

WYOMING COAL INDUSTRY

HEARING
BEFORE THE
COMMITTEE ON
ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE
ONE HUNDRED NINTH CONGRESS

SECOND SESSION

ON

ISSUES ASSOCIATED WITH THE GROWTH AND DEVELOPMENT OF THE
WYOMING COAL INDUSTRY

CASPER, WY, APRIL 12, 2006



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WYOMING COAL INDUSTRY

WEDNESDAY, APRIL 12, 2006

U.S. SENATE,
COMMITTEE ON ENERGY AND NATURAL RESOURCES,
Casper, WY.

The committee met, pursuant to notice, at 1:33 p.m., at the Wyoming Oil and Gas Conservation Commission Building, Hon. Craig Thomas presiding.

OPENING STATEMENT OF HON. CRAIG THOMAS, U.S. SENATOR FROM WYOMING

Senator THOMAS. The purpose of this hearing is to be able to get the information from you, and bring it back to Washington, so that you don't have to go there. So, I want to thank all the witnesses for appearing before the committee.

The purpose of the hearing is to gain better understanding of the legislative, economic, and environmental issues associated with the growth and development of the Wyoming coal industry. Our conversation today has important implications, not only for Wyoming, but also for our country and for the international community.

Coal amounts to 90 percent of the United States total energy reserves. Coal fuels over half of the electricity generated within our borders. By 2015, global use of coal will double. Today coal accounts for 25 percent of worldwide energy consumption. In less than 20 years, it will more likely account for more than 50 percent.

The United States has been using coal for two centuries. The challenge is to meet our Nation's environment, economic, and energy security goals while developing the resource. The use of clean coal technology is critical in meeting this challenge. Clean coal technologies can dramatically increase the efficiency of, and significantly reduce the emissions from coal combustion.

Coal is often associated with the generation of electricity, that is going to change in the future. There's a growing concern about the dependence on foreign suppliers of oil, and coal is one of the effective solutions. Carbon Dioxide will be captured during the electrical generation and can engage the production of domestic oil fields.

Paired with the conversion of coal to liquid fuel, these technologies will help reduce our dependence on foreign oil. By 2005 fuels from coal could replace as much as 2 million barrels of oil and 5 trillion cubic feet of natural gas a day, Wyoming is our Nation's largest coal supplier.

Last year 36 percent of domestic coal production came from Wyoming. We must build on this production's success by attracting activities relating to advancing coal technologies in our State. The en-

ergy policy in 2005 has already set the stage for this new era. It established a long ranging program which will cover 80 percent of clean imaging projects. It establishes three tax credits that will stimulate investment in clean coal facilities. It authorizes a billion dollars over 3 years for liquid coal and gaseous fuels from coal.

Unfortunately, the President's budget did not reflect the Energy Policy Act's emphasis on coal and we're working with him on that. We have some real opportunities to get going and we've got people in the private sector ready to move forward. These are activities that need to take place within the next 2 or 3 years in the strong private-public partnership and advance that effort. Essential infrastructure will rise, will also be required to accomplish our bill's full potential when it comes to Wyoming's coal resources. The exportation of our vast coal resources has been advantageous, but there are added benefits to keeping the fuel in the State where the fuel can energize other activities. Railroads will be essential to the part of our service to increase capacity and provide reliable service.

Electrical transmission must be constructed. We must construct and expand pipeline infrastructure. Our State's ability to engage in these kinds of value added activities has limited only by our capacity to get these products to the market. There are significant challenges, but we're standing on the edge of a promising new era in energy development and production. Wyoming will continue to be a national leader in these efforts. If we overcome these challenges, we can improve the Nation and Wyoming's economy, security and environment while creating jobs and strengthening education. I look forward to hearing our witnesses, to their thoughts on these issues and we now turn to our first panel.

I would like to welcome Tom Shope, Chief of Staff of the Department of Energy's Office of Fossil Fuel and Dr. Lowell Miller, Director of the Office of Sequestration, Hydrogen and Clean Coal Fuels with the Department of Energy. I understand the Assistant Secretary, Jeff Jarrett, had some difficulties, health difficulties, and wasn't able to be here. I hope all goes well with him and we welcome you gentlemen here. Would you like to proceed?

STATEMENT OF THOMAS SHOPE, CHIEF OF STAFF, OFFICE OF FOSSIL ENERGY, DEPARTMENT OF ENERGY

Mr. SHOPE. Thank you Senator, and I would like to apology for the Assistant Secretary who was unable to make it, but I'm happy to report he is doing much better and looks forward to coming out to Wyoming soon.

Senator THOMAS. Good, glad to hear it.

Mr. SHOPE. Mr. Chairman, it is a pleasure to join you here in Wyoming today. First, I would like to say how much the Department appreciates the support of the chairman and the members of the committee over the past years and we look forward to working with you on fossil energy's research and development programs.

Now, the Senator cited many of the statistics which I am going to repeat, but I think they bear repeating, about the status of fossil fuels in our country today. It is truly an exciting time to be at the Office of Fossil Energy. As the Senator mentioned, coal, oil, and natural gas today supply about 85 percent of the total energy con-

sumed in the United States and coal accounts for well over half of our total electricity generation.

The Energy Information Administration forecast that in 20 years, coal, oil and natural gas will still account for about 85 percent of the U.S. total energy consumption and roughly the same numbers apply for total world energy consumption. Now, that's not to say that we won't be making incredible strides in increasing and perfecting alternate and renewable energy sources, because the President and the Department of Energy are committed to doing just that.

Rather, EIA's estimates reflect our insatiable appetite for energy. Total U.S. energy demand is forecast to increase by about 27 percent over the next 20 years, and that's just in this country. Total energy demand is forecast to increase by 64 percent, worldwide. To meet this energy challenge, demand for oil in the United States is projected to increase by 25 percent. Demand for natural gas to increase by 21 percent. Demand for coal by 37 percent.

We can and must meet this growing demand for energy through the use of advanced technology. That's what we are focusing on at the Department of Energy. At the Office of Fossil Energy, these are not just talking points or lofty goals, we are taking concepts from the drawing board through demonstration into commercialization.

Real world applications, applications in the field and on the ground. And we are doing it by leading cooperative national and international research development efforts. And in all cases, partnering with industry, scientific and technology leaders. Obviously Wyoming and neighboring States play a critical role in this process. We are continuing to demonstrate new oil and gas production technologies at the Rocky Mountain Oilfield Testing Center, located right here in Casper. We continue to work with the Western Research Institute, and we are working with many advanced technologies of particular interest to Wyoming. Like those used for enhanced oil recovery, using carbon dioxide injection, which could allow us to quintuple our domestic recoverable oil reserves.

We're continuing to work on advanced technologies like the extraction of oil from shale, which could add another 300 billion barrels of oil to our domestic reserves. These are oil shale resources which are concentrated in Colorado, Utah, and right here in Wyoming.

We are also working on advanced technologies that will allow us to take regular advantage of unconventional domestic natural gas resources, such as coal bed methane, which now accounts for 9 percent of all gas produced in the United States.

And of course we are working on advanced technologies that will continue to allow us to take advantage of our most plentiful fossil fuel, coal. Coal is the workhorse of the Nation's electric power industry. Serving as the cornerstone of America's central power system. Technology has made coal and other fuels far cleaner today than they were a generation ago.

Electricity generated from coal has risen 177 percent since 1970, yet emissions of small particulate matter sulfur dioxide and nitrogen-oxide emissions have decreased significantly. But these successes are not enough, to preserve this economically vital energy foundation, we must invest in innovative, low-cost environmental

compliance technologies for existing plants and develop cleaner and more efficient technologies for use in new plants.

Our clean coal programs are driven by President Bush's policies and initiatives to achieve energy security and reduce polluting emissions in the air as well as greenhouse gas emissions. They are underscored by the President's advanced energy initiative and his 10 year \$2 billion coal research initiative. In furtherance of these efforts, we are currently undertaking various cutting edge research and development projects. While each project and program is aimed at a specific technological goal, all the projects are designed to be mutually supported and contribute to our ultimate goal a completely clean coal-based plant that maintains coal's favorable cost advantage over competing fuels.

Our coal research extends from innovations for existing plants to needed technologies of the future in the areas of gasification, turbines, carbon sequestration, hydrogen from coal, fuel cells and associated advanced technologies. In about 6 years, we expect our work to result in an up and running working, large scale, coal-based powerplant and hydrogen production facility that emits no polluting or greenhouse gasses into the atmosphere. We call this project "FutureGen."

Think for just a minute about what that will mean. FutureGen will prove out the new technologies we're working on today and serve as a model for the coal based powerplants of the future. FutureGen will not only assure coal's future as the dominate source of electric power, it will also be an important source of the hydrogen that will fuel a hydrogen based economy of the future. That is transformational technology, and it's within our reach.

Of course these advances will be very important to Wyoming, with market shares of Western coals continuing to rise and production growing at about 20 million tons per year, Wyoming leads the Nation in coal production. Our ultimate goal of energy security can only be reached by scientists and engineers working to research and develop new, cost effective technologies to take us beyond our current performance.

As a Nation we will provide the energy we need, we will continue to make incremental and impressive gains in environmental performance. It will take time, effort and resources, but we're far enough down the research and development road to say with confidence that the promise is now much larger than the problem.

The President's energy policy and its related initiatives holds nothing less than to consign to the history books the energy and environmental challenges that preoccupy our country and the world today. We are not indulging in idle fantasies. The products of our clean coal and other energy and environmental technology research and development will continue to supply the energy, the everyday miracle of modern life that makes every thing else possible. Mr. Chairman, that concludes my oral remarks, I have some written comments for the record and I would be happy to answer any questions along with my colleague, Dr. Lowell Miller, the Director of Hydrogen Sequestration and Clean Coal Fuels.

[The prepared statement of Mr. Shope follows:]

PREPARED STATEMENT OF THOMAS D. SHOPE, CHIEF OF STAFF, OFFICE OF
FOSSIL ENERGY, DEPARTMENT OF ENERGY

Mr. Chairman, members of the Committee, it is a pleasure to join you here in Wyoming today to discuss the promise of technology to allow coal to remain the bedrock of the American and the world power generation industry. The Department appreciates the support of the Chairman and the Members of the Committee over the past years and we look forward to working with you as we move forward with Fossil Energy's research and development programs.

It is a fact that coal is our most abundant domestic energy resource—we have a 250-year domestic supply at current consumption rates, and the entire world has a nearly 200-year supply. Coal is a critically important contributor to both America's and the world's energy security: a potentially clean, affordable and key source of energy for the indefinite future.

I'd like to begin by laying out a few facts about fossil fuels and energy in general.

The first fact I want to highlight is that fossil fuels—coal, oil and natural gas—today supply about 85 percent of the total energy consumed in the United States. Oil accounts for 40 percent of that total—most of it for transportation fuels—while coal and natural gas account for about 23 percent each. Nuclear energy, large hydroelectric facilities and other renewable energy account for the remaining 14 percent. Coal accounts for well over half of our total electricity generation.

Interestingly, roughly the same numbers apply for total world energy consumption.

If we do not change the way we produce and consume energy, the U.S. will remain reliant on imported sources of oil. Current forecasts suggest that in 20 years the U.S. and the rest of the world would need even more energy than we now consume to serve more people in improved economic circumstances. Total U.S. energy consumption is forecast to increase by about 27 percent and world consumption by 64 percent. The use of our domestic resources, especially coal, will continue to be important in meeting our energy needs and ensuring our energy security.

Consumption of oil in the U.S. is projected to increase by 25 percent; of natural gas by 21 percent and of coal by 37 percent. Wyoming and neighboring states will play a critical role in satisfying that demand growth. Consumption of nuclear, and renewable energy is also projected to increase.

We will need energy from every available source and, for that reason, we cannot be for one source of energy and against another. We need them all and we must be for them all.

How are we going to meet this growing demand for energy? The answer, as it always has been, is through human ingenuity—advances in technology.

Intelligence and imagination have allowed us to tap oil and natural gas resources deeper in the ground, deeper underwater and in more inhospitable places than ever before.

That will continue as new technologies allow us to develop oil and gas resources in parts of the Rocky Mountain region, on the Outer Continental Shelf, and in Alaska.

Enhanced oil recovery technology using carbon dioxide injection could significantly increase our domestic recoverable oil reserves by allowing more oil to be recovered from mature oil fields.

At the same time, technology is allowing us to take greater advantage of "unconventional" domestic resources. Perhaps the most prominent example is coal-bed methane, which now accounts for nine percent of all gas produced in the U.S. Our coal-bed methane resources are centered in Wyoming, Colorado and New Mexico.

Other unconventional resources, while not yet proven to be economic, hold significant potential for the future if certain technological hurdles can be overcome. As you know, our oil shale resource is concentrated in Wyoming, Colorado and Utah. In addition, an estimated 200,000 trillion cubic feet of gas resource exist in methane hydrate formations in the U.S. Worldwide, methane hydrates are estimated to contain 400 million trillion cubic feet of gas.

Technology has made solar and wind power sensible technology choices in certain circumstances today, and further R&D breakthroughs will continue to drive down costs and encourage more widespread applications of these technologies.

Technology has made nuclear power plants safer, more secure and more efficient. It has transformed the transportation sector, providing far cleaner fuels and, increasingly, more efficient vehicles. And it has made industry and society overall much more energy efficient, producing more goods and services while using less energy and emitting less pollution for an ever-expanding economy. Our economy grew by over 125 percent from 1972 to 2000, yet energy use increased by only 30 percent.

The EIA projects a further 32 percent improvement in energy intensity—energy consumption per dollar of Gross Domestic Product—by 2025.

Technology has made coal and other fuels far cleaner today than they were a generation ago. While our economy and population have been growing, pollution has been declining. Electricity generated from coal has risen 177 percent since 1970, yet emissions of small particulate matter have decreased by 87 percent, along with a 38 percent decrease in SO₂ emissions and a 24 percent reduction in nitrogen oxide emissions.

Our ultimate goal is energy security, which can be defined concisely as reliable, affordable, and environmentally sound energy for the future. That goal can be reached with the help of scientists and engineers working to research and develop new, cost-effective technologies that take us beyond current performance.

Based on what we have accomplished to date, anyone with knowledge of the energy and environmental field should be an optimist about our future prospects.

President Bush is an optimist, and his energy plan has from day one been founded on technology. The President's new Advanced Energy Initiative which he unveiled in his State of the Union Address is founded on accelerating research in technologies that hold great promise. As the President has said, we are on the verge of spectacular technological advances that will redraw the energy and environmental landscape beginning in our lifetimes.

We can and will provide the energy we need and we need to have short, medium and long term approaches to this challenge. We must also continue to make incremental but impressive gains in environmental performance. There is no one immediate solution to our energy challenge. We must face this challenge with a long term view to change fundamentally the way we produce and consume energy. There are things we can accomplish in the short term that change the way we power our homes and businesses and vehicles. Energy efficiency measures will play an important role. But many of the big changes are still some way off. It will be perhaps 10 to 20 years before we see the transformational technologies we are researching and developing today begin to have real-world, beneficial effects on our lives.

The wait will be worth it. The benefits will be enormous, changing our lives and addressing the energy and environmental concerns that preoccupy us today.

There are great things coming in the energy and environmental world and many of them have to do with clean coal's promise and the role we envision for it in helping to meet our overall energy challenge. The Office of Fossil Energy has taken and is taking a lead role, in partnership with industry, university researchers, state governments, independent energy organizations, foreign governments and others in researching and developing technological advances that are making coal a cleaner, more efficient source of energy every day. Our clean coal programs are driven by: President Bush's energy policy goal of energy security; by the Clear Skies Initiative to reduce polluting emissions to the air by 70 percent by 2018, and recent complementary Environmental Protection Agency regulations; by the climate change goal to reduce the greenhouse gas intensity of the economy by 18 percent by 2012; and by the President's 10-year, \$2 billion Coal Research Initiative to develop near-zero atmospheric emissions, coal-based power generation and hydrogen production.

Perhaps the best way to survey the goals and activities of the coal and power generation sector is to take a brief tour of the Department of Energy's clean coal program. If a technology is important, we're working on it, often leading cooperative international R&D efforts. And in all cases we are partnering with industry and scientific and technology leaders.

The various R&D projects currently underway are mutually supportive; while each project and program is aimed at a specific technological goal with a specific energy/environmental benefit to be met according to a specific timetable, all the projects are designed to contribute in one way or another to our ultimate vision: a completely clean—that is, emissions free—coal-based plant that maintains coal's favorable cost advantage over competing fuels.

Coal plants have a useful life of at least 40 years, which means that there are coal plants currently operating that were built as far back as the 1960s, just about the time we as a nation began to take the phenomenon of pollution emissions seriously. The federal government and state governments have passed pollution control legislation and the coal power industry has met the challenge by retrofitting technological improvements to older plants and incorporating new technology in each new plant as it was built, with impressive results, as mentioned earlier.

That's good, but in order for coal to continue to account for more than half of America's electricity supply, and nearly a quarter of our—and the world's—total energy output, the coal research program is proceeding along three interwoven, complementary tracks: a Clean Coal Power Initiative for the commercial demonstration of new technology; design, construction and operation of the coal-based power plant

of the future called FutureGen, a 275-Megawatt, fully integrated, near-zero emissions, coal-fired power plant and research facility that will produce both electricity and hydrogen while sequestering carbon emissions; and a coal research effort that is concentrated on clean coal's key technology needs.

Our coal research extends from innovations for existing plants to needed technologies of the future in the areas of gasification, turbines, carbon sequestration, hydrogen from coal, fuel cells, and associated advanced technologies.

In about six years, we expect our work to result in an up-and-running FutureGen plant: a working, large-scale power plant and hydrogen production facility that emits almost no polluting or greenhouse gases to the atmosphere. Think about: virtually no nitrogen oxides, no sulfur dioxides, no mercury, no particulate matter, no carbon dioxide. Nothing but energy.

