfur coals

4. Coal Conversion

Coal conversion processes for production of gases or liquids are in several stages of development. Virtually all aspects of such processes are open to additional research and innovative development. Research in this category is being directed at the fundamental principles of the processes. Since the processes under the most intensive investigation today are variations of those discovered years ago, research is also being conducted in search of dramatically different approaches to coal conversion. These are expected to spring from a better understanding of the fundamental chemistry and physics of coal reaction processes. The characterization of conversion products continues to be important. Also, many supporting areas need attention, including topics such as instrumentation, control, and "let-down" valves. Priority topics in this research area are as follows:

A. Improvement of fundamental processes in coal conversion systems
B. Product characterization

C. Supporting and exploratory research

5. Petroleum and Natural Gas Extraction

West Virginia has much to contribute from its petroleum and natural gas resources. Until recently, the application of new technology to petroleum and natural gas recovery in West Virginia was not cost-effective. The recent large increases in petroleum prices have changed the situation. Topics of priority concern in this developing research area are as follows:

A. Enhanced recovery from traditional fields
B. New technology for locating and plugging old wells
C. Natural gas production from

    1. Devonian shale and tight sand
    2. Coal beds before and during mining
    3. Geological frontier areas

D. Evaluation of West Virginia oil shales

Other projects that do not fit clearly in the areas outlined above will also be funded from time to time. These include topics such as economic and regulatory issues, novel uses of fossil fuels, fundamental studies that relate to several applied areas and fuel wood usage in West Virginia.

Appendix I shows a list of the projects that will be funded by state and MMRRI funds during fiscal year 1984. This list not only shows our program breadth, but also points to specific areas of weakness. At the current levels of funding it is impossible to address all of the subjects listed in the research plan. In fact our ability to steer the overall program in directions important to the State has been eroding in recent years. Table I shows that while funds from private industry increased 52% from 1979 to 1982 and federal funding kept pace with inflation, state support has actually been reduced due to inflation and budget cuts.

This is ridiculous since it is the state funds that permit our research teams to concentrate on problems of specific importance to our state industry. The work of Professor Stiller is a classic example of how state funding can be used in ways not possible with federal agencies. Such allocations in 1977 allowed Professor McCormick in the Chemistry Department to hire post-doctorate Stiller to pursue the somewhat unconventional thoughts of a group of professors -- Jack Renton, Al Donaldson, Pedro Montano. They dared to challenge the conventional wisdom of the day concerning the basic chemistry of how acid is formed in the AMD process.

The WVU administration took some flack at the time. Persons in the mining industry who were consumed with dealing with the immediate problem believed money invested in very basic chemistry research was unwise. I need not tell you how this and other fundamental research performed in other places is now opening dramatically new opportunities for mitigating AMD.

TABLE I

WEST VIRGINIA UNIVERSITY
ENERGY RESEARCH CENTER
TOTAL FUNDING BY YEAR

Fiscal Year	Private Industry*	Federal Agencies*	State Budget Line+
79	$861,113	$10,096,344	$1,000,000
80	930,917	13,653,866	1,000,000
81	1,195,672	12,403,637	1,068,000
82	1,308,222	13,128,344	1 157,630
83	-	-	1,000,000
Total Change	52%	30%	0%

*Total value of all grants and contracts active during year. Expenditures for each year are about one third of the value indicated.

+Budget authority under State line "Bureau for Coal Research" excluding reductions.

The road from the research laboratory to major industrial impact, is long and rocky. Cooperation between the research community, the government and industry is the key. The Acid Mine Drainage Task Force is an ideal example of such cooperation. It recognizes that none of the cooperating entities has all the answers, but collectively acceptable solutions can be found. I trust that in the future similar groups will be established in West Virginia to address problems important to our industries.

As part of our planning for future research at WVU we too recognize the value of bringing researchers together to cooperatively address specific problems. We are calling these "Special Areas of Emphasis". Our premier group is the reclamation and acid drainage area. While being a somewhat informal group organizationally, it is becoming a model for what we hope will happen with other research areas. Fluidized bed combustion of high sulfur coal has also received considerable emphasis in recent years. With the employment of a new leader for this effort, it should move ahead again soon. Basic studies on catalysts for coal conversion is an emerging area of special emphasis. Other areas we expect to develop in the next two years include control of respirable dust in mining, computer usage in coal mining and processing, and longwall mining.

Now that we have reviewed what is happening and planned in the energy research program at WVU, I believe that we can now look to the future of West Virginia. It is clear that much of our research pertaining to the coal industry has been driven for well over a decade by the industry's struggle to cope with new safety, health and environmental regulations. While the need for research in these areas is not over by any means, it is also clear that the competitiveness between mines and mining regions within the U.S. and internationally will be an important factor throughout the 80's and 90's.

In the 70's the struggle was to merely comply with regulations. In dealing with regulatory issues the emphasis is now shifting to a search for new and more cost effective methods of compliance. Thus whether one is dealing with safety, health, environment, production, processing or marketing, concerns for efficiency and economy will be a stronger driving force in the future.