The goal is for FutureGen to prove out the new technologies we're working on today and serve as a model for the coal-based power plants of the future. FutureGen holds the potential to not only assure coal's future as the dominant source of electric power, but to also be an important early source of the hydrogen that will fuel a hydrogen-based economy of the future.

That is transformational technology—and it's within our reach.

Clean coal is set to continue its enormous contribution to America's energy security and as you will see, to world energy security.

While FutureGen is our promise for the future, let me turn to some of the more immediate advances being brought about by the Clean Coal Power Initiative, or CCPI.

CCPI has progressed steadily since it was initiated by the President in 2002, providing Government co-financing with utility partners for new coal technologies that can help utilities meet the President's Clear Skies Initiative and other energy goals. Some of the early projects are also showing ways to reduce greenhouse gases from coal plants by boosting coal combustion and power plant efficiency.

To take one example from the 10 CCPI projects that have been selected after two rounds of competitive solicitations, the "Mustang" project in New Mexico will demonstrate a multi-pollutant control process that can remove virtually all sulfur dioxide and nitrogen oxide emissions and 90 percent of mercury emissions.

While CCPI demonstrates existing new technology, our core coal research program is developing the technologies of the future that will eventually be essential components of FutureGen.

We can break the program elements down in general terms, beginning with our Innovations for Existing Plants program, which is aimed at short- and medium-term goals.

We aim by next year to develop cost-effective technologies ready for commercial demonstration that reduce mercury emissions by 50 to 70 percent, and eliminate microscopic particle emissions.

By 2010, we plan to test technologies for cutting mercury emissions by an average of 70 percent.

For the long-term, our coal research goals are ambitious but achievable.

We are far along in research, development and demonstration of advanced Integrated Gasification Combined Cycle, or IGCC, technology. IGCC, in essence, converts coal to its constituent gases and then burns the gas. The IGCC process is inherently clean, highly efficient and versatile. It is potentially capable of generating electricity, steam, and a broad range of chemicals including synthetic natural gas, and virtually eliminating atmospheric emissions of nitrogen oxides, sulfur dioxides, mercury and other pollutants.

With IGCC, carbon dioxide emissions may eventually be reduced by half compared to conventional coal technology, with the majority of the remaining carbon dioxide emissions ready for capture and permanent underground storage.

As we move along our R&D path for coal gasification, we have specific technological hurdles to leap. We have to improve new gasifier and turbine performance and reliability while steadily bringing down costs. We will have to develop new gas-related technologies and integrate them with fuel cells and fuel cell/turbine hybrids.

Fuel cells are usually thought of as a feature of automotive vehicles of the future. Often overlooked is their potential to be a very important part of our power generation future, both as an integral part of future power plants and as a "distributed generation" supplement to the electricity grid—a local power source for commercial and public buildings, hospitals and residences, for energy-intensive telecommunications facilities, and other uses.

Because fuel cells rely on electrochemical reactions rather than combustion, they are inherently efficient, quiet, and virtually pollution-free.

Combined with the kind of IGCC system described earlier, fuel cells will make possible near-zero emissions, coal-based power with nearly double the efficiency of today's coal-fired plants. Fuel cells are a key option for the FutureGen concept.

Our Solid State Energy Conversion Alliance program, known as SECA, is working today to develop fuel cell modules that can operate at one-tenth the capital cost of today's systems, and hybrid fuel cell-turbine systems that operate at up to 60% efficiency on coal. Compare that to the average 33 percent efficiency rate at today's coal power plants.

Another of our research projects is aimed at a new and potentially transformational market, given the right price environment, for hydrogen derived from coal. Transition to hydrogen from coal as a transportation fuel could help reduce our dependence on imported oil.

Finally, our carbon sequestration program has immense potential for reducing greenhouse gas intensity.

Carbon sequestration is the capture and permanent storage of carbon dioxide. Our ability to eliminate CO₂ emissions from coal-based power plants by permanently capturing and storing them underground will have a significant, beneficial effect on greenhouse gas intensity. That's why carbon capture and storage, as well as measurement, monitoring and verification are at the heart of our efforts to meet the goals President Bush set out in his Global Climate Change Initiative.

We plan to demonstrate a portfolio of safe, cost-effective greenhouse gas capture, storage and mitigation technologies at the commercial scale by 2012, with the potential for substantial deployment and market penetration beyond 2012.

By 2018 we should have developed commercial systems for the direct capture and sequestration of greenhouse gases and pollutant emissions that results in near-zero emissions with less than 10% increase in the cost of produced energy.

To accomplish this ambitious program, we have formed seven Regional Carbon Sequestration Partnerships in the United States and Canada. Wyoming, it should be noted, is an active participant in two of the regional partnerships: Big Sky, led by Montana State University, and the Southwest Partnership led by the University of New Mexico. We have also formed the international Carbon Sequestration Leadership Forum (CSLF) to share scientific and technological information and participate in joint projects. The CSLF has drawn the enthusiastic attention of many of the world's largest coal consumers and now comprises 21 member nations and the European Commission.

Just last week we conducted a meeting of the CSLF in New Delhi, at which we reached another, closely related milestone in international energy/environmental co-operation when India become the first country to join the government steering committee for FutureGen. As a partner, the Indian government will contribute \$10 million to the FutureGen Initiative and Indian companies will be invited to participate in the private sector segment. India is the first of what we hope will be many international government partners to join with us in the FutureGen project.

I don't need to point out that Carbon Sequestration technology is integral to the design and operation of FutureGen.

But I do want to emphasize a couple of additional potential benefits of carbon capture. First, carbon dioxide derived from power plants will be increasingly in demand as a commercial product for injection into mature oil fields, adding to our domestic oil reserves and production and providing revenue to power generators. And second, research projects currently underway are testing the strong possibility that CO₂ injected into active oil fields can be sequestered there, providing a very attractive energy and environmental double benefit: reduced greenhouse gas emissions and increased oil production.

The successful development and deployment of clean coal technology will undoubtedly be important to America's energy future. It will also be important to Wyoming. Here are a few numbers to illustrate just how important:

- Substantial new coal fired power plants are being prospected nearly every week. More than 140 new coal-fired power plants have been proposed representing 85 GW of electricity, over \$119 billion investment, and enough power to electrify over 85 million homes. At least 6 new coal fired plants have been proposed for Wyoming.
- Market shares for western coals continue to rise, with production growing at about 20 million tons per year. More eastern power plants are expected to use western coals, with western coal supply to eastern power plants expected to increase by more than 50 percent through 2030.
- Wyoming continues to lead the Nation in coal production. Your mines account for more than one-third of the approximately one billion tons of domestic coal produced each year, and nearly 70 percent of western coal production.

- Wyoming coal production is increasing, thanks in large part to your world class coal seams and desirable low sulfur composition.
- The Powder River Basin is a tremendous coal producing region with over 65 trains filled with coal leaving the basin each day destined for various end uses throughout the country.
- The coal industry continues to be an important source of employment for Wyoming.
- Coal industry jobs here are among the highest paying, with the Department of Commerce reporting Wyoming's labor earnings from coal mining at more than \$300 million. That breaks down to wages of more than \$64,000 per year (excluding benefits), more than twice the state average.
- Each coal mining job supports an estimated three related jobs, leading to a total payroll effect of more than \$600 million to the state of Wyoming.

Coal is at the heart and soul of Wyoming, both now and for the foreseeable future. I will conclude by emphasizing how deeply committed we are to the research underway today.

The President's energy policy, his new Advanced Energy Initiative, his goals for climate change, his Coal Research Initiative and the other activities I outlined propose nothing less than to rewrite the future of the energy and environmental challenges that preoccupy our country and the world today.

We must invest today to reach the day when combined energy from all sources will be reliable and affordable; when energy-related emissions from stationary sources will be minor to non-existent; when a large segment of the transportation sector will be converted to fuel-cell vehicles running on hydrogen; when our efforts to control emissions and increase efficiency will be complemented by less-developed, faster-growing countries with far larger populations having the benefit of the technologies we have taken the lead in developing.

Imagine, for example, the beneficial effect on global emissions and energy resource consumption if China, which is building new coal-based power plants at the rate of one a week, were to adopt some of these new power generation and energy efficiency technologies and processes. We're working with them on it.

The combination of sensible energy policy, scientific and engineering ingenuity, the genius of American business and the rich energy resources of Wyoming and other states will allow us to continue to grow our economy and enjoy our way of life for centuries to come.

Mr. Chairman, that concludes my testimony. I will be happy to answer any questions the Committee may have.

Senator THOMAS. Okay, thank you. Your remarks will be put into the record. I wonder, from the technological standpoint, what other issues associated with building an IGCC plant that uses Western coal at altitudes above 4,000 feet.

Mr. SHOPE. I will defer to the technological expert in that area.

Senator THOMAS. Very well.

Dr. MILLER. I think the biggest challenge will be to address the moisture that's in the Western coal in order to make it compete with some of the other coals. The integrated gasification combined cycle starts with the gasifier and that is somewhat sensitive to the moisture content of the coal.

Senator THOMAS. I see. Do you have plans to deal with that issue.

Dr. MILLER. Yes, we have. There have been an number of studies that have been performed using the Wyoming coal as a feedstock, looking at different ways to address the moisture in the coal. There are gasifiers that can be selected. Some that do not require the moisture to be dried and others that do dry the coal prior to going through the gasifier and both of them are processes which look like they are going to produce economically competitive products from the gasification process.

Senator THOMAS. Of course, the basic elements are essential, but we sometimes get a little politically involved in terms of where these projects take place and I hope we continue to remember

where the source of coal is and that seems to me that's the kind of key to where the coal would go. And, of course that's the reason we put that provision in the law that at least half of this business needs to go in elevations that exceeds 4,000 feet.

Dr. MILLER. That's true and most of the studies we are now doing, are what we call mine mouth studies, locating the facility near the mine mouth or near the source of coal.

Senator THOMAS. Good, thank you. The Department recently commissioned a study on the use of carbon dioxide to enhance the recovering oil fields, they found carbon dioxide injection allows the recovery of 50 percent of the oil in place, compared to 33 percent. What opportunities exist for an emissions from coal fire generation to be used for enhanced recovery? Does the Policy Act of 2005 encourage the construction of infrastructure and technological development with these innovative solutions, Mr. Shope?

Mr. SHOPE. Well, Senator, again, enhanced oil recovery certainly is a very promising opportunity for us. Certainly we are focusing on carbon sequestration in general. But looking for those opportunities for synergies, not just with carbon sequestration and geological voids which of course is extremely important. But also taking advantage of the opportunities for enhanced oil recoveries. I mentioned in my opening remarks some of the studies are indicating we could possibly quintuple our reserves of oil that we were able to produce. Our FutureGen project that I mentioned certainly has carbon sequestration as part of it, as part of the FutureGen Alliances consideration of the various projects, certainly we are looking at opportunities to see if enhanced oil recovery could be a part of that, to see how that squares up with other offerings, other bids.

Of course, then FutureGen Alliance would be making the final determination as to what exact sites would be selected. But, it is a provision we are trying to work diligently on and working, not only within our own office, but working with the Office of Science within the Department of Energy, to seek the crossover synergies there, but even within the Office of Fossil Energy, we are making sure that our oil and gas program is working closely with our own sequestration program to maximize those opportunities.

Senator THOMAS. Thank you. You mentioned FutureGen, that's been talked about for some time, it's been one of the priorities the President has talked about, probably more than anything else. What's the status of that? What's the timing you put on that program?

Mr. SHOPE. Senator, I'm very pleased to talk about the status of FutureGen, again, as I mentioned, the FutureGen project will revolutionize coal use. Eliminating environmental concerns and also, more so than just the project itself, it'd be validating emerging energy technologies and pioneering new partnerships. The request for proposals for site locations has gone out, we're now in February, those proposals will be due back in May of this year. Once the proposals are reviewed, they will be narrowed down and the site selection will be done by the FutureGen Alliance themselves.

The short list would be expected to be produced by mid-this year, some time in the latter part of this year, in the summer. We will then be engaging in full NEPA compliance for those candidate sites that have the potential to be selected for the site. Final selection

would be targeted to take place in late 2007. Now, the FutureGen Alliance itself is continuing to gain industry acceptance. They've now had another member join up—bringing the total to nine major producers, major significant companies. So, the FutureGen project is moving along well, and we're very excited about it.

Senator THOMAS. So, your expectation is this project will be decided upon by the end of 2007?

Mr. SHOPE. That's correct, Senator. I believe by 2007. We'd then finalize design and begin construction, with plant operations projected to begin in 2012. They would continue in operations for 4 years in 2016 and there would be 2 to 3 year maintenance, or follow-up, period to gather additional monitoring data and analysis. The target for long term commercial employment of this would be within 20 years, approximately 2025.

Senator THOMAS. This kind of falls into my earlier comment that's a great idea and we're very much for it and certainly hope we're giving good consideration on it. But, it's going to be awhile. In the meantime, we have some other opportunities that could be accomplished much more quickly. Is that true?

Mr. SHOPE. Well, again, Senator, I would address it this way. As I mentioned, that plant that we talked about for commercial deployment would be in 2025. Again, this is a living working laboratory.

Senator THOMAS. Right.

Mr. SHOPE. And so, all of the technologies that we're going to be developing for that plant, are ones that we could be using today. As far as gasification, membranes, hydrogen technologies, carbon sequestration. All of the technology leading up to that plant, so I would hesitate to focus solely on the future plant. We also have the benefits leading up to it.

Senator THOMAS. We could do the transition from coal to fuel right now, can't we?

Mr. SHOPE. That's correct.

Senator THOMAS. Dr. Miller, will the water content problem that you talked about for Western coal be factored into this FutureGen project?

Dr. MILLER. It could be, well, it will be, depending on the source of coal that is chosen and the site of the plant. However, as we mentioned in my earlier comments, it's not what I would call, or what we engineers call a rate-limiting step. It is certainly something that can be overcome and there are technologies already available. Depending upon what the price of the product should be in order to be competitive to solve that particular problem, Senator. I don't think it's a, as I said, it's not a rate-limiting problem from my point of view.

Senator THOMAS. So this wouldn't be an obstacle to Western coal, where the coal is?

Dr. MILLER. One of our studies has shown that, already that we can utilize the Western coal and come out with a more competitive product when we consider what the other competitors might be.

Senator THOMAS. Thank you. Mr. Shope, you mentioned the President had talked a lot about a 10-year, \$2 billion clean coal initiative, would you explain that just a little bit? What's this talking about?

Mr. SHOPE. Certainly, Senator. Again, I'm pleased to report that we're at \$1.9 billion of that 10-year commitment and we've done it within 6 years, we're talking about the entire coal research program that we're working on. FutureGen, of course, would be a part of that. Developing clean coal technologies that are ready for the marketplace, that are environmentally sound and operate in a cost efficient manner. Our budget in 2006 does put us up, again, to the \$1.9 billion mark. By the end of the 10 year cycle we could have approximately \$4 billion in coal research having been committed by the administration.

Senator THOMAS. I see, thank you. Over 6 months ago, the Energy Policy Act of 2005 was signed into law. There's been a lot of talk about additional litigation and new bills. You have a bill now as a result of a decade's amount of work. What do you think is necessary to implement what we now have? And are there other legislative initiatives that need to be put into place to cause this to happen in your view?

Mr. SHOPE. Senator, I would defer to folks above my pay grade to decide on the long-term policy direction, and any legislation that might be needed. I'm open to say that under the Energy Policy Act that there are many provisions that we don't have the funding to implement. So, from my perspective, of course, from a budgetary standpoint, we must focus on what is the prize. Focus on what is it that will get the most bang for our buck. Is that technology clean? Will we have positive environmental impacts? We have to look at what is the impact on the market? Is there a market failure that needs to be bridged?

Senator THOMAS. But, do you need more legislative authority to do that?

Mr. SHOPE. Again, I would have to defer on the question as to making that decision.

Senator THOMAS. I know the money is one thing, and I understand that to implement these things we need money. But, I guess that the thing that I am going to pursue a little and pretty soon is whether our challenge is to implement the policy that we now have in place or whether in fact, it doesn't seem to me that we probably need a new policy. Maybe we need new, some features and factors to implement that policy.

Mr. SHOPE. Yes Senator, and again there are some wonderful provisions within the Energy Policy Act and things that will make a big difference. We mentioned earlier the tax credit provisions, loan guarantee provisions. These are things that will help bridge that valley of death for advanced technologies, from development into market, and into commercialization. These are incentives that I think are, will be beneficial and will pay in the long-term.

Senator THOMAS. Good, I hope you'll keep in touch with us as to what you think needs to be done to implement the policies we have. Because we have failed, we want to look forward to alternatives, we need to look forward to finding more efficient ways to produce. We want to look forward to being able to use things that we have available to us at this point.

There are a number of provisions in the energy bill that would help coal development in ways that we are discussing here today. One of the most important is title XVII, which establishes a loan

guarantee program to cover up to 80 percent of those advanced projects. And there are people lined up with private funding to make these projects a reality, but the Department has not yet issued guidelines as to how to apply these loans. What is your view as to when that will happen and what are the provisions we can expect to make a difference in the short term?

Mr. SHOPE. Senator, the guidelines are currently under departmental review. I can report that. I know that the Department is looking at creating a central office for the management of the loan guarantees. So it would not be something that would be done strictly within the Office of Fossil Energy but more of a departmental approach. That's being considered right now. And the final decision hasn't been made on all that, but again, they want to make sure that the loan guarantees pay off. Because, as I mentioned before, we want to make sure that they are in fact good investments in companies. There's always risk associated with any R&D investment, but we want to make sure that we maximize, or limit our exposure to it as much as possible.

I've been told that we could expect those guidelines to be published in the very near future. We're targeting late spring for the publication of them, and targeting some time in the fall for implementation of the loan guarantee program.

Senator THOMAS. There appear to be a substantial number of private sector investors that are willing to move forward to do some of these things. But one of the questions they have in their minds, of course, is to what these incentives are going to be. What's necessary to qualify for them? How do they get implemented? And, certainly, some of these relatively new programs, there needs to be some incentives for the private sector to invest. And so, I think it's important to move forward on it as quickly as we can.

Mr. SHOPE. I agree with you, Senator. And as far as the tax incentives, if you're addressing those as well, the guidelines published in February. We've been working closely with the IRS on those and their guidelines were published in February. There is information that's now available for entities interested in applying for those incentives. The window for their applications are, would be closing, I believe its June 30 when they're closing. They are open now for the submittal, they will be closing it June 30. Once those applications are received, the Office of Fossil Energy will be reviewing those and making a certification as to the viability, technological viability, economic viability of the particular project that is seeking the incentive. Once we certify it, it would go to the IRS, that would also have to approve of that incentive. The program is limited to that \$1.3 billion in caps, so the IRS is targeting having final selection by fall of this year.

Senator THOMAS. All right. I appreciate that.

Dr. Miller, do you have any observations as you see it from your role? If we're here to kind of address, how do we implement these ideas that we have in terms of new techniques and so on? Are there any observations that you have that might help us move forward?

Dr. MILLER. Senator, I think it's important to remember that coal technology is very, very flexible and Wyoming coal is particularly well suited for what we call coal conversion technology. And,

that's using integrated gasification combined cycle concept for what we call a coal production facility. Which permits us to produce power as well as other products, depending upon what the local market might bear or desire at that particular point. And, as I said, the coal here is particularly well suited for a coal conversion concept whether it be for synfuels or whether it be for power or a combination of both.

I think that the energy bill, from my point of view, of working with industry, probably addresses the one major factor that concerns anybody, an entrepreneur going into building the first plant of any kind. An integrated gasification combined cycle facility is a lot more complex than a general powerplant. A coal conversion facility is the same, the risk is fairly high and the capital investment is higher than normal.

So, by providing that incentive, you reduce the element of risk to a point where it might be acceptable to an entrepreneur and we can see, even in the past few months, we are experiencing a great deal increase in interest through studies and through participation in industry looking at trying to be the first now to implement one of those facilities.

Senator THOMAS. Great. I appreciate that. Obviously one of the questions that's always in mind of people and has to do with location of these things and so on, is that we have the fossil fuel resources that are generally in this area and the market is in other areas, so we have to have, we have to consider how we transport it. We have to do it one way or another, whether we do it as we do it now with rail and transfer the coal to be refined somewhere. Whether indeed along with this goes pipelines or transition lines whatever the case is, so that we can get this started to market.

Any closing comments, Mr. Shope?

Mr. SHOPE. No, Senator, I am just excited for the opportunity to be here today, and again the promise of fossil fuels are important, extremely important part of this energy mix for energy security, as I mentioned in our opening comments, we're going to be defendant on fossil fuels in one form or fashion or another for a long time to come. And we do need to do all that we can to try and make these fossil fuels as clean and efficient as possible. We are diligently trying to do that and we look forward to working with you and the committee to continue that process.

Senator THOMAS. Well, thank you very much. And we appreciate what you do, I know it's difficult. Energy has become one of the most pressing issues that we have. It also, of course, is a unique commodity and is something that everybody has and is used to having. We have to persuade them that we have to make some changes to continue the kind of service that they have is not always an easy thing to do. But, I think that it is becoming more clear to people that we are going to have to do things differently and certainly we want to do that. So, we just want to urge you to work with us in Wyoming and work with our producers here and see if we can move forward in accomplishing the policy goals we have. I thank you very much for being here.

Mr. SHOPE. Thank you.

Senator THOMAS. Okay, we'll invite our second panel to come up if you will please. We have Dr. Norman Shilling from General Elec-

tric, Steve Waddington from Wyoming Infrastructure Authority, Marion Loomis from the Wyoming Mining Association, Joe Coyne from the Converse Area New Development Organization, and Dr. William Gern who will testify on behalf of the Western Research Institute at the University of Wyoming. Gentlemen, we appreciate very much your being here and certainly you are the folks who will fill us in on your observations as to what we need to do to cause this to happen and to cause it to happen locally for the advantage of the mining people and for the Nation to be able to use mining resources.

So we'll get started and let you make your statements and we'll have a few questions. We appreciate you being here.

Dr. Shilling.

**STATEMENT OF DR. NORMAN SHILLING, PRODUCT LINE
LEADER, IGCC POWER, GE ENERGY**

Dr. SHILLING. Thank you. Good afternoon. I am Norm Shilling, product leader for IGCC Power at GE Energy. GE appreciates the opportunity to participate at this hearing and in the Wyoming Energy Summit. GE is a worldwide supplier of advanced power generation technologies from renewable resources such as wind, water, biogas and solar, to natural gas, oil nuclear, and coal, the focus of today's hearing. I will focus on five points.

First, coal will continue to be a significant part of our energy mix. We are seeing a nationwide resurgence of interest in coal. The West is leading this trend. The power industry has grown to recognize the advantages that low cost Western coal provides. EIA's most recent Annual Energy Outlook predicts that over the next 25 years, the West is one of the regions in which the largest amount of coal-fired capacity addition is expected.

Second, environmental considerations will strongly influence any decision to use coal. The environmental challenges to coal are well known. We believe that the answer lies in using the cleanest, most efficient technology to generate electricity from coal.

This leads to my third point: integrated gasification combined cycle, or IGCC, is a technology for using coal more cleanly and efficiently. IGCC delivers significantly reduced emissions of sulfur dioxide, nitrogen oxides and particulate matter. IGCC is highly effective in removing mercury. IGCC consumes 30 percent less water than combustion coal technology and produces useful byproduct. All are matters of particular importance in the West. IGCC also offers the capability to remove carbon before combustion thus providing a significant savings in cost and efficiency in comparison to post-combustion capture.

Commercial development of large IGCC plants is underway. GE, in alliance with Bechtel, is a single source supplier of a 630 MW IGCC reference plant, with strong contractual guarantees & warranties. The alliance is working to reduce the cost of IGCC. GE and Bechtel have entered into front-end engineering design studies for the 630 MW IGCC reference plant for two major utilities—AEP and Cinergy.

These "first-of-a-kind" plants are a critical step to the widespread commercialization of IGCC. GE is working now to advance IGCC to significantly improve the performance and economics of IGCC for

low rank coals. The low heating values and high moisture in Western coals, as well as the altitudes at which Western plants would be located, require further engineering, design and development work for IGCC systems that are optimized for Western coals.

My fourth point is to thank you and your colleagues in the Congress for recognizing the vital role of cleaner coal in last year's energy bill. The advanced coal project investment tax credit is valuable as a means to mitigate the cost differential facing the first commercial scale IGCC plants. The new DOE loan guarantee program, once implemented, offers another financial mechanism to support IGCC deployment.

We are particularly interested in the provisions included in section 413 of the Act authorizing the Western Integrated Coal Gasification Demonstration Program. If the full environmental and energy benefits of IGCC are to be achieved, the ability of IGCC to efficiently use Western coals must be established. Significant engineering and technology integration is required for the first-of-a-kind plants for Western coals. The cost-shared Western IGCC demonstration program could provide the framework for Federal Government and industry to work together to expand the envelope of efficient, low emissions IGCC plants to economically use these coals. We support and appreciate your efforts to speed the implementation of this program.

My last point is to highlight the opportunities that are available through the gasification component of IGCC to deliver broader benefit from coal. Gasification is a coal refining process. It can generate a slate of products including hydrogen and ultra-clean transportation fuels such as diesel. The gasification aspect of IGCC thus provides a path away from imported petroleum or natural gas for the production of many of our national staples. We encourage the consideration of a broader Federal policy initiative to take advantage of this opportunity.

In summary, GE believes that the national, economic and energy security interests of the United States will be served by deploying cleaner coal technologies, such as IGCC, that enable us to utilize the full range of our domestic coal resources—including those found here in the West. We thank you for your leadership, and look forward to working with you to this end.

I look forward to your questions. Thank you.

Senator THOMAS. Thank you.

Mr. Waddington.

**STATEMENT OF STEVE WADDINGTON, EXECUTIVE DIRECTOR,
WYOMING INFRASTRUCTURE AUTHORITY, CHEYENNE, WY**

Mr. WADDINGTON. Mr. Chairman, thank you for inviting me to appear here before you today. My name is Steve Waddington, I am the executive director of the Wyoming Infrastructure Authority. The Authority is a instrumentality of the State of Wyoming. Our mission is to diversify and expand the State's economy through improvements in the electro-transmission system. And, also to support advanced coal technology for electricity production. The future for Wyoming coal is great, but we must look to address market and infrastructure challenges. My testimony will touch on three areas related to the growth and development of Wyoming coal.

Congress and the Federal Government have important roles to play to help in all three of these areas which are: the need for transmission investments; the need for advanced coal technologies to emerge on a commercial scale in Wyoming; and the captive shipper issue. One means for future growth and development of Wyoming coal is to ship the coal by wire instead of by rail. Generating electricity from coal in Wyoming will create jobs and other economic boosts for the State. Coal fire generation in Wyoming and our world-class wind generation potential offer an attractive option for utilities throughout the West. But, the key to unlocking this value-added expansion of Wyoming's economy is transmission.

The Wyoming Authority was created to help address this issue. We have embarked on a number of important transmission developments and our pending projects are summarized in written testimony, Mr. Chairman, that I submitted today. There are two areas I want to emphasize which Federal actions is important for encouraging transmission investment. The first is the Department of Energy's role under the Energy Policy Act to designate national interest electric transmission corridors. We think the projects we're working on, are in the national interest and DOE should be prepared to accept applications and expedite designations.

The second area, Mr. Chairman, is to consider providing incentives for transmission investment through Federal tax policy. The Authority can issue regular bans to finance transmission, and included in that is our ability to loan up to \$1 billion to the private sector. Several other States, in fact, are following Wyoming's lead creating State bonding authorities to finance transmission. However, because of an IRS rule, these public sector bonding capabilities would not be federally tax exempt except under very limited and unusual circumstances. Congress should consider relaxing these private use restrictions for transmission investments. Senator Kent Conrad is working on a bill to promote energy production and one of his provisions would relax the private use restriction and if this became law, our bonds could be issued on a tax exempt basis. And, I ask the committee to consider this as a means of not just incentivizing transmission investment, but lowering the cost of transmission financing for consumers.

The Energy Policy Act last year signaled the Federal Government's intent to continue with stimulating the support of advanced coal. And, we've already heard much about that. Wyoming needs to be actively participating in these Federal programs. These technologies must be developed to work and to emerge on a commercial scale to meet the needs Wyoming coal at elevation. Otherwise as these technologies become mainstream elsewhere in the Nation, Wyoming's full market share may be at risk. FutureGen as we've heard is a government industry project to design, build and operate the world's first coal-based new zeroed emission part of generation plant. The State of Wyoming will submit a proposal responding to the FutureGen industrial alliances RFP for wholesale sponsorship. The Governor's office is leading our effort to put forth a competitive proposal and we plan to vigorously compete for the FutureGen demonstration plant to be sited in Wyoming.

Our FutureGen application effort, Mr. Chairman, will also help position Wyoming strategically as we prepare to seek Federal funds

for the rush in integrated coal gasification demonstration project that's provided for under section 413 in the Energy Policy Act. We are very interested in working with you, Mr. Chairman and this committee to ensure that this program is adequately funded and that Wyoming is given strong consideration as the location for this demonstration project.

My third topic is just to briefly note the captive shipper issue. The captive shipper issue is a threat to the production of coal and other key commodities from Wyoming. A captive shipping customer is one, who by virtue of its location, has access to only one rail provider. Captive shippers can pay rail rates of up to 450 percent above railroad costs, by one statistic I've seen. As opposed to the 6 percent above cost paid by shippers where competition exists. There are bills that attempt to address this issue pending before Congress, their objectives are summarized in my written testimony.

In conclusion, the future for Wyoming coal is bright, but we must work proactively to address market and infrastructure challenges including the need for transmission investments, the need for advanced coal technologies to emerge on a commercial scale in Wyoming and addressing the captive shipper issue. This concludes my testimony, thank you very much.

[The prepared statement of Mr. Waddington follows:]

PREPARED STATEMENT OF STEVE WADDINGTON, EXECUTIVE DIRECTOR, WYOMING
INFRASTRUCTURE AUTHORITY, CHEYENNE, WY

Mr. Chairman and distinguished members of the Committee, thank you for inviting me to make this appearance before you today. My name is Steve Waddington. I am the executive director of the Wyoming Infrastructure Authority. The Authority is an instrumentality of the state of Wyoming. Our mission is to diversify and expand the state's economy through improvements in the electric transmission system to facilitate increased utilization of Wyoming's energy resources. Earlier this year, the Wyoming state legislature expanding the Authority's role to also take a leadership role in supporting emerging advanced coal technologies as it relates to electricity production.

I believe the future for Wyoming coal is bright—but only if we work proactively to address market and infrastructure challenges that have the potential for eroding Wyoming's share of the national coal market long term. My testimony will touch on three areas of concern related to the future growth and development of Wyoming coal. In all three issue areas, Congress and the Federal Government have important roles to play, in collaboration with the State, to overcome these market and infrastructure obstacles. My three topic areas are: 1) the need for transmission investments; 2) the need for advanced coal technologies to emerge on a commercial scale using Wyoming coal at Wyoming altitudes; and, 3) the captive shipper issue.

THE NEED FOR TRANSMISSION INVESTMENT

One value-added means for future growth and development of Wyoming coal is to ship coal by wire, instead of by rail. Generating electricity from coal in Wyoming, and shipping the product by wire, will create jobs and other economic base for the state. Coal-fired generation in Wyoming, combined with Wyoming's world-class renewable wind generation potential, offer an attractive option for utilities throughout the western interconnect. Many utilities serving fast growing urban areas in the west have relied heavily on natural gas-fired generation in recent years to meet their growth. These utilities are now seeking alternatives to diversify their power supply and Wyoming has abundant natural resources—and a political will to deploy these energy resources—to help meet growth in the west. The key for unlocking this value-added expansion of Wyoming's economy is adding to the transmission infrastructure.

It is critically important to recognize that the existing electric transmission system was built by electric utilities in a vertically integrated manner. As a result, the existing system was built and sized to serve local customers, integrate utility-owned generation and to support reliability. In addition, the existing regulatory and insti-

tutional system relied upon to address congestion and facilitate resource development on the grid has not functioned well. A wide variety of regulatory, financial and policy uncertainties have significantly slowed the pace of both private sector and public power system investments in the utility transmission system. The impacts of these uncertainties on the consumer and overall economic activity have been, and continue to be, profound. Unless immediate improvements to the transmission grid are made, increasing pressure on existing facilities will intensify and system reliability will erode. At the same time, the Nation could find itself continuing to over-rely on natural gas fired generation located close to load centers. Such an outcome would not further the national interest. Each of these concerns has a particular significance for the West.

In the West there is intensifying interest in securing a more diverse power supply through increasing reliance on low cost fuels, such as coal and wind, that are abundant in areas of the West, but that are distant from load centers. However, with few exceptions, in the West the transmission system was not designed to support economic transfers of power or the development of new sources of supply. To enable this development to occur will require new transmission facilities.

The Western interconnection is especially vulnerable as a result of growth in the region. To meet these needs, load serving entities are seeking to build new power generation to keep pace with both the retirement of aging power stations and the need for more capacity to meet growing electric power demand. This, along with increasing requirements for fuel diversity to offset natural gas reliance and improved environmental performance, is placing added pressure on existing transmission facilities. There is an immediate need for transmission upgrades to enable additional transmission-dependent generation facilities to serve load growth in the very near-term.

The Wyoming Infrastructure Authority was created to help address this issue in a positive way for Wyoming. The Authority has embarked a several transmission development feasibility projects. Our pending projects are summarized briefly below.

TOT3 Partnership with Trans-Elect and Western

The Authority has entered into a partnership with Trans-Elect Inc. to pursue development of new electric transmission between Colorado and Wyoming—known as TOT3. The Western Area Power Administration (Western) has joined the WIA and Trans-Elect to work jointly together on the TOT3 project to determine the public service benefits and interest in this transmission upgrade. Interest expressed in the proposed line ranges from between 2,100 MW and 7,300 MW of additional capacity, including prospective coal and wind project developers. Load serving entities in Colorado have also expressed interest. We are now entering the technical feasibility study phase on this project.

Wyoming-West Partnership with National Grid

The Authority has also entered a public-private partnership with National Grid USA to jointly conduct a transmission study that will help lay the groundwork for a significant increase in electric transmission capacity between Wyoming and neighboring states in the west. This project is dubbed Wyoming-West. The Authority is also in active discussions with Western, which operates one existing corridor between Southwest Wyoming into Utah, and Western is actively interested in working with us on the Wyoming-West endeavor as it moves forward.

TransWest Express Partnership with Arizona Public Service

Arizona Public Service Company (APS), National Grid and the Wyoming Infrastructure Authority (WIA) signed a Memorandum of Understanding (MOU) in early March to collaborate in developing new electric transmission lines between Arizona and Wyoming. This MOU expands upon previous announcements by APS in October 2005 to begin development of the TransWest Express Project and by the WIA and National Grid in December 2005 that they would jointly undertake the Wyoming-West Transmission Study.

Arizona and neighboring states are experiencing significant growth in electricity demand. To help meet that growth, APS envisions construction of two new 500,000-volt (500-kV) transmission lines from northern Arizona, through Utah to Wyoming. APS and other utilities in the west are attracted to Wyoming as an abundant source of low-cost wind and clean coal generation. The TransWest Express Project will be designed to help meet growth in demand with low-cost sources of supply from Wyoming.