Industry's struggles of the 70's involved much federally sponsored research yielding results shared with all. In a growing market, solutions quickly spread for the use of all. Competitive

advantage between similar mines has largely been one of experience and technique and not one of advanced science or engineering.. I believe this is already changing and the influx of new sophisticated technology into mining is altering the competitive character of the industry. I predict that mining companies will become much more protective of the technology used in production processes and engineering.

Studies have shown that when industries experience technological change two key factors become important to the survival of individual companies and groups of companies in governmental regions. First, there must be an aggressive effort to apply new technology to stay ahead of the competition. Secondly, R&D must be an integral part of the business activities including decision making at the highest levels. The speed with which companies must respond today in conducting and applying R&D is increasing and related business decisions must be made on the basis of world wide technology developments. I believe these principals will increasingly apply to the coal industry in the years ahead.

At West Virginia University we are anxious to work with the West Virginia mining industry to prepare for the future. We not only need your cooperation, but also you support in the legislature and the governor's office. While we have laid the foundation for a meaningful energy research program for West Virginia, there is much work to be done to achieve the desired results.

APPENDIX I
PROJECTS FUNDED FOR FY 84

Title of Proposal	PI
COAL MINING	
Production/Safety	
Support Load Requirements for Roof Behavior in Longwall Mining	S. Peng Mining Eng.
Back Injury Reduction Through Ergonomic Job Redesign	R. Plummer, IE T. Stobbe, IE
Coal Mine Fires and Explosions	R. Rollins Mining Eng.
Optimum Mining Plan for Multiple Seam Mining	W. Su/S. Peng Pet. Eng./Min.Eng.
Expert Systems in Coal Mining	Y.V. Reddy, Stats. & Computer Science R. Nutter, EE
New Methods/Surface/Environmental	
Survival, Growth, and Nutrient Accumulation by Mycorrhizal Bigtooth Aspen on Minesoils	E. Jencks D.F. Hindal Pl & Soil Sci.
Electrochemical Neutralization of an On Site Mine Drainage Pond	A. Stiller ChE
Evaluation of Selected Abandoned Mine-Land Revegetation Treatments	J. Sencindiver Pl & Soil Sci.
Candida albicans as an Alternative Sanitary Indicator Organism for Waters Containing Acid Mine Drainage	G. Bissonnette Pl & Soil Sci.
Mineral Concentration of Forage Grown on Reclaimed Surface Mines	B.S. Baker J. Sencindiver Pl & Soil Sci.

Title of Proposal	PI
COAL MINING	
Support	
A Modeling Approach to Coal Policy Analysis in West Virginia	W.C. Labys Min Res Econ
A Rational Procedure for Predicting Surface Subsidence	H. Siriwardane CE
Effects of Respirable Coal Dust on Pulmonary Alveolar Macrophages	E. Cilento, ChE R. Lantz, Anatomy
Subsidence Effects on Structures in WV	G. Halvorsen CE
Subsidence Model Study Using Laser Holographic Interferometry	A.W. Khair Mining Eng.
COAL PROCESSING	
Chemical/Physical	
Mechanistic Model for Cyclone Separators	A. Padhye, MAE R. Bajura, MAE
Chemical Separation in a Low Temperature Coal Dissolution Process	A. Stiller ChE
Fines & Dewatering	
Dewatering and Desulfurization of Oxidized, Fine-Sized Coal From Tailing Impoundment by Agglomeration	F. Peng Min Proc Eng.
Characterization	
Coal Characterization with Radioisotopic Neutron Sources	D. Downey Chemistry
Mechanical Properties of Coal	G. Kirby MAE
Substoichiometric Isotope Dilution Analysis of Sulfur	D. Downey Chemistry

Title of Proposal	PI
COAL COMBUSTION	
New Processes	
Flame Speeds and Flammability Limits of Lean Mixtures	W. Squire, MAE Hill
Fluidic Nozzles for Pulverized Coal Combustion	J. Jurewicz H. Viets, E. Johnson, MAE
COAL CONVERSION	
Fundamental Processes	
Study of the Surface Interactions on Co-MO and Ni-Mo Catalysts During Coal Liquefaction	P. Montano Physics
Low Coverage Surface Adsorption Effects Pertinent to Catalytic Synthesis	B. Cooper Physics
Fluid-Phase Equilibria for Coal-Derived Fluids	W. Whiting ChE
Development of an Experimental and Theoretical Model for the Fischer-Tropsch Reaction	E. Mintz Chemistry
Investigation of the Extent and Nature of Chemical Reactions in Coal Derived Liquids/ Supercritical Solvent Systems	J. Henry A. Stiller ChE
Catalytic Properties of Small Bi-Metallic Pt-Ni Particles	M.J. Yacaman Physics
Supporting/Exploratory	
Coal By-Product Toxins: Animal Detoxification	R.S. Pore Microbiology
High Temperature EPR and ENDOR Characterization of Coals and Shales and Black Lung Tissue	N.S. Dalal Chemistry
A Numerical Model for Fluid and Particle Motion Near the Inlet of an Aspirating Probe	J. Jurewicz MAE
The Use of Coal for Energy Savings in the Metal Industry	R. Creese IE
Crossflow Coal Gasification	E. Johnson MAE