The Frontier Line

In April 2005 four western Governors joined and announced their memorandum of understanding to stand ready to support a major transmission corridor develop-

ment between California, Nevada, Utah and Wyoming. The Frontier Line will be designed and developed to ensure citizens of all four sponsoring States benefit from it. The four sponsoring Governors recognized our region needs a significantly more robust interstate electricity system in order to enable access to more sources of clean energy. The Frontier Line will deliver this goal for millions of consumers across the West.

In the past year there has been significant groundwork laid. The Authority has been actively involved, providing technical and financial resources toward the successful development of this project. Next week, on April 17-18, the four sponsoring Governors are hosting a major energy conference to be held in San Diego. A significant announcement is planned for this event, laying out the plan for actively beginning the detailed feasibility study of the Frontier Line concept.

Moving to federal actions, Congress recognized the challenges related to transmission development with a number of measures in the 2005 Energy Policy Act. In particular, the Department of Energy's role to study and designate critically important transmission expansion needs as corridors that are in the National Interest, and the Federal Energy Regulatory Commission's backstop siting authority related to corridors so designated, is a critically important initiative. For the West especially, where transmission is needed across long distances involving several states, and likely over vast tracts of Federally-managed lands, FERC's potential back-stop siting role could be a significant help.

The Department of Energy needs to be encouraged to move ahead as quickly as possible with the designation of National Interest Electric Transmission Corridors (NIETCs). DOE should also accept proposed projects early for DOE review and possible early designation, where projects are already underway. The Authority provided DOE with comments recently raising a number of concerns with its proposed approach. These comments are summarized below.

- It is critically important that DOE's designation of corridors not be limited to those where persistent congestion obtains today. Doing so would put an inappropriate brake on the legislative intent to encourage transmission infrastructure to develop to reduce consumer prices and diversify the fuel mix.
- DOE must expedite the study and designation of NIETCs, and do so by designating corridors for potential projects broadly, as generalized paths between two (or more) locations.
- DOE must fully recognize the features and characteristics of the Western transmission system, and take into account the numerous studies that have already demonstrated the need for, and benefit from, transmission infrastructure investment.
- DOE should recognize several ongoing major transmission expansion efforts in the West, including the Frontier Line, the TransWest Express Project and WIA's two ongoing projects in partnership with Trans-Elect, Inc. and National Grid USA, and anticipate that one or more of these projects will likely apply to DOE for early designation as a NIETC.
- DOE should remain flexible and in a position to accelerate an early review and the designation of corridors on a case-by-case basis, and establish the application process for such early designation.

The Authority can issue revenue bonds to finance transmission investments, including extending up to \$1 billion in borrowing capability to the private sector. Several other States in the west have following Wyoming's lead, creating state bonding authorities to finance transmission infrastructure. Today, because of a IRS rule known as private use restrictions, these public sector bonds would not be Federally tax exempt except under very limited and unlikely circumstances.

Congress should consider relaxing the private use exemption for transmission investments. The exemption should be relaxed for certain circumstances, such as for investment in a corridor that has received a national interest designation or is being financed by a public entity such as the Wyoming Infrastructure Authority. Another alternative would be for Congress to allocate an amount of tax credit bonding authority for state entities to use to finance important needed transmission infrastructure. By either means, tax exemptions or tax credits, the cost of financing the transmission investment would be significantly reduced. Lowering the cost of transmission investments would help to stimulate its development and deployment, and will reduce the costs to consumers.

Senator Kent Conrad is working on a bill to promote energy production and one of its provisions would relax the private use exemption in certain circumstances. The language in the draft bill on tax-exempt bonds would recognize the Wyoming Authority to be a governmental entity and thus qualify relative to waiving the IRS private activity rules—making WIA bonds a federally tax exempt issuance. This pro-

vision is meritorious and I respectfully ask the committee to strongly consider it on its merits.

ADVANCED COAL TECHNOLOGY

Congress, with the leadership of this committee, has signaled in the Energy Policy Act last year the Federal Government's intent to continue to stimulate and support clean coal technology and synthetic fuels production. Wyoming needs to be actively participating in these Federal programs. These technologies must be developed to work and to emerge on a commercial scale using Wyoming coal at elevation. Otherwise, as these technologies become mainstream elsewhere in the nation, Wyoming's coal market share will be threatened.

The Governor and the State legislature have taken a number of significant steps to position Wyoming strategically to secure a value-added utilization of coal through advance technologies. A Clean Coal Work Group is actively engaged. The Infrastructure Authority and the Pipeline Authority are both actively involved in this effort.

Emerging advanced coal technologies are a significant opportunity for the future growth and development of Wyoming coal. Wyoming's coal market potential can be viewed in terms of a value chain. Currently, the commodity, coal, is produced and primarily directly sold and shipped by rail for use in electricity generation around the country. But in the future there are a number of products and co-products that will be profitably produced from Wyoming coal. If petroleum prices continue their recent upward trend, these value-added markets will become increasingly commercially viable. The figure below shows the value chain with coal as the base commodity. As the value of coal-derived commodities increases, the likelihood of moving even further up the primary products value chain increases. Additionally, the co-products of water and hydrogen could have potential economic value as the nation moves toward a hydrogen economy.

FutureGen

FutureGen is a government-industry cost-shared project to design, build and operate the world's first coal-based, near-zero emission power plant. The plant will also produce hydrogen and byproducts for use by other industries, while capturing and permanently storing carbon dioxide in deep geologic formations.

A FutureGen industrial alliance has been established and on December 2, 2005, the U.S. Department of Energy entered into a cooperative agreement with the alliance to begin the site selection process and prepare a conceptual design for the facility. The Alliance has issued its RFP inviting proposals for host sites upon which to build and operate the FutureGen plant.

The State of Wyoming has submitted its notice of intent to submit a proposal responding to the FutureGen Industrial Alliance's RFP for host sites sponsors. The detailed proposals are due May 4, and the Governor's office is leading a concerted effort to put forth a competitive proposal. We intend to compete vigorously for FutureGen to be developed in Wyoming.

A total of nine states have formally expressed interest in hosting the FutureGen project, representing as many as 22 proposed sites. Given the complexity and rigor of the proposal process, there will probably be some attrition in the application process and less sites actually submitted by May 4. The process will then move to a short-listing of candidate sites to be announced this summer. Then DOE will take one year to develop an environmental impact statement, and then issue a record of decision with a likely even shorter list of sites that it deems acceptable. The Alliance will then select the one preferred site from this shorter list by around September, 2007.

We believe Wyoming has a competitive edge because of our strong position for permanent storage of carbon dioxide—which is one of the key deliverables in the FutureGen project scope. That said, the application criteria are rigorous and the competition will be fierce. We expect that Wyoming will at least reach the short list and continue to be considered as DOE does its environmental study work.

Section 413—a Western Integrated Demonstration Project

The FutureGen application effort will also help position Wyoming strategically to seek an appropriation and allocation of Federal program funds to support a Western Integrated Coal Gasification Demonstration Project using western coal at elevation. Section 413 of the Energy Policy Act calls for this demonstration project as a means for ensuring that coal gasification technology emerges on a commercial scale using Western coal and operating at Western elevation. Wyoming is very interested in working to ensure that this program is funded, and we believe Wyoming will merit strong consideration as the location for this demonstration project.

THE CAPTIVE SHIPPER ISSUE

The captive shipper issue is a threat to the production of coal and other key commodities in Wyoming, as it is in rural America generally. A captive shipping customer is one who, by virtue of its physical location, has access to only one rail provider. Captive shippers pay rail rates of up to 450 percent above railroad costs, by one statistic I've seen, as opposed to the 6 percent above railroad costs paid by shippers where railroad competition exists.

One Wyoming example is the Laramie River Station, a coal-fired generation facility located near Wheatland, Wyoming. This power plant is vital for serving the electricity needs of consumers served by cooperative utilities across Wyoming. It is served by one railroad, which transports 8.3 million tons of coal annually from the Powder River Basin south 175 miles to the plant. The power plant's contract with the railroad expired last year and the railroad renewed the contract with dramatically higher rates. At four times the railroad's average coal hauling rates, these new fees will cost electric customers \$1 billion over the next 20 years. Since the power plant is captive to this sole practical option for shipping the fuel it needs to produce power, there was little choice but to accept what would appear to be the exercise of monopolistic advantage and, with that, a very rate increase.

Congress needs to act and bills are pending. The Railroad Competition Improvement and Reauthorization Act (S. 919 and H.R. 2047) would clarify and ensure that the primary objectives of the nation's rail transportation policy are:

- To maintain consistent and efficient rail transportation service for shippers, including the timely provision of rail cars requested by shippers;
- To promote effective competition among rail carriers at origins and destinations; and,
- To maintain reasonable rates in the absence of effective competition.

The Railroad Antitrust and Competition Enhancement Act (H.R. 3318) would also help promote competition among railroads and provide better rates for shippers. This competition enhancement act would amend the Clayton Act to eliminate the antitrust exemption applicable to railroads.

IN CONCLUSION

In conclusion, the future for Wyoming coal is bright—but only if we work proactively to address market and infrastructure challenges that have the potential for eroding Wyoming's share of the national coal market long term. These significant challenges include: 1) the need for transmission investments; 2) the need for advanced coal technologies to emerge on a commercial scale using Wyoming coal at Wyoming altitude; and, 3) the captive shipper issue. In all three issue areas, Congress and the Federal Government have important roles to play, in collaboration with the State, to overcome these market and infrastructure obstacles.

Thank you for the opportunity to appear before the committee today. This concludes my testimony. I would be pleased to answer any questions you may have.

Senator THOMAS. Thank you, sir.

Mr. Loomis.

**STATEMENT OF MARION LOOMIS, EXECUTIVE DIRECTOR,
WYOMING MINING ASSOCIATION, CHEYENNE, WY**

Mr. LOOMIS. Senator Thomas, ladies and gentlemen, I am Marion Loomis, I am the executive director of the Wyoming Mining Association. Thank you for the opportunity to talk to you today about the coal industry in Wyoming.

WMA represents 24 mining companies in Wyoming producing bentonite, coal, trona and uranium. And as you know, Wyoming leads the Nation in the production on all four of those minerals. On the coal front, Wyoming producers supply over 35 percent of this Nation's coal. Last year 17 mines produced over 405 million tons. Those 17 mines generated over \$670 million for Wyoming in the form of severance taxes, ad valorem production taxes, Federal mineral royalties, bonus bids on new coal reserves, Abandoned Mine Land Reclamation fees, local property taxes on equipment and fa-

cilities, State royalties, and sales taxes. They provided another \$364 million to the Federal Government in those same types of taxes.

The industry employed over 5,300 miners with an annual payroll of over \$475 million, that's almost \$90,000 per miner. That money flows through our economy, buying houses, cars, food, clothes and provides for an excellent quality of life for those miners. The Wyoming geological survey estimated that the average selling price for coal in 2005 was \$7.75 per ton, so the total value of Wyoming's coal production is projected to exceed \$3 billion. I think it is interesting that 44 percent of the selling price of the coal goes to the State and Federal Government in the form of taxes, royalties and fees and that doesn't include any income taxes.

I also mentioned that a good deal of that \$3 billion comes back to the State of Wyoming in the purchase of goods and services—trucks, tires, fuel, explosives—and any other equipment necessary to run those operations. Wyoming has the third largest coal reserves in the Nation. Our proven reserves exceed 45 billion tons of recoverable coal. But the total resource, that is the proven reserves combined with the coal uneconomic today exceed 1 trillion tons. Most of our coal is shipped out of State as steam coal for electric plants across the Nation. The latest figures which are from 2004 showed we consumed 25 million tons of coal in the State of Wyoming. We shipped 372 million tons to 35 other States from New York, to Oregon, from Texas to Wisconsin and most States in between. I've included a map of our distribution of our coal in the written information.* That distribution demonstrates the ability of Wyoming coal to be shipped economically across considerable distances due too primarily due to the fact that we have extremely low sulfur content in our coal. But as plants across the country install wet scrubbers, Wyoming producers will lose that competitive advantage. But we believe that Wyoming's efficiency and effectiveness will prevail when it comes to producing coal at a competitive price per million Btus. Additionally, the quality and contemporaneous nature of reclamation at Wyoming coal mines will provide this resource in a low impact manner.

You asked what we thought the future of coal might look like, and we were certainly very optimistic for, not only the future here in Wyoming, but also in the United States. We feel coal will play a continued major role in the electricity generation mix. But it's also going to provide a source for supplemental liquid fuels. As the world oil production nears a peak, the value of our domestic coal reserves and production in conjunction with energy conservation will be even more important to our Nation's economy and security.

There's been a great deal of recognition about how wonderful the United States is to disruption of oil supplies. As you know, 60 percent of our oil supply comes from foreign nations. So, to address this most important issue, we feel coal is going to be a big part of the answer. Coal to liquids, coal to gas has to be a big part of it. It takes .7 to .9 tons of coal to make a barrel of liquid, so in order to generate 100 million barrels per year of coal derived fuel, we would have to devote approximately 89 tons of coal a year to a con-

*The map has been retained in committee files.

version plant. That's only 20 percent of our 2005 coal production rate. With an average thickness of 70 feet for Wyoming's coal seams, it would only take 726 acres per year to supply the coal to generate 100 million barrels of fuel. Last year the United States imported 145 million barrels of oil from Russia, so we would come pretty close to replacing that.

As I stated above, in the future, coal is going to be burned differently, it's in my written comments. The existing technology—and it's already been talked about—but the existing technology is going to allow new coal fire powerplants to capture the particulates which we do today. The nitrogen oxide, the sulfur dioxide and the mercury. And further into the future we are going to develop approaches to address CO₂ emissions.

I think it's important, and you mentioned this time frame between what we do today and when IGCC comes online down the road and it's important to remember that the real means of transition are we're going to have to construct a more conventional coal fired powerplants. But, they're going to be different than the plants we have today. The ultra super critical pulverized plants and the other plants that are available with technologies are going to have to bridge some of that.

All of the projections indicate that the demand for electricity is going to continue to grow. From 1993 to 2004, total generation increased 24 percent. If that growth rate continues over the next 10 years, we're going to need an additional 15,000 to 23,000 megawatts of generated capacity every year. That's 10 plants the size of the Wheaton coal fired powerplant every year.

In summary, we feel coal must play a key role in addressing our future energy needs. While renewables and enhanced oil recovery can do a lot to address our needs, only coal has the reserves to produce significant amounts of new fuels. The technology exists to produce these new fuels. Now is the time for the United States to take the position that reducing our reliance on foreign imports of fuel is critical to our security and our economy. Thank you.

[The prepared statement of Mr. Loomis follows:]

PREPARED STATEMENT OF MARION LOOMIS, EXECUTIVE DIRECTOR, WYOMING
MINING ASSOCIATION, CHEYENNE, WY

Senator Thomas, ladies and gentlemen. I am Marlon Loomis. I am the Executive Director of the Wyoming Mining Association (WMA). Thank you for opportunity to talk to you about the coal industry in Wyoming. WMA represents 24 mining companies in Wyoming producing bentonite, coal, trona and uranium. As you know, Wyoming leads the nation in production of all four of those minerals. This hearing is only about coal, but I think it is important to note that Wyoming provides 85-90% of the soda ash used in the United States and contributes positively to the foreign balance of payments with the soda ash exported from the United States. Our bentonite goes all over the world for oil and gas drilling and Wyoming leads the nation in production of uranium.

On the coal front, Wyoming producers supply over 35% of this nation's coal. Last year 17 mines produced over 405 million tons. Those 17 mines generated over \$670 million for Wyoming in the form of severance taxes, ad valorem production taxes, federal mineral royalties, bonus bids on new coal reserves, Abandoned Mine Land Reclamation fees, local property taxes on equipment and facilities, state royalties, and sales taxes. They provided another \$364 million to the federal government in the form of federal mineral royalties, Abandoned Mine Reclamation fees, and Black Lung fees. I am sure they also paid a significant amount in federal income taxes, but I don't have those numbers. The industry employed over 5,300 miners with an annual payroll of \$475 million. That is money that flows through our economy buy-

ing houses, cars, food, clothes and provides for an excellent quality of life for those miners.

REVENUE TO WYOMING FROM COAL PRODUCED IN 2005

Severance Tax	\$160,000,000
Ad Valorem Tax on Production	\$133,000,000
Ad Valorem Tax on Real and Personal Property	\$11,000,000
Federal Mineral Royalty—Wyoming share	\$180,000,000
Abandoned Mine Reclamation Fee Returned to Wyoming	\$29,000,000
Bonus Bids Returned to Wyoming	\$102,000,000
Sales Tax	\$44,000,000
State Royalties	\$8,000,000
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Total Revenue returned to Wyoming	\$667,000,000
<hr/>	<hr/>
Payroll	\$475,000,000
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Production in tons	405,000,000

The Wyoming Geological Survey estimated that the average selling price for coal in 2005 was \$7.75 per ton so the total value of Wyoming's coal production is projected to exceed \$3 billion. I think it is interesting that 34% of the selling price of the coal goes to state and federal government and, as I stated above, that does not include any income taxes to the federal government.

Wyoming has the third largest coal reserves in the nation and, as stated above, leads the nation in production. Our proven coal reserves exceed 45 billion tons, but the total resource, i.e. proven reserves combined with coal uneconomic today, exceed 1 trillion tons.

Most of our coal is shipped out of state as steam coal for electric plants across the nation. The latest figures show that Wyoming consumers used 25 million tons of coal in 2004. The other 372 million tons were shipped to 35 states from New York to Oregon, from Texas to Wisconsin and most states in between. That distribution demonstrates the ability for Wyoming coal to be shipped economically across considerable distances due primarily to the low sulfur content. As plants across the country install wet scrubbers, Wyoming producers will lose that competitive advantage. But, we believe that Wyoming's efficiency and effectiveness will prevail when it comes to producing coal at a competitive price per million BTU's. Additionally, the quality and contemporaneous nature of reclamation at Wyoming coal mines will provide this resource in a low impact manner.

You asked what we thought the future of Wyoming coal might look like. While the future is going to be much different than the past, we are very optimistic about the future of coal, not only in Wyoming, but also for the United States. As we see it, coal will not only play a continued major role in the electricity generation mix, it will also provide a source of supplemental liquid fuels. It is our view that the trends in oil production will play a potentially significant part in the future of coal. We believe that as the world oil production nears a peak, the value of domestic coal reserves and production, in conjunction with energy conservation, will be even more important to our nation's economy and security.

Many forecasters say that world oil production will peak in the next 20 years. There are some that say world oil production actually peaked in 2005. Although we won't know for some time how close we are to a peak in world oil production, it is accepted that U.S. oil production peaked in the 1970's and nothing, including development of ANWR, is projected to turn that around. At best ANWR will improve the decline curve, but U.S. production will continue to decline. Maybe with Enhanced Oil Recovery and ANWR we will be able to hold our production flat, but no one seems to suggest that we can increase production.

There has been a great deal of recognition about how vulnerable the United States is to a disruption in oil supplies. Sixty percent of our oil consumption comes from foreign sources. Some comes from friendly allies such as Canada, Mexico and Ecuador, but a good portion comes from countries much less friendly to the United States such as Nigeria, Venezuela, and Iraq. OPEC countries supply over 2 billion barrels per year of our annual consumption of 7 billion barrels. Just from a national security position, it is critical that the United States become more self reliant on our own reserves. To not address this most important issue puts our nation at risk. Combine the security concerns with our balance of payment deficits and it just makes so much sense to develop the resources available in the U.S.

Coal is a major part of the answer. The U.S. has 250 billion tons of proven coal reserves. Some of this could be converted to supply 100 million barrels per year in the near future. It would require 30 coal-to-liquid plants producing 10,000 barrels per day. However, the coal reserves could supply much more than that if the U.S. takes the position that energy security is worthy of an effort similar to putting a man on the moon. This will need to be approached as strategic and sustainable development, including measures that address emissions or other environmental considerations related to additional coal production and utilization.

Coal-to-liquids and coal-to-gas has to be a big part of the answer to our future supplies. It takes 0.7-0.9 tons of coal to make a barrel of liquid. In order to generate 100 million barrels per year of coal derived fuel, we would have to devote approximately 80 million tons of coal per year to conversion plants. That is only 20% of the 2005 Wyoming coal production rate. At an average thickness of 70 feet for Wyoming's coal seams it would take 726 acres per year to supply the coal to generate 100 million barrels of fuel. Last year the United States imported 145 million barrels of oil from Russia, 418 million barrels from Nigeria, 549 million barrels from Venezuela and 556 million barrels from Saudi Arabia. We need to find new sources of fuel.

The cost of coal conversion plants averages about \$750 million for a 10,000 barrel per day plant. The proportional costs decrease with increasing plant size, but it will conservatively take over \$20 billion of investment to reach 100 million barrels per year. It is important to recognize, however, that this will represent only 5% or less of the 2 or 3 billion barrels per year of new sources that the U.S. will need to find.

One coal to liquids plant has been announced in Wyoming. It would produce 11,000 barrels per day with the plans to take it to 40,000 barrels per day if the money and technology is available. It would be located in Carbon County near where the first coal mine in the state opened in 1869. There are several other announced plants in the U.S., but there is nothing built yet.

As I stated above, in the future coal will be burned differently than it is today. Existing technology will allow new coal fired power plants to capture the particulates, NO_x (nitrogen oxide), SO_x (sulfur dioxide), and maybe mercury. Further in the future coal fired power plants will need to develop approaches to address CO₂ emissions. Coal still has so much energy that it cannot be ignored; it will be a major part of our electricity resources for generations to come.

The U.S. electricity demand is increasing at a rate of 2% per year. All projections indicate that demands for electricity will continue to increase. From 1993 to 2004, total generation increased 24%. If that growth rate continues over the next ten years, we will need an additional 15,000 to 23,000 MWe of generation capacity each year. That is 10 plants the size of the Wheatland coal fired power plant every year.

In summary coal must play a key role in addressing our future energy needs. While renewables and enhanced oil recovery can do a lot to address our needs, only coal has the reserves to produce significant amounts of new fuels. The technology exists to produce these new fuels. Now is the time for the United States to take the position that reducing our reliance on foreign imports of fuel is critical to our security and our economy.

Thank you.

Senator THOMAS. Thank you very much.

Mr. Coyne.

STATEMENT OF JOE COYNE, EXECUTIVE DIRECTOR, CONVERSE AREA NEW DEVELOPMENT ORGANIZATION, INC., DOUGLAS, WY

Mr. COYNE. Senator Thomas, thank you for the time this afternoon. I work for the Converse Area New Development Organization, a local economic development agency known by the acronym "CANDO". We work hard with our congressional staff, State legislature, Governor, local elected officials and other organizations to help grow our local economy.

I understand that today you are receiving testimony regarding the legislative, economic, and environmental issues associated with the growth and development of the Wyoming coal industry. I would like to address those issues from my perspective as a local economic developer in Douglas and Converse County, Wyoming.

In the 10 years that I have been in Wyoming, I have witnessed a shift in the traditional thinking here. Folks want more than survival. We want to move away from the historical third-world economy of mineral extraction. And moreover, we want to keep our youth in Wyoming. And to do that we must diversify our economy. The opportunity that is before us today is to add value to our coal by gasifying it and then exporting electricity and ultra-clean diesel fuel instead of train load after train load of raw coal. The coal gasification industry could significantly enhance Wyoming's and the Nation's economy while greatly strengthening our security by minimizing the amount of petroleum we import to meet our country's transportation needs.

There are significant risks to development of a coal gasification facility or a coal to liquids plant. The cost alone is staggering, easily in excess of \$1 billion. While there is a great opportunity for making serious money, while petroleum is selling at \$65 to \$75 a barrel, who can guarantee that the price will stay that high for 20 years? And who is willing to prove up the Fischer-Tropsch process with Wyoming coal, at Wyoming altitude? Moreover, who is willing to build the electrical transmission lines that would be necessary for carrying any additional power generated in Wyoming?

We in Wyoming are very thankful for your efforts, Senator, and your colleagues who have addressed some of those concerns in the energy bill of 2005. Much more work remains to be done.

It may be that Wyoming's coal gasification industry gets started, not by generating electricity, nor by producing ultra-clean diesel fuel, but instead simply by producing synthetic gas. Existing pipelines can easily move that synthetic gas to the market right now. Thereby minimizing the fiscal risk associated with coal gasification. However, that limited use of coal does not come close to its full potential. It would not significantly diversify our economy and it would not go very far to reduce foreign oil imports. Eventually, we must do those things.

Currently, Wyoming's procuring a bid to the U.S. Department of Energy regarding FutureGen. If the Federal Government's goal is to place this facility in one location that it can truly change our future, it needs to be built in Wyoming. Other States may be able to gasify coal, but I urge you to think larger. The gasification of coal allows you to capture virtually all of the carbon dioxide from coal. Preventing its release into the atmosphere. What you could then do is make beneficial use of that gas and not simply sequester it forever under ground.

In Wyoming, carbon dioxide is already being injected into the ground, revitalizing our vast oil and gas fields. Additionally, the Fischer-Tropsch classes can be combined with coal gasification, creating a fantastically ultra-clean diesel fuel. While there is a national market for that fuel, Wyoming can offer the Federal Government a much more compelling test for coal gasification.

Here's where I would like to challenge your committee further, Senator. Our efforts at CANDO and elsewhere in State have led us to conclude that coal gasification can best succeed if it is matched up with wind or bio-fuel production. For instance, Fischer-Tropsch process creates a high-energy by-product called naphtha, refineries commonly naphtha to increase the octane of gasoline and other

products. But it could also make an excellent companion to wind-power generation. As you know, even in Wyoming, sometimes the wind does not blow. In fact the intermittent supply of wind is often seen as a major drawback in this development. However, if wind energy were partnered with coal gasification, the excess naphtha could be burned and it burns quite cleanly in generators to provide a relatively constant source of electrical power, solving the problem of transmission.

There are equally synergistic opportunities for bio-fuels, fertilizers, and other industries associated with coal gasification. If our Nation is truly to become more energy independent, we will need to look at every resource available. Wyoming's vast fossil fuel resources can be perfectly balanced with alternative energy production, particularly wind. Too often, we have looked only to export raw materials such as coal, oil, gas and uranium, which Wyoming has an abundance. But we must not ignore the opportunities that are before us just because they may seem complicated, complex or initially expensive. We can do this today if we are patient, wise and visionary.

Wyoming has unique attributes that you've already heard about this afternoon that would allow a project like FutureGen to succeed beyond your imagination. Please do what you can to appropriately encourage the decision makers to put FutureGen in Wyoming. In Wyoming, you will find the support at the grassroots level and also at the leadership levels. You'll also find all of the building blocks, not just the geology to effectively, economically prove that coal gasification is a viable energy alternative to importing more foreign oil.

Senator, thank you for studying this issue. Working together, I know that Wyoming can help meet America's growing energy appetite and at the same time strengthen our country's independence. It's been a privilege to speak with you today, and if time permits I'll try to answer any questions.

[The prepared statement of Mr. Coyne follows:]

PREPARED STATEMENT OF JOE COYNE, EXECUTIVE DIRECTOR, CONVERSE AREA NEW DEVELOPMENT ORGANIZATION, INC., DOUGLAS, WY

Mr. Chairman, welcome to Wyoming! I thank you and the committee members for your time this afternoon.

I work for the Converse Area New Development Organization, a local economic development agency known by the acronym "CANDO". We work hard with our Congressional staff, state legislature, Governor, local elected officials and other organizations to help grow our local economy.

I understand that today you are receiving testimony regarding the legislative, economic, and environmental issues associated with the growth and development of the Wyoming coal industry. I would like to address those issues from my perspective as a local economic developer in Douglas and Converse County, Wyoming.

First, we should take a moment to make some general observations about the rural nature of Wyoming. Some have called Wyoming a small city with very long streets. Our total population is less than 500,000 residents. Douglas has grown to 5,200 citizens, and Converse County is only about 12,000 people. By contrast, the population of Albuquerque, your hometown, Mr. Chairman, is about 800,000. However, even Albuquerque is small compared to the size of the metropolitan areas back East or out on the Pacific Coast. Wyoming's rural—even frontier—nature has cultivated a strong independence in her residents. Traditionally, the State has taken pride in its ability to survive.

The wind here can be astonishing. When similarly strong winds blow back East, folks get all excited, give the wind a formal Name and call it a Tropical Storm! Yet here, we just brace ourselves and get on with our day.

Our “long streets” and open spaces intimidate many. I drove 50 miles to be here this afternoon—a distance that might take you across three state lines as you drive around Washington, DC—but I only spent a fraction of the time (about 45 minutes) you would spend driving the same distance. In Wyoming, we relish our “windshield time,” taking in the open space, wildlife and scenery every day.

Wyoming is, by far, the nation’s largest coal producer, shipping 400 million tons of low sulphur coal annually to 35 states to generate electricity. Wyoming’s coal industry has established an incredible record of safety with its mining operations, and has repeatedly proven itself to be a good steward of our environment.

My point is this: As you examine the issues surrounding Wyoming’s energy growth, you simply cannot do so with the same perspective as you might in other areas of the United States.

Yet, I have also witnessed a shift in the traditional thinking of Wyoming. Folks want more than survival. We want to move away from the historic third world economy of mineral extraction. Moreover, we want to keep more of our youth in Wyoming. To do that, we must diversify our economy. One opportunity that is before us today is to add value to our coal by gasifying it, and then export electricity and ultra clean diesel fuel instead of trainload after trainload of raw coal. The coal gasification industry could significantly enhance Wyoming’s and the nation’s economy, while greatly strengthening our national security by minimizing the amount of petroleum we import to meet our country’s transportation needs.

There are significant risks to development of a coal gasification facility or a coal-to-liquids plant. The cost alone is staggering, easily in excess of \$1 billion dollars. While there is a great opportunity for making serious money while oil is selling for \$65-70 per barrel, who can guarantee that the price will stay that high for 20 years? And who is willing to prove up the Fischer-Tropsch process with Wyoming coal, at Wyoming altitude? Moreover, who is willing to build the electrical transmission lines that would be necessary for carrying any additional power generated in Wyoming?

We in Wyoming are very thankful for the efforts of Senator Craig Thomas and his colleagues, who have addressed some of these concerns in the Energy Bill of 2005. Likewise, the Wyoming Infrastructure Authority is working hard to stimulate development of much needed transmission lines, while the Wyoming Pipeline Authority pushes for the development of more oil and gas pipeline capacity.

It may be that the Wyoming coal gasification industry gets started not by generating electricity, nor by producing ultra clean diesel fuel, but instead can simply produce synthetic gas. Existing gas pipelines can easily move synthetic gas to market right now, thereby minimizing the fiscal risk of coal gasification. However, that limited use of coal does not come close to the full potential of Wyoming coal. It does not significantly diversify Wyoming’s economy. And it would not go very far to reduce foreign oil imports. Eventually, we must do those things.

Political and business decisions to be made in the immediate future will address the inherent financial risks of coal gasification. I thank you for taking the lead on addressing some of those issues in the Energy Bill of 2005. Much more work remains to be done.

Currently, Wyoming is preparing a bid for the U.S. Department of Energy regarding FutureGen. If the government’s goal is to place this federal facility in the one place that it can truly change our future, it needs to be built in Wyoming. Other states may be able to gasify coal, but I urge you to think larger. The gasification of coal allows you to capture virtually all of the carbon dioxide from coal—preventing its release to the atmosphere—and then to make beneficial use of that gas. In Wyoming, carbon dioxide is already being re-injected into the ground, revitalizing our vast oil and gas fields. Further, the Fischer-Tropsch process that can be combined with coal gasification creates a fantastically ultra clean diesel fuel. While there is a national market for that fuel, Wyoming can offer the federal government a much more compelling “test” for coal gasification.

Our efforts at CANDU have led us to conclude that coal gasification can best succeed if it is also matched up with wind and bio-fuel production. For instance, the Fischer-Tropsch process creates a high-energy byproduct called naphtha. Refineries commonly use naphtha to increase the octane of gasoline and other products. But it also makes an excellent companion to wind energy. As you know, even in Wyoming, sometimes the wind does not blow. In fact, the intermittent power supply of wind is often seen as a significant drawback to its development. However, if wind energy were partnered with coal gasification, the excess naphtha could be burned (and it burns quite cleanly) in generators to provide a relatively constant source of electrical power. Likewise, there are synergistic opportunities for bio-fuels, fertilizers, and other industries wherever this process is followed.

If our nation is to truly become more energy independent, we will need to look at every resource available. Wyoming's vast fossil fuel resources can be perfectly balanced with alternative energy production, particularly wind. Too often, we have looked only to export raw materials, such as coal, oil, gas and uranium. We must not ignore the opportunities that are before us just because they may seem complicated, complex or expensive. We can do this thing if we are patient, wise, and visionary.

Wyoming has unique attributes that would allow a project like FutureGen to succeed beyond your imagination. Please do what you can to appropriately encourage the decision-makers to put FutureGen in Wyoming. In Wyoming, you will find support at the grassroots and leadership level. You will also find all the building blocks to effectively and economically prove that coal gasification is a viable energy alternative to imports.

Overall, there is one major deterrent to development of any kind of coal plants in Wyoming: The inadequacy of electrical transmission lines. Without transmission, Wyoming cannot build another significant power plant of any sort. The experts in this area are the folks at the Wyoming Infrastructure Authority, and I urge you to listen carefully to their comments.

Finally, I ask you to consider another time in history, when the Congress created, essentially, a "bounty" to be paid to any company that could create an energy efficient appliances. You created an industrial race to develop energy efficiency, environmentally friendly refrigerators. As a result, consumers quickly got the appliances they needed. An adequate incentive was offered to industry, who immediately responded, and the entire appliance market was positively impacted. I would suggest that a similar bounty might whet the appropriate appetites to motive industry to build the first commercially viable, full scale, coal gasification plant.

Thank you for studying this issue. Working together, I know that Wyoming can help meet America's growing energy appetite, and at the same time strengthen our country's independence.

It has been a privilege to speak today and, if time permits, I will try to answer any questions.

Senator THOMAS. Thank you very much.
Dr. Gern.

STATEMENT OF DR. WILLIAM A. GERN, VICE PRESIDENT FOR RESEARCH AND ECONOMIC DEVELOPMENT, UNIVERSITY OF WYOMING, AND CHAIRMAN OF THE BOARD OF DIRECTORS, WESTERN RESEARCH INSTITUTE

Dr. GERN. Mr. Chairman, thank you. I am William Gern, vice president for research and economic development at the University of Wyoming. I also speak on behalf of the University of Wyoming Research Corporation, which is better known as the Western Research Institute, where I serve as the chairman of the board of directors.

I start my remarks with more context. In a report compiled by the Wyoming Geological Survey using DOE Energy Information Agency data, Wyoming is number one in the States in coal production, as you've heard already, and it's held this position for more than two decades. It is also number four in natural gas and seven in petroleum and number one in uranium. When all of this energy is placed into the common accounting system using quadrillion, that's 1.0×10^{15} , British thermal units of energy produced, the amount of energy—and the amount of energy consumed by a State is subtracted from that total, Wyoming leads the Nation in net energy production twice as much as the next State, which is Alaska.

Recognizing Wyoming's status in energy production, the University of Wyoming has just completed a successful initiative to develop a school for energy resources. This initiative recognizes Wyoming's existing strength in energy related research and will add important new compliments. The school has three elements, all of

which are also meet the Energy Act of 2005 goals. We will enhance our existing institute for energy research. We will add new centers, including one examining uses of subbituminous Western coals. Here we will study gasification, catalysis, carbon sequestration, and trapping. We will develop undergraduate and graduate curriculum in energy sciences and the third element is the technology outreach center which will provide important information concerning the energy related technologies to industry and to our government partners.

The Wyoming legislature passed this legislation providing funding to create the energy school in March 2006 and Governor Freudenthal recently signed legislation into existence and authorizing immediately our ability to commence work in establishing this new chapter in the University's role for the State of Wyoming. The school is slated to receive \$12 million for the first two years of a three year ramp-up period and thereafter it will be sustained with approximately \$10 million annually. Significant funding.

As the energy school proposal was being developed, we were mindful of elements in the Energy Act of 2005 and opportunities presented by research partnerships with Federal agencies, the most important of which is the U.S. Department of Energy. The University of Wyoming has great interest in the new PACE-E legislation. We recognize the importance of this legislation, especially in the elements of dealing with the education of a new competent workforce for energy in the United States.

In order for coal to be used as cleanly as possible, the Nation needs greater understanding about the process of trapping of carbon dioxide from combustion and gasification processes and about the geologic sequestration of carbon dioxide. The University of Wyoming (UW) has considerable expertise in CO₂ tracking and off-loading technologies and in the geologic sequestration of carbon dioxide and its use in enhanced oil recovery. UW is a member of the DOE funded Big Sky Carbon Sequestration Partnership where our role is to examine CO₂ sequestration in carbonate rock reservoirs such as the Madison Formation, which underlies most of the basin and in the economic analysis of carbon sequestration. We are also interested in understanding petroleum reservoir stimulation using the offloaded carbon dioxide which will further use the Nation's known existing supply of oil.

According to the Wyoming Geological Survey, there's 1.4 trillion tons of coal in Wyoming, of which 64 billion tons can be mined using current technologies. But in order for the Nation to use the energy residing in the remaining 1.3 trillion tons, new technologies are required. Specifically, *in situ* gasification processes need greater understanding through research. Also, we need much more fundamental understanding of the biological and physical events associated with coal bed methane or coal bed natural gas formation.

The University of Wyoming Research Corporation is a 501(c)(3) not for profit research entity known as the Western Research Institute funded primarily by U.S. Department of Energy and U.S. Federal Highway Administration. In the energy sector, WRI continues its strong efforts in coal conversion and upgrading power generation, waste management, and utilization and alternative fuels, environmental remediation, renewable energy technologies, and bio-

processing. WRI supports utilities in a number of emissions issues. WRI has built a test scale combustion test facility mimicking a coal fired utility boiler. This facility now is supporting technology developing verification for a number of utilities for coal technology companies and in the combustion and emission control equipment manufacturers.

For example, current technologies are testing NO_x reduction with Breen Energy Solutions, testing mercury capture technologies with Mobile Tech USA, testing strategies for multi-point pollution control with Headwaters, Incorporated. WRI has developed a patented pre-combustion mercury removal process that first dries the coal, then uses hot recycle gas to remove the mercury. Unlike post-combustion processes that remove mercury from the flue gas, WRI's patented process removes mercury from coal prior to combustion. This process has been shown to remove up to 80 percent of the mercury from Powder River Basin coal. In February 2006, WRI was notified by the U.S. Department of Energy that their project was selected for an award supporting commercial scale up. DOE funding, which is approximately \$1 million, will be matched with \$460,000 from industry affiliated co-sponsors such as the Electric Power and Research Institute, Southern Company Basin, an Electric Power Cooperative, and the North Dakota Industrial Commission, Montana, Dakota Utilities in Detroit, Edison, as well as Sask Power. WRI is working to develop enabling technologies for zero emission coal based powerplants in the future. With oxycombustion, fuel is combusted in pure oxygen, the flue gas is recycled back into the furnace to maintain optimum burning conditions. Because oxycombustion excludes nitrogen, the byproduct is nearly pure carbon dioxide, a waste gas that can be effectively managed.

The cost of oxygen, however, is a major issue in the development of sequestration ready power systems of the future. Working with a specialty gas manufacturer, BOC Process Gas Solutions of Murray Hill, New Jersey, WRI is developing a novel technology for the lower cost production of oxygen that takes advantage of the oxygen storage properties of the mineral, perovskite. The cost of producing oxygen using the BOC catalytic auto-thermal reformer technology is estimated to be 20 to 30 percent lower than the cost of cryogenic air separation.

A hydrogen project now underway at Western Research Institute at the University of Wyoming is expected to yield cheaper and easier ways to produce pure hydrogen from gasified coal and other mixed gasses. The new process advances the water gas shift process whereby coal is reacted with steam and oxygen to produce the synthesis gas. Under a Department of Energy grant, WRI and the University of Wyoming are developing a device that combines water gas shift technology with improved hydrogen separation to maximize the total hydrogen produced.

Both WRI and the University of Wyoming recognize the importance of ARPA-E legislation that is currently being discussed and we are pleased, Senator Thomas, that you are a co-sponsoring senator. And with that, thank you, Senator, for this opportunity.

[The prepared statement of Dr. Gern follows:]

PREPARED STATEMENT OF WILLIAM A. GERN, VICE PRESIDENT FOR RESEARCH AND ECONOMIC DEVELOPMENT, UNIVERSITY OF WYOMING, AND CHAIRMAN OF THE BOARD OF DIRECTORS, WESTERN RESEARCH INSTITUTE

Mr. Chairman, I am William A. Gern, Vice President for Research and Economic Development for the University of Wyoming; I will also speak on behalf of the University of Wyoming Research Corporation which is better known as the Western Research Institute where I serve as the Chairman of the Board of Directors.

Wyoming leads the Nation in net energy production. The Wyoming Geological Survey developed a report placing all forms of energy production, by each state, into the common accounting system of quadrillion (1.0×10^{15}) British Thermal Units (Btu's). The survey used DoE EIA data (2003) for this report (the report may be viewed at http://www.wsgs.uwyo.edu/Coal/DNR_RE_Study.pdf). The Geological Survey also used the DoE EIA data to estimate energy consumption by state. The result of subtracting consumption from production is estimated net energy production. In terms of gross energy production Texas led the Nation, with 9.08 quads Btu, Wyoming was second with 8.80 quad Btu. It is estimated that Texas consumed 12 quad Btu however, meaning that as a state they were a net energy importer. At the same time, Wyoming was estimated to have consumed 0.4 quad Btu, thereby exporting approximately 8.4 quad Btu to the nation. This is why Wyoming is the Nation's leader in net energy production. Alaska was estimated to rank second in net energy production with approximately 4.77 quad Btu.

Wyoming's energy portfolio is multifaceted, it produced 6.65 quad Btu of coal (ranks #1), 1.52 quad Btu of natural gas (ranks #4) and 0.29 quad Btu of crude oil (ranks #7). Wyoming has led the nation in coal production for the past two decades, with Wyoming coals responsible for an estimated 35 percent of the nation's electrical power. While nuclear power generation was examined in this report, it did not attempt to attribute the source of the nuclear fuel; Wyoming ranks #1 in uranium production.

Recognizing Wyoming's status in energy production, the University of Wyoming has just completed a successful initiative to develop a School for Energy Resources. This initiative recognizes UW's existing strength in energy-related education and research, most of which is fundamental, and will add important new components. The school has three elements, all of which also meet Energy Act of 2005 goals. UW will enhance existing research capabilities. We will hire permanent research staff and provide state-funded operating budget to elements of our existing Institute for Energy Research. Incentives will be provided to UW departments in the form of support funding for three-year faculty appointments into various energy related centers on the campus as well as support for graduate students. A large annual pool of funding is available for grant matching (this will be very helpful in winning competitive awards from the DoE). Finally an interdisciplinary technical advisory board will help steer the scientific work conducted under the aegis of the Institute for Energy Research.

The second element is academic. Funding for 12 distinguished professorships is available. This will help attract faculty who have achieved international recognition for their research and teaching in fields related to energy. Our curriculum will be broadened in interdisciplinary directions to support the state's economic health and strengthen UW's graduates' preparation for careers in energy-related fields.

The third element is statewide outreach and service. Here a permanently funded Energy Outreach Center will provide technical consulting, hold statewide workshops, and produce technical reports supporting energy project design, scientifically-based analysis of energy resources and effective long-term energy planning. The Outreach Center will serve as an important link between the School for Energy Resources, industry and government agencies.

The Wyoming Legislature passed legislation, providing funding to create the School for Energy Resources in March, 2006. Governor Freudenthal recently signed this legislation into existence with the authorization to immediately commence the work of establishing this important new chapter in the University's role for the state of Wyoming. The school is slated to receive \$12 million for the first two years of a three year ramp-up period, after which it will be sustained with approximately \$10 million annually.

As the energy school proposal was being developed, we were mindful of elements within the Energy Act of 2005 and opportunities presented by research and education partnerships with Federal agencies, the most important of which is the Department of Energy. We are pleased with Senator Thomas' co-sponsorship of the PACE-E and ARPA-E Senate bills. We recognize the importance of this legislation especially the elements dealing with education of a competent workforce and of increased funding for energy-related research.

In order for coal to be used as cleanly as possible, the nation needs greater understanding about the processes of trapping carbon dioxide (CO₂) from combustion and gasification processes and about geologic carbon sequestration. "Carbon sequestration" is initiated with CO₂ capture from the flue gas, followed by usage or storage or both. Flue gas, produced by conventional air combustion, contains approximately 10-15% CO₂; the balance is nitrogen and minor combustion byproducts. Flue gas produced by plants using oxygen instead of air for combustion, as in future Integrated Gasification Combined Cycle (IGCC) plants, also contains CO₂ but more concentrated (say 50%) and at higher pressures. Aqueous-amine absorption currently is widely used for separating CO₂ from flue gas. This type of separation substantially increases the cost of electricity generated. DoE's goal is to reduce this cost and therefore they support programs developing new separation technology that will reduce the CO₂ capture cost, hopefully by a factor of 4 (http://www.netl.doe.gov/technologies/carbon_seq/index.html). DoE's target for IGCC plants is a new separation technology that will reduce the CO₂ capture cost by a factor of 2-3. To our knowledge existing separation technologies, however optimized and configured, cannot approach these stretching targets. A route to achieve these capture targets is through novel sorbent and membrane materials. Sorbent is made of granular material that can trap CO₂, but not the other flue gas components, and hence is similar to the materials used in in-line filters for purification of water and air. These materials need both high CO₂ capacity and high CO₂/nitrogen selectivity, and they must be easy to regenerate. The University of Wyoming is actively pursuing research to identify and develop this needed material.

UW has considerable expertise in geological CO₂ sequestration. As a member of the DoE-funded Big Sky Carbon Sequestration Partnership (Montana State University is the lead institution), we are examining CO₂ sequestration in carbonate rock reservoirs and the economic analysis of CO₂ sequestration. This work is being done UW's Enhanced Oil Recovery Institute where we will couple this knowledge with research deepening our understanding of petroleum reservoir stimulation using the off-loaded CO₂; an end result will further use of the nation's existing known oil supplies.

According to the Wyoming Geological survey, there is 1.4 trillion tons of coal in Wyoming, of which about 64 billion tons can be mined with current technologies. In order for the nation to use the energy residing in the remaining 1.3 trillion tons, new technologies are required. Specifically in situ gasification process needs greater understanding through research. In situ gasification is not new; as a matter of fact, Wyoming was home for such research over twenty years ago. The Nation also needs a much more fundamental understanding of the biological and physical events associated coal bed natural gas (CBNG) formation. Many important scientific questions remain open—what is the rate of gas formation? what are the physical and biological components of gas formation? can the gas production be altered through manipulation?—to name a few. Finally the University of Wyoming is doing considerable research into issues associated with CBNG process water production using DoE funding.

As Wyoming's surface coal mining industry was strongly developing in the early 1970's many felt that reclamation of the mined surface would be quite slow in the arid, cold regions of the state. The Wyoming Abandoned Coal Mine Land Research Program, part of the Wyoming Department of Environmental Quality Abandoned Mine Division, produced much valuable information for mine managers to use in reclaiming mined lands. This program is managed by the University of Wyoming for DEQ and many UW-based research projects have resulted in a wide array of reclamation techniques useful not only in coal mine reclamation, but to the reclamation of other disturbed lands throughout the West. While surface coal mining is by its nature a disruptive process, active reclamation is effective in returning once mined land into effective places for grazing and wildlife.

The University of Wyoming Research Corporation is a 501(c)3 not-for-profit research entity known as the Western Research Institute, funded primarily by the U.S. Department of Energy and the Federal Highway Administration to support these organizations' mandates for the benefit of the Nation.

In the energy sector, WRI continues its efforts in coal conversion and upgrading, power generation, waste management and utilization, alternative fuels, environmental remediation, renewable energy technologies, and bioprocessing.

WRI is supporting the utilities on a number of emission issues. For example, WRI has built a test-scale Combustion Test Facility that mimics a coal-fired utility boiler. This facility is now supporting technology development and verification projects for utilities, for coal technology companies and combustion and emissions control equipment manufacturers. The following are examples of the projects being conducted: testing of NO reduction technologies (with Breen Energy Solutions); testing of Hg

capture technologies (with MoboTec U.S.A.); testing of strategies for multi-pollutant control (with Headwaters, Inc.).

WRI has developed a patented pre-combustion mercury removal process that first dries the coal, then uses the hot recycle gas to remove the mercury. Unlike post-combustion processes that remove mercury from the flue gas, WRI's patented process removes the mercury from the coal prior to combustion. The process has been shown to remove up to 80 percent of the mercury in PRB coal (additional mercury is removed during combustion). Not only is this technology competitive with post-combustion processes on a cost basis, it also is easily integrated into a power plant, and the treated coal product increases plant efficiency by 3-4 percent for Powder River Basin (PRB) coal. What's more, the water removed from the coal can be condensed and used at the power plant for cooling and other uses, a considerable benefit in the arid West. A recent economic study sponsored by the Electric Power Research Institute showed the WRI process to be one of the lowest-cost technologies for removing mercury from PRB coal-fired power plants. In February 2006, WRI was notified by the Department of Energy that this project was selected for an award to support commercial scale-up. The DoE funding of approximately \$1 million will be matched by approximately \$460,000 from industry-affiliated co-sponsors Electric Power Research Institute, Southern Company, Basin Electric Power Cooperative, North Dakota Industrial Commission, Montana-Dakota Utilities, Detroit Edison and SaskPower.

WRI supports the coal industry in mine reclamation through the development of a novel bio-based source treatment of acid mine drainage (AMD). Although the high-sulfur coals of the East make this problem more widespread in the eastern half of the country, acid mine drainage is associated with hard rock mining and coal mining throughout the United States. Other processes treat the drainage through neutralization. WRI has partnered with Kennecott Energy to demonstrate the effectiveness of the biobased source treatment process at a mine in Tennessee. The results to date have confirmed that the process effectively controls acid mine drainage by controlling the source of the acid within the mine. Additional demonstrations are being planned with other coal companies at other mines.

Since the first commercial coal bed natural gas (CBNG) well was established in the Powder River Basin in 1986, CBNG production has grown explosively and now constitutes a major resource within the energy mix for Wyoming, the region and the Nation. More than 40,000 wells are expected to be drilled in the next decade alone. The management of the produced water, however, remains a significant consideration. When an operator drills a CBNG well, large amounts of water are withdrawn in order to free the methane to be extracted. In some areas of Wyoming and Montana, the water quality is such that it cannot be used for agriculture, livestock or discharge into surface streams without causing degradation of the water. WRI is working with developers and others to demonstrate treatment methods that will allow the beneficial use of the produced waters. For example, WRI is working with CBM Associates to demonstrate an application that allows the water to be used for irrigation purposes. WRI also is exploring the use of CBNG produced water in power plants to reduce the draw of fresh water for cooling and other plant purposes.

WRI is working to develop enabling technologies for zero-emissions coal-based power plants of the future. With "oxycombustion," fuel is combusted in pure oxygen (rather than air which contain considerable nitrogen gas) and flue gas is recycled back into the furnace to maintain optimum burning conditions. Because oxycombustion excludes nitrogen, the byproduct is nearly pure carbon dioxide, a waste that can be more effectively managed. The cost of oxygen, however, is a major issue in the development of sequestration-ready power systems of the future. Working with a specialty gas manufacturer, BOC Process Gas Solutions (Murray Hill, New Jersey), WRI is developing a novel technology for the lower-cost production of oxygen that takes advantage of the oxygen "storage" properties of the mineral perovskite. The cost of producing oxygen using the BOC Catalytic Autothermal Reformer (CAR) technology is estimated to be 20 to 30 percent lower than the cost of cryogenic air separation.

A hydrogen project now underway at Western Research Institute and the University of Wyoming is expected to yield a cheaper and easier way to produce pure hydrogen from gasified coal and other mixed gases. The new process advances the water-gas shift process whereby coal is reacted with steam (water) and oxygen to produce a synthesis gas. Under a U.S. Department of Energy grant, WRI and the University of Wyoming are developing a device that combines water-gas shift technology with improved hydrogen separation to maximize the total hydrogen produced. The University of Wyoming is leading the development of a ceramic catalyst, while WRI will test a variety of vanadium alloy foil membranes for durability and optimum effectiveness at lower temperatures. Finally, the ceramic catalyst and the

vanadium membrane will be integrated into a single stackable device that can operate at lower temperatures.

Through this testimony, I want to make apparent that Wyoming is a major player in the Nation's energy production. We desire to have a much greater role in processes associated with the conversion of coal into other forms of energy. The University of Wyoming has established the School of Energy Resources for this and other reasons. It will have a very important role in research, outreach and education regarding energy production. The Western Research Institute continues to apply knowledge leading to new and efficient production technologies that are less polluting but will result in meaningful new uses for the Nation's energy supply.

Mr. Chairman, thank you for the opportunity to provide testimony to this committee.

Senator THOMAS. Thank you all very much. I appreciate your comments and I appreciate your ideas. I have a few questions and we'll see what we can do there.

Dr. Shilling, how would you evaluate GE's position with regard to technology development as opposed to actually being close to constructing a plant for IGCC?

Dr. SHILLING. There is a fairly significant amount of work that goes between the development of technologies such as we're doing now for low rank coals and then implementation within the design. And of course we're developing a reference plant design right now for coal for high sulphur coal. We'd have to do something similar to bring that to market in terms of a reference plant design, a standard plant design. And of course the benefits of that, when you look at the typical utility that's going to be putting in one of these plants, what they do not have within their model of acquiring technology or building coal plants is the type of additional engineering that would have to go into a—what we call a first of a kind plant. And similar to what we're doing now, we would need also to develop a first of a kind plant for Western coals. It would allow us to take advantage of the lower sulphur that's in Western coals, plus it would integrate technology that we're developing now for being able to deal with the moisture that's in Western coals. And of course that plant will look significantly different. We'll have a different balance of the topping cycle to the bottoming cycle piece of—you know, the plant distribution, where the power's coming from. We'll have a significantly different waste handling system as a gas removal system, and IGCC is very complex.

Technology today is very complex. We can see it in the development of, for example, advanced aircraft engines, locomotives. It's a part of our technology today. It's part of our technology society.

So, going from the design from the development into the deployment, there is another step, which the engineering of the plant. And I would say that's a—probably right now a major feature that still has to be accomplished before we define and before we deploy a plant optimized for western coal.

Senator THOMAS. So would you say that the policies and incentives that are currently in place are enough for General Electric and others to pursue and construct plants, or are you simply in the process of research?

Dr. SHILLING. There is—no. We're not just in research. We need to deploy these technologies that we're developing very rapidly. Within the Energy Act, there is, of course, title IV for the incentive tax credit. There is title XVII for the loan guarantee. There's section 413 for Western coal demonstration. There is still a gap that

deals with that first of a kind engineering. And again, when utilities look at implementing an IGCC project, that winds up being called still the kind of a final gap that needs to be closed and we need to find a way to fund that and support that development.

Senator THOMAS. Okay. Well, I hope that all of you are looking at actually getting something built as opposed to just research. And I understand research has to be certainly performed. General Electric recently signed the agreement with DKRW to use GE's gasification technologies, the proposed coal to liquids facility right here in Wyoming. The first phase was supposed to produce approximately 11,000 barrels per day of ultra clean diesel fuel from carbon base and coal. It is my understanding this will be the first application of that technology. What are the environmental benefits of producing transportation fuel as opposed to running crude oil through the refineries?

Dr. SHILLING. The good news is that the coal to liquids is very clean compared to what I'll call standard refinery, taking in crude and refining that into distillate or into diesel fuels. The reason is that we take out—the metals we take out, the mercury we take out, the sulphur, as part of the process, and it's going to be very, very clean compared to a standard refinery where they're dealing with high sulphur—

Senator THOMAS. This process is pretty much available, ready to move forward?

Dr. SHILLING. That's right. The technologies are available. They need to be integrated into a total plant and whether or not the decision is made, for example, to do it with a complete processing, after you convert the coal, you will have a—what we call synthetic crude, in a way. It has waxes and it has a higher and lower order of hydrocarbons. You can do that final processing to produce either diesel or methanol or other products onsite, or you can ship that to a refinery. And the good news about shipping it to an existing refinery is even that synthetic crude will also have very low de minimus levels of sulphur. So the sulphur part and the mineral part of the processing of that fuel or that feed stock within a normal refinery even will show significant environmental benefit.

Senator THOMAS. You're not planning to make meth, are you?

Dr. SHILLING. Pardon me?

Senator THOMAS. I'm sorry. That's just a joke. That's what, it's in the Medicine Bow area, and that's something that's fairly likely to happen, is that right?

Dr. SHILLING. Well right now, GE would be licensing our gasification technology into—and providing, of course, the engineering support for that into the total project. I believe right now that project is moving towards and into the financing phase.

Senator THOMAS. Good. Thank you. Mr. Waddington, what do you think Congress might do to help improve and move forward with this transmission project the Authority's working on?

Mr. WADDINGTON. Well, Mr. Chairman, we have two public-private partnerships on relatively near term transmission opportunities. And in both instances, one of our partners is the Western Area Power Administration along with a private sector party. We're just about ready to embark on detailed technical study work that's expensive and I would suggest, Mr. Chairman, you consider a Federal

funding piece to that that would help bolster Western's ability to work with us as we get into the detailed study. Whether that's a redirect of DOE's existing appropriate funds or by some other appropriated means.

Senator THOMAS. WAPA?

Mr. WADDINGTON. WAPA. Mr. Chairman, they like to be called Western, is what I've been told.

Senator THOMAS. Oh, is that right?

Mr. WADDINGTON. Yes. So I've been trying to get—I've called them WAPA for years, and I'm trying to get into the habit of calling them—

Senator THOMAS. WAPA sounds more familiar to me. Okay. So a frontier corridor is one of the things you're working on. Is that right?

Mr. WADDINGTON. Mr. Chairman, yes, we are involved in the frontier line. We also have a partnership and a relationship with Arizona Public Service on the Trans-West Express Project. Both of those are multi-State, long distance, long term initiatives. The two projects I was referring to are actually shorter distance projects connecting Wyoming with Colorado and Utah.

Senator THOMAS. Good. Just a short answer, because I know it's a complicated problem, but obviously, there's more to the so-called capacity shipper thing and the railroad thing than just the price. Capacity, investment. What do you think is the solution to railroad capacity?

Mr. WADDINGTON. Mr. Chairman, I didn't come today with the solution readily at hand. This is a complicated matter. I think it's important to Wyoming. It's important to rural States throughout the country and it needs a concerted look. But frankly it's a complicated matter and I don't have the solution for you today.

Senator THOMAS. But there is a capacity problem, isn't there, in terms of the Powder River Basin?

Mr. WADDINGTON. Mr. Chairman, absolutely. There are coal plants that are receiving very limited supplies of coal and working down their inventories because of the lack of cars, as one example. So it—

Senator THOMAS. And market and capacity are higher than we're able to provide because of the limitations on the capacity of the railroad?

Mr. WADDINGTON. That's my understanding, Mr. Chairman.

Senator THOMAS. I see. Okay. You mentioned bonding authority and the possibility of creating tax exempt status. I'm aware of this issue, but I want you to know that other things Congress can do—are there other things Congress can do to help in the construction or the transmission? There's some confusion about sometimes on tax exemption in terms of construction and ownership and those kinds of things.

Mr. WADDINGTON. Well, Mr. Chairman, I'd say in general that the Energy Policy Act that passed last year gives us the tools if—provided two things. That Congress keeps the implementing agency's feet to the fire and those provisions get implemented. And second, if there's sufficient funding appropriated as we go through times. In general, I think we have an energy policy to implement. The one area that I suggested in my testimony that might be a new

provision is recognition—and several States have emerged now with these State bonding authorities, where we're trying to make a difference, as one more financing tool to move these projects ahead. And federally tax exempt bonding would give us a significant lift in terms of lowering the cost of those transmission investments.

Senator THOMAS. Yes. Sometimes there's a little discussion over who benefits from that, whether it's the builder, whether it's the owner, whether it's the user. That gets to be a little bit of a complicated question. But I understand what you're saying. So, Mr. Loomis, just very briefly, in general terms, how do you state the differences between mining coal and other types in terms of mining practices, energy content, environmental factors, and reserves? We need to explain that to people sometimes.

Mr. LOOMIS. Senator Thomas, certainly we are blessed here in Wyoming, as you're aware, with coals that are surface mineable coals that are close to the surface which, in many cases in the other parts of the country, they're deeper. Our coal seams are thicker, 70 to 100 foot coal seams which, in the east Midwest and other States, they might be 3 feet to 10 feet. So those two, being relatively close to the surface, are extremely thick coal seams, making them much different and the reason why we produce so many more tons per man year than an Eastern or Midwestern coal. On the environmental side, as I mentioned, our coals—and has already been mentioned by others—are extremely low in sulphur. Our coals will meet the demands of the Clean Air Act of 1.2 pounds of SO₂ per million Btus without scrubbers. So that has been a big reason that has allowed us to go coast to coast in competing for new markets. That, in addition to our extremely efficient mining operations. And as I said, as more and more utilities split on what scrubbers, we're going to lose that particular advantage, but we still believe we will be the most efficient mines when it comes to tons per million Btus.

Senator THOMAS. Okay. Very good. Thank you. Obviously, the energy industry's been good at providing employment for Wyoming people. You mentioned the salaries and so on. Give us a snapshot of the average age and the types of expertise and perhaps salaries that exist in the industry.

Mr. LOOMIS. I'll kind of take them in the opposite order. I mentioned the salaries. We were looking at \$80,000 to \$100,000 a year for a miner in Wyoming. The skills are not the labor skills of 100 years ago. They're highly technical skilled jobs today. The people that work in the mines have to be able to look at computers, be able to run them. They're on their trucks. They're on the drag lines. Even the dozers that do the reclamation work will have GPS systems where they will be able to contour that land back to within inches of what is required for final topographic relief. So these are highly skilled jobs that are available in the industry.

As far as the aging, I don't have an average age, but I know a great deal of the people that are working in the operations started at about the same time I did, and I'm getting pretty old, Senator. So you know that work force is aging as well. So that is a major consideration. It's not a crisis. We're addressing it, but certainly the industry is going across the country to job fairs in the East and

South telling people about the jobs that are available here in Wyoming. We're going out to the schools in the State of Wyoming and trying to make presentations to the high schools and the vocational education classes that these jobs are available in Wyoming and they should take a look at them. And that they need to have math skills, they need to have reading skills, they need to have writing skills in order to compete for these jobs, but they are good jobs and we're doing that out of the association. I'm trying to raise the education level of—or knowledge level of these jobs and the ability for Wyoming students.

Senator THOMAS. Do you have available employment—have people in the industry? Are you short?

Mr. LOOMIS. We're short.

Senator THOMAS. You're short?

Mr. LOOMIS. Especially welders, electricians, mechanics, those skill sets are in extremely short supply.

Senator THOMAS. I see. Okay. Marion, did you hear that salary range? What would you guess would be the time frame to get to IGCC production? Do your folks have any particular feelings?

Mr. LOOMIS. Mr. Chairman, Dr. Shilling would be a much better person to ask that question of, but I—

Senator THOMAS. Yes. But do you see it though in your industry as something happening quite soon, or—

Mr. LOOMIS. Mr. Chairman, I think we're going to see some of that happening, but I mentioned the need for 10,000 to 20,000 megawatts a year of new power. That's not going to happen with IGCC. It's going to happen, if it happens with coal, with more conventional plants. But saying it's a conventional plant, it's not going to be the plants that we built even 10 years ago. They're going to be cleaner, more efficient plants addressing mercury and SO_x and NO_x and particulates. But nevertheless, I don't believe we're at the IGCC plant for these immediate needs of this Nation. They're going to be the more conventional plants with the new technologies for emission control.

Senator THOMAS. So you agree with the concept that there's a short term future and a long term future?

Mr. LOOMIS. Absolutely, Mr. Chairman.

Senator THOMAS. Mr. Coyne, what do you think Congress might do that it hasn't already done to reduce the regulatory, economic, and logistical hurdles that exist for attracting coal projects to Wyoming?

Mr. COYNE. Senator, I think there's a handful of things that could still be addressed. You're already doing, I think, maybe all of this, but first, we need the Department of Energy to finish up the regulations. They need to be written and then objective wise decisions need to be made by that Department regarding that energy bill. Second, there's been a lot of talk about a national grid to address the transmission line issues through FERC or through other areas. I'm no expert in that area, but if there's a path where we could increase the capacity to export electricity and to make the grid maybe more stable and safer throughout the country, then I would encourage you to bless those efforts.

There's also been a lot of talk recently about the development of a single battlefield fuel I think the Department of Defense could

use. It may be that the Fischer-Tropsch process and the ultra clean diesel fuel that it could create from coal may be that fuel. I would urge you to encourage the Department of Defense to find the money in their many billion dollar budget to actually study and determine whether that is the fuel and, if so, to move forward with those projects.

Senator THOMAS. What did you call it?

Mr. COYNE. Single battlefield fuel.

Senator THOMAS. I see.

Mr. COYNE. And then finally, if there's anything within your power to encourage or to drive the completion of due diligence for coal gasification efforts, I would encourage you to do that.

Senator THOMAS. Think we can get California to buy our coal generated fuel?

Mr. COYNE. When I studied law, there was a little thing called the interstate commerce clause that had a lot to do with what could cross State lines and perhaps that clause doesn't apply to California, but it sure seems that Wyoming's coal is clean enough for 34 other States.

Senator THOMAS. What an idea. Okay. I'm not sure I quite understood. You are in favor of moving forward with the coal gasification, coal conversion, but you think it ought to be balanced with non-fossil activities. Is that your point?

Mr. COYNE. It is, and I think that Wyoming's resources, particularly wind, have largely been left untapped because of the intermittent nature of wind power through the year, throughout the time of the year. It may be that both of these industries can best be moved forward if they are joined together, particularly when we look at transmission issues.

Senator THOMAS. That's interesting. I had some contacts this week saying that if you're going to generate wind power you need to participate in the cost of transmission and the tax exemptions that go for wind power ought to have a little something to do with the transmission costs as well, which would be a little different change with the—and then something in the future. Of course, I agree with you and unfortunately, currently, wind and solar produce about 1 percent of our total. Do you see a potential for wind energy to be more efficient to where we produce more with the relatively fewer number of facilities, or are we going to have to have—are we going to have the same kind of efficiency in the production? Or what's your view of that?

Mr. COYNE. The potential for wind power is huge. You would need to talk to the doctor on my left about what power of hugeness it would need to become in order to become significant in the overall picture. But the opportunity's there. It's clean fuel.

Senator THOMAS. Yes.

Mr. COYNE. And certainly there's room for it to grow. In my opinion, it's not going to become the significant answer to our future energy needs. It's just too small.

Senator THOMAS. All right. No question, but with integration is an idea. Do you recall that in the initial idea of the wind generation in Medicine Bow was to integrate it with the Colorado River. Unfortunately, the Medicine Bow one blew away, but that still was the concept, and a good concept. Dr. Gern, as you move forward,

what is the relationship between Western Research Institute and the University Energy College in terms of research? How do you work those two functions together?

Dr. GERN. Thank you, Senator. As you know, the Western Research Institute is the University of Wyoming Research Corporation and our trustees appoint the board of directors of the Western Research Institute. And the president of the University of Wyoming or that person's designee is to serve on the board, and that's why I serve on the board. I am the president's designee.

As we develop this energy school, it is very logical to think about the strengths that WRI has and the strength that the University has. All universities are strong. Restrictions are strong in fundamental research, and that is the research that looks down the road a fair distance. But that research, in order to be important, must be brought into economic reality. It must be placed into businesses. It must be done in such a way that it can actually be deployed and therefore employ people using it.

WRI is very good at moving concepts, fundamental concepts, into the applied arena and then all the way up to pilot or demonstration scale projects. And so I see the relationship, one, being as a provider of fundamental research and WRI's serving as a site where this fundamental research can be moved into the applied realm. That doesn't mean that WRI doesn't do fundamental research on its own, but the University is such—a much larger research entity than WRI. More research will come out of the University just because of size. But WRI has significant applied technology based tools and infrastructure like this utility boiler that can be used and other things in examining a whole bunch of issues.

One of the things that, for example, we're very interested in is in catalytic membranes. Several people have spoken about these kinds of new technologies. We are also very interested in catalytic membranes. We have developed our own proprietary patented catalytic material and placing it into a membrane whereby the flow through process can occur, that is you react it as the combustion gas moves through and then separate it at the same time, is extremely important and really improves the efficiency of these things. That's fundamental research and then it becomes how you place it into a functioning technology.

Senator THOMAS. That's great. And you have had research of course, and we've worked with you in the past and you've gotten a considerable amount of dollars there for WRI and for the University, for the Rocky Mountain Research Institute and all those things, but of course we haven't really been recognized as having facilities to do a great deal of—now do you see the Energy College as being an energy research center?

Dr. GERN. I do. The School for Energy Resources, like I said, will have three major components, all aimed at supporting energy related technologies out of the University. We are hoping to hire 12 distinguished professors as soon as we can. Now think about this. These are the nation's, or maybe the world's experts in areas of energy and we will have the capability, the financial capability of hiring these people and bring their expertise to the Laramie campus. I think that that bodes well for our ability to continue to develop

new technologies and continue the applied route for these technologies, and we're very happy about that.

Another piece of this is something that is not often considered, but the Wyoming legislature did consider it. And that is they provided us \$1 million a year of matching funds to go after Federal projects, DOE projects. And as you know, there is always a significant match requirement when you work with the Department of Energy and this million dollars is going to make us very competitive.

Senator THOMAS. Very good. Very good. We appreciate that. That's great. Well thank you all very much for your input and we appreciate it. I hope you'll all stay seated for a moment because I want to visit with you a little later. But for those of you who may be interested, all the statements that are given today will be posted on this Energy Committee's website, so if you want more of this information, you can find it there.

From this testimony there may be some questions sent to some of you and I hope you'll respond to them and they will be put in the record. So, without any further ado, I'll adjourn the official meeting of the committee.

[Whereupon, at 3:06 p.m., the hearing was adjourned.]

APPENDIX

ADDITIONAL MATERIAL SUBMITTED FOR THE RECORD

STATEMENT OF FRED LAWRENCE, PRESIDENT, CARBON RECOVERY TECHNOLOGY, INC.,
AND DR. RONALD W. SPAHR, PROFESSOR AND DEPARTMENT CHAIR, UNIVERSITY OF
MEMPHIS

TRANSAMERICA GRID (TAG) PROJECT

The TransAmerica Grid (TAG) Project is a comprehensive, strategic plan to construct a high voltage AC and/or DC transmission system that would link the wind and coal rich western and great plains states with the large electrical load centers to the east (Chicago, St. Louis, Memphis), the west (Los Angeles and through the Pacific Intertie, San Francisco and the Northwest), and the south (Phoenix, Tucson, Houston, Dallas/Fort Worth). The TAG concept has evolved from discussions within the utility, transmission, wind and coal industries and among state officials in the West and Midwest over the past 15 years. It addresses many of the concerns that currently face the U.S. power industry:

(1) It provides access and facilitates utilization of up to 10,000 MW of wind-power resources of the Dakotas, Colorado, Kansas, Montana, Nebraska, New Mexico, Oklahoma, Texas, Wyoming, and other wind-rich states;

(2) It provides access and facilitates utilization of up to 14,000 MW of plentiful clean low-sulfur coal/lignite resources of Colorado, Montana, North Dakota and Wyoming;

(3) It relieves transmission constraints and bottlenecks that exist in the West, Southwest, Midwest and Texas;

(4) It would create synergies by linking the East, West, and Texas grids and would also link energy abundant regions with load centers;

(5) It enhances the deregulation of the U.S. power industry by (a) providing new and existing generation with better access to new markets, and (b) tying in the Eastern, Western and Texas electrical grids, thereby creating a more efficient, essentially national market for electrical power;

(6) The proposed system would provide nationally generated power to accommodate regional demand peaks, diversify weather-related and hourly peak loads across the country, providing higher utilization of efficient power generation and reducing the need for standby peaking generation capacity;

(7) It diversifies seasonal and daily peak loads among load centers in the country, thereby reducing further the need for standby peaking generation capacity,

(8) It provides for the diversification of renewable (wind, hydro, and solar) electrical generation to increase the reliability of renewable power; and

(9) It stabilizes and improves the reliability of the entire electrical grid system in the U.S.

The TransAmerica Grid project is a huge undertaking—in many ways comparable to the construction of the U.S. interstate highway system in the 1950's and 1960's. However, unlike the highway system, the TAG project will generate revenues from tariffs on the power that it transports. These revenues are estimated to be in the range of \$2 billion per year. Although the system itself is estimated to cost \$11.7 billion, once in operation, revenues will allow the system to generate a positive net present value in as little as 5-6 years. To develop the concept more fully into an actual blueprint with more precise cost and revenue projections will require a comprehensive feasibility study. Funds from the U.S. Congress are currently being requested by the University of Memphis for partially funding this study.

LAWRENCE GENERATION STUDY

The Lawrence Generation Project proposal is a component of the Trans-America Grid (TAG) Project, a long-term energy master plan to provide greater generation

capacity and a stronger electrical grid in the central and western United States. It is proposed that the Lawrence Generation Project provide electrical power for consumers in Colorado and California. Power would be transmitted by transmission lines proposed by Trans-Elect, Inc and Wyoming Infrastructure Authority, the TOT 3 line to Colorado, and to California by a modified version of the currently proposed Frontier Line or the proposed Northern Lights Line. These new interstate high-voltage electric transmission line proposals grew out of work done as part of the Rocky Mountain Area Transmission Study (RMATS).

The Lawrence Generation Project is located in the Powder River Basin, Johnson County, Wyoming. Property, owned by Lawrence Land Company, contains approximately 7,500 acres with in excess of 500 million tons of coal and a second property contains approximately 11.8 billion tons of coal. The project is expected to generate 2,800 to 3,000 MW of new clean almost zero emission, electrical power by using either a conventional Pulverized Coal Rankin Cycle or by utilizing the newer Integrated Gasification Combined-Cycle (IGCC) technology. Either alternative is expected to capture carbon dioxide (CO₂) and other harmful emissions. The CO₂ will be used for enhanced oil recovery, thus sequestered. CO₂ flooding has been described as the most cost-effective method for extracting the final amounts of recoverable oil from depleted fields. Enhanced oil recovery will significantly increase production of crude oil in older producing fields and significantly prolong productive lives of the fields in which it is applied.

STATEMENT OF E.G. MEYER, LARAMIE, WY

It is important to properly define the categories of "clean coal technologies". For example, gasification and subsequent use of the CO and H₂ either for an IGCC power generation or for an FT reaction to produce liquids is a form of a CCT. Likewise, boiler and burner configurations to lessen emissions are another form of CCT as is treatment of flue gases. Chemical refining of coal to produce char for fuel, chemicals for feed stocks, and CO and H₂ is a separate CCT category. Thus I request that the Committee recognize these and other distinct types of technologies and provide adequate support for them. It is unwise to focus on a single type of CCT before knowing which ones are the best.

STATEMENT OF SCOTT B. SMITH, CEO, WESTERN RESEARCH INSTITUTE, LARAMIE, WY

Mister Chairman and Members of the Committee, thank you for allowing me the opportunity to submit a statement for the record. Chairman Domenici, I'd like to thank the Senate Energy and Natural Resources Committee for conducting this field hearing in the great state of Wyoming. In particular, I wish to offer our appreciation to Senator Craig Thomas for his leadership on the issue of Wyoming's and the Nation's energy future.

As the CEO of Western Research Institute (WRI), it's an honor to highlight some of the key energy-related work Western Research Institute is performing, largely under the auspices of and in coordination with the Department of Energy.

INTRODUCTION TO WRI

WRI is a Laramie, Wyoming-based \$8 million-per-year entity and a multi-disciplinary team of 70+ highly skilled scientists, engineers and other professionals. We conduct research, develop and bring to market significant new technologies, and deliver value to private clients through contract services.

In all we do, whether originating new technologies that attract industrial partners or working with industrial partners to realize the full potential of their concepts, WRI functions in partnership with others. In fact, that is our goal: To be a preferred source that government and industry clients go to when they seek innovative partners and technologies in the energy, environmental and transportation materials sectors.

Our main facilities, located on the University of Wyoming campus, house administrative functions and 38 laboratories. Our 22-acre Advanced Technology Center (ATC), north of Laramie, contains 15 buildings with shops and offices, laboratories, and pilot facilities. The ATC is where most of our energy technologies get legs under them.

Western Research Institute is a 501(c)3 not-for-profit research entity funded primarily by the U.S. Department of Energy and the Federal Highway Administration to support these organizations' mandates for the benefit of the Nation. Western Research Institute enjoys a relationship with the University of Wyoming but receives

no UW dollars and no funding from the state of Wyoming. Our aspiration has always been to be an asset to the University and, more than that, to serve the best interests of the state of Wyoming in the energy, environment and highway materials realms.

In the energy sector, WRI continues its efforts in coal conversion and upgrading, power generation, waste management and utilization, alternative fuels, environmental remediation, renewable energy technologies, and bioprocessing.

My purpose today is to highlight Western Research Institute's considerable work in the field of coal research and technology. WRI is the leading energy research entity located in the number-one coal-producing state in the Nation. I assure you this is not by accident. Nor is it a recent phenomenon: For 23 years, WRI's proximity to the energy resources in the western United States, especially the Powder River Basin, has given us a heightened sense of responsibility and purpose in how we conduct our business and set our direction. We have made the knowledge of virtually every aspect of coal technology and use our domain.

SUPPORT FOR TODAY'S COAL INDUSTRY

From the mine mouth to the rails

WRI has a long history of assisting the coal industry in the area of coal upgrading. The high moisture content and resultant low heating value of western U.S. coals affects both boiler efficiency and transportation costs. WRI is working with Fuels Management Inc. (Miami, Florida) to develop its mine-mouth coal drying and upgrading process. We constructed a pilot-scale facility in our Coal Research Building at the Advanced Technology Center and conducted tests to determine optimum processing conditions. The technology is now ready for scale-up, and a 100-ton-per-day plant is being designed and constructed.

From the utility boiler to the stack

WRI is supporting the utilities on a number of emissions issues. For example, WRI has built a test-scale Combustion Test Facility that mimics a coal-fired utility boiler. This facility is now supporting technology development and verification projects for utilities, for coal technology companies and for combustion and emissions control equipment manufacturers. Here are some examples of projects being conducted:

- Testing of NO_x reduction technologies (with Breen Energy Solutions)
- Testing of Hg capture technologies (with Mobotec USA, Inc.)
- Testing of strategies for multi-pollutant control (with Headwaters, Inc.)

WRI has taken a lead role in policy support for air quality regulations by creating and facilitating the Subbituminous Energy Coalition (SEC), an organization of approximately 50 members representing the major coal companies in the Powder River Basin, utilities burning PRB coal, railroads serving the PRB, and other interested parties. The SEC provides a forum for industry discussions on environmental control issues and provides a collective voice for PRB coal producers and users. The SEC has orchestrated a detailed review of proposed EPA mercury rules to ensure that subbituminous coal remains an environmentally acceptable and competitive fuel source. Members include Arch Coal, Kennecott Energy, Peabody Energy, Basin Electric Power Cooperative, Pacific Power and Xcel Energy.

WRI has developed a patented pre-combustion mercury removal process that first dries the coal, then uses the hot recycle gas to remove the mercury. Unlike post-combustion processes that remove mercury from the flue gas, WRI's patented process removes the mercury from the coal prior to combustion. The process has been shown to remove up to 80 percent of the mercury in Powder River Basin coal (additional mercury is removed during combustion). Not only is this technology competitive with post-combustion processes on a cost basis, it's also easily integrated into a power plant, and the treated coal product increases plant efficiency by 3-4 percent for PRB coal. What's more, the water removed from the coal can be condensed and used at the power plant for cooling and other uses, a considerable benefit in the arid West. A recent economic study sponsored by the Electric Power Research Institute showed the WRI process to be one of the lowest-cost technologies for removing mercury from PRB coal-fired power plants. In February 2006, WRI was notified by the Department of Energy that the project was selected for an award to support commercial scale-up. The DoE funding of approximately \$1 million will be matched by approximately \$460,000 from industry-affiliated co-sponsors Electric Power Research Institute, Southern Company, Basin Electric Power Cooperative, North Dakota Industrial Commission, Montana-Dakota Utilities, Detroit Edison and SaskPower.

As the Nation develops a Cap-and-Trade market for mercury emissions, the importance of accurate measurement from different sources becomes not only an environmental issue but a profit-and-loss issue. At WRI, we are working with the National Institute of Standards (NIST), the Department of Energy and the Electric Power Research Institute (EPRI) to develop calibration standards and a methodology for continuous mercury emissions monitoring. In 2005, WRI commissioned a report from NIST that revealed that different vapor pressure formulas used for calibrating mercury testing equipment disagree by as much as seven percent. In March 2006, WRI spearheaded a meeting in Orlando that attracted stakeholders from around the world to discuss the issue and how to approach it. Last month's meeting launched the effort co-sponsored by WRI, EPRI, the DoE and NIST to establish a NIST protocol and new ASTM standard for calibrating monitors. In attendance were representatives from NIST, the U.S. Environmental Protection Agency, the EPRI, ASTM International (formerly the American Society for Testing and Materials), and mercury analysis equipment manufacturers.

Ash management and mined lands reclamation

The power industry in the United States produces more than 100 million tons of coal combustion products, or ashes. More than 70 million tons of ash is disposed of annually, increasing the costs of electricity and posing a potential liability to the industry. WRI is developing new, large-volume niche uses for ash and provides technical services to the ash management and utility industries. These include ash-based grouts for the control of underground mine subsidence and flowable fill materials for use in construction applications as backfills, structural fills and trench bedding. The market for construction-grade aggregate in the United States offers a significant opportunity for the use of coal ashes. WRI has developed the SYNAGTM process, which uses coal combustion ashes to produce lightweight and standard-weight synthetic aggregate for use in construction. Partners in the development of ash technologies have included Xcel Energy, Montana-Dakota Utilities and the North Dakota Industrial Commission.

WRI is supporting the coal industry in mine reclamation through the development of a novel biobased source treatment of acid mine drainage (AMD). Although the high-sulfur coals of the East make this problem more widespread in the eastern half of the country, acid mine drainage is associated with hard rock mining and coal mining throughout the United States. Other processes treat the drainage by neutralizing it. WRI has partnered with Kennecott Energy to demonstrate the effectiveness of the bio-based source treatment process at a mine in Tennessee. The results to date have confirmed that the process effectively controls acid mine drainage by controlling the source of the acid within the mine. Additional demonstrations are being planned with other coal companies at other mines.

Coal bed methane

Since the first commercial coal bed gas well was established in the Powder River Basin in 1986, coal bed methane (CBM) production has grown explosively and now constitutes a major resource within the energy mix for Wyoming, the region and the Nation. More than 40,000 wells are expected to be drilled in the next decade alone. The management of the produced water, however, remains a significant consideration. When an operator drills a CBM well, large volumes of water are withdrawn in order to free the methane to be extracted. In some areas of Wyoming and Montana, the water quality is such that it cannot be used for agriculture, livestock or discharge into surface streams without causing degradation of the water. WRI is working with developers and others to demonstrate treatment methods that will allow the beneficial use of the produced waters. For example, WRI is working with CBM Associates to demonstrate an application that allows the water to be used for irrigation purposes. WRI is also exploring the use of CBM produced water in power plants to reduce the draw of fresh water for cooling and other plant purposes.

ENERGY FOR THE 21ST CENTURY

Coal

WRI is working to develop enabling technologies for zero-emissions coal-based power plants of the future. With "oxycombustion," fuel is combusted in pure oxygen and flue gas is recycled back into the furnace to maintain optimum burning conditions. Because oxycombustion excludes nitrogen, the byproduct is nearly pure carbon dioxide, a waste that can be effectively managed. The cost of oxygen, however, is a major issue in the development of sequestration-ready power systems of the future. Working with a specialty gas manufacturer, BOC Process Gas Solutions (Murray Hill, New Jersey), WRI is developing a novel technology for the lower-cost production of oxygen that takes advantage of the oxygen "storage" properties of the

mineral perovskite. The cost of producing oxygen using the BOC Catalytic Autothermal Reformer (CAR) technology is estimated to be 20 to 30 percent lower than the cost of cryogenic air separation.

WRI is developing new catalysts and related synthesis technologies to produce transportation fuels. One such technology converts any carbonaceous feedstock into a mixture of alcohols. Imagine a power plant using Wyoming coal as the feed. With the WRI process, the plant would not only produce electricity but also an alcohol mixture ready for blending with gasoline. This mixture of alcohols could replace MTBE, could supplement the Nation's ethanol supply, and could serve as a chemical feedstock. Used in conjunction with coal gasification, this synthesis technology is a coal-to-liquids technology. As a biogas-based system, the technology provides a means of capturing and converting greenhouse gasses into a useful product.

A hydrogen project now underway at Western Research Institute and the University of Wyoming is expected to yield a cheaper and easier way to produce pure hydrogen from gasified coal and other mixed gases. The new process advances the water—gas shift process whereby coal is reacted with steam (water) and oxygen to produce a synthesis gas. Under a U.S. Department of Energy grant, WRI and the University of Wyoming are developing a device that combines water—gas shift technology with improved hydrogen separation to maximize the total hydrogen produced. The University of Wyoming is leading the development of a ceramic catalyst, while WRI will test a variety of vanadium alloy foil membranes for durability and optimum effectiveness at lower temperatures. Finally, the ceramic catalyst and the vanadium membrane will be integrated into a single stackable device that can operate at lower temperatures.

Other significant WRI energy technologies

WRITE, WRI's Thermal Enhancement technology, is being developed and tested for upgrading heavy oils, specifically to upgrade the thick, carbon-rich bitumen produced from oil sands such as those found in Canada and Venezuela. An estimated 1.7 to 2.5 trillion barrels of oil lies within the oil sands of Alberta, making it the world's largest known oil reserve. The bitumen produced from oil sands, however, must be either diluted or upgraded to meet the specifications for transport by pipeline to refineries. The WRITE Process is a field upgrading technology, which is fueled by internally generated coke and which uses a distillation step to produce a pipeline-ready material. WRI's partner in the technology development is MEG Energy of Alberta.

The U.S. Department of Energy has traditionally promoted large-scale gasifier technology development while U.S. Department of Agriculture research has concentrated on fermentation methods such as those used to produce ethanol. Most agricultural feedstocks, however, are not suited to the production of biofuels by fermentation, and most biofuel development efforts don't address the needs of farmers. With both the DoE and the USDA as partners, WRI is pioneering a farm-scale gasification system that can address agricultural waste disposal and at the same time make every farmer an energy producer. For example, the grass seed producers of the Pacific Northwest currently have a 6.2 million ton waste grass disposal problem. Assuming they produce one or two tons of waste straw per acre and the new process produces 60 gallons of liquid fuel per ton at \$1 per gallon, they could be adding 372 million gallons of liquid fuel worth \$372 million into the Nation's net fuel production. Similarly, the farmers could use the same process to produce \$87 million worth of electricity.

GUIDING PRINCIPLES AND CONCLUSION

WRI believes with the U.S. Department of Energy that domestic coal, oil and alternative resources can contribute substantially to our Nation's economic strength, energy security and quality of life through the 21st century.

The Cooperative Research Program under which WRI performs most of its energy-related work was established to stimulate research in support of the mission of the Department of Energy Office of Fossil Energy. Western Research Institute supports this mission by developing technologies that promote the development of secure and reliable domestic energy supplies, clean power generation, and the production of hydrogen from domestic coal and natural gas. As a public/private research initiative, the program leverages DoE funding, ensuring that the demand for energy innovations is validated by private funding.

Western Research Institute is grateful for the vision of this Committee and we are deeply appreciative of the support you give to the annual appropriation that funds the Department of Energy's Cooperative Research and Development Program. This is the Program that enables WRI to perform our work for the benefit of Wyoming and the Nation. The Program has been very successful in recent years because

it helps establish a solid partnership with end users, thereby ensuring that our limited R&D dollars are at work in areas that foster energy independence and that industry and the American public find relevant and commercially worthwhile.

This testimony is respectfully submitted on behalf of the Western Research Institute team shown below.

