## SUMMARY OF TESTIMONY OF MARK MCCULLOUGH
## ON BEHALF OF AMERICAN ELECTRIC POWER

AEP has long been an industry leader in technology development and fuel diversity planning. Our leadership and innovation in core generation, transmission, and distribution services have led to dramatic improvements in the efficient and clean production and delivery of our product. This innovation has helped insulate our customers from fluctuations in the cost of electricity, reduced overall costs, and diversified the ways we provide service to our customers. Technology solutions have also enabled us to use domestic and abundant coal more efficiently, minimizing customer exposure to volatile fuel markets. Some recent AEP technology initiatives include the 2009 startup of the world's first CCS demonstration at a coal power plant and the December 2012 commissioning of the ultra-supercritical John W. Turk Power Plant, one of the world's most efficient coal power plants. Both initiatives underscore AEP's industry leadership and prove the value of technology innovation.

Energy diversity plays an important role in reducing the potential exposure of our company and customers to major fluctuations in markets, costs, regulations, and electric demand by allowing for the use of the lowest cost resources possible while enabling rapid response to changes in demand that occur throughout the day. However, policies that could prevent the construction of new baseload generating units or force the retirement of existing coal-fired capacity could cause significant shifts to this balanced energy mix; reduce capacity diversity; and hinder our ability to provide reliable and affordable electricity to our communities and customers. For example, the proposed $CO_2$ NSPS for new sources effectively prohibits the construction of any new coal-fired power plant because of the lack of a commercially available $CO_2$ control technology. Due to these regulations, as well as numerous other challenges facing nuclear energy, our nation's electric grid will become increasing reliant on natural gas for new generation capacity, likely eliminating both diversity and flexibility in new power plant builds. Federal policy should support fuel diversity, not preclude it.

The importance of fuel diversity cannot be overstated given its implications for assuring economic and energy security. Too great a reliance upon any one energy source (particularly those with a history of price volatility) creates a significant risk of exposure to electricity price spikes and supply disruptions. This can lead to severe impacts on the supply stability and price of electricity for residential, commercial, and industrial customers. Consider the Tsunami catastrophe in Japan, where a natural disaster resulted in all 54 nuclear reactors being abruptly removed from service. Nearly two years later only two units are back in service. Hurricane Katrina in 2005 disabled nine oil refineries and rendered 30 oil platforms damaged or destroyed. Coal and nuclear plants buffer against fuel supply disruptions because they can inventory months of fuel on site, a fundamental value to any energy security solution with national security benefits.

Over the past twelve years AEP has added more than 5,000MW of natural gas fuel diversity, which has enabled our company to switch between fuel sources based on price fluctuations of fuels over time. This diversity has served our customers and communities well and has allowed us to keep our electricity rates low. For example, AEP responded to the spikes in natural gas pricing during the mid-2000's by increasing its use of cheaper coal to serve our customers, while at the same time decreasing emissions. Similarly, recently depressed natural gas pricing have allowed us to keep our electricity prices low by using additional natural gas where more cost effective than coal. However, AEP is concerned that a prolonged "dash" to gas will lead to over reliance on one fuel and have adverse consequences for the balance and diversity of the power sector and the economy.

With the current low cost of natural gas, now is the ideal time to look to the future and adjust the focus of technology development to truly innovative, revolutionary paradigms for energy conversion and use. We support commercialization of Small Modular Reactor (SMR) technology for the next generation of nuclear power. For fossil fuels, the United States must invest in technologies that show promise of meaningfully moving the needle regarding cost, fuel efficiency, and environmental performance. With success, chemical looping and other new revolutionary technologies will enable our next generation of power plants to use coal with extremely high efficiency and ultra-low emissions, while producing a pure stream of CO2 with no added energy penalty. Not only will these new paradigms revolutionize the power generation industry, they can open the vast, yet untapped, oil reserves in this country to Enhanced Oil Recovery (EOR) production by making enormous quantities of low-cost CO2 available for EOR purposes. These technology innovations are essential to a diverse energy future, but they require attention now and focused funding to enable industry to overcome the high cost of commercialization. Encouragingly, as stated in the CURC-EPRI Technology Roadmap, the necessary funding to develop and commercialize these concepts is not beyond the levels invested in recent years with DOE's Fossil Energy clean coal programs; this funding just needs to be focused on the proper technologies.

**WRITTEN TESTIMONY OF MARK MCCULLOUGH**

**EXECUTIVE VICE PRESIDENT**

**AMERICAN ELECTRIC POWER**

**BEFORE THE U.S. HOUSE OF REPRESENTATIVES**

**ENERGY AND COMMERCE COMMITTEE**

**SUBCOMMITTEE ON ENERGY AND POWER**

**March 5, 2013**

Chairman Whitfield, Ranking Member Rush, and distinguished members of the Subcommittee on Energy and Power, thank you for inviting me here today. I appreciate this opportunity to offer the views of American Electric Power (AEP) on fuel diversity and the role of technology in supplying clean and affordable electricity. My name is Mark McCullough, and I am the Executive Vice President of Generation at AEP. Headquartered in Columbus, Ohio, AEP is one of the nation's largest generators – with more than 37,000 megawatts (MW) of generating capacity – and serves more than five million retail consumers in 11 states in the Midwest and South Central regions of our nation. AEP's generating fleet employs diverse fuel sources – including coal, nuclear, hydroelectric, natural gas, oil, and wind power**.** Due to the location of our service area and the historic importance of coal to the economies of our states, approximately two-thirds of our generating capacity uses coal to generate electricity.

## AEP TECHNOLOGAL DEVELOPMENT AND DIVERSITY PLANNING

AEP has a long history of proactive involvement in technology development and fuel diversity planning. This practice is ingrained in our culture as we remain committed to providing our customers with low cost and reliable electric service and minimizing their exposure to cost increases due to fuel cost fluctuations or regulatory changes.

AEP's leadership and innovation in our core generation, transmission and distribution services have led to improvements in efficient and clean production and delivery of our product. We accomplished these improvements through continual advances in generation technology efficiency, improved environmental performance, reduced transmission line losses, implementation of energy audits, support of improvements in the efficiency of end-use appliances and fixtures, and improved delivery of real-time pricing and usage information for the electric grid. This innovation has helped insulate our customers from fluctuations in the cost of electricity, reduced overall costs and diversified the ways we provide service to our customers.

For over a century, AEP has been a pioneer in the development of advanced coal-fueled generation technologies, which include many first-in-the-world accomplishments that have set the standard for combustion efficiencies, emissions control, and system performance. A few examples include the first reheat generating coal unit (1924); the first heat rate (a measure of efficiency) below 10,000 Btu/kWh at a coal plant (1950); the first natural-draft, hyperbolic cooling tower in the Western Hemisphere (1963); and the first operation of a pressurized, fluidized bed combustion plant in the United States (1990). The technologies have enabled us to use domestic and abundant coal more efficiently and thus minimize customer exposure to volatile fuel markets.

While the AEP generation portfolio has shifted over the last decade to include more natural gas-fired and renewable generation, we also, last year, completed construction of the country's first ultra-supercritical coal-fired generating unit, the John W. Turk, Jr. Power Plant in Hempstead County, Arkansas. The Turk Plant has one of the highest thermal efficiencies of any coal plant in the world. This unit was designed to provide low-cost baseload power to complement new gas generating resources that were constructed in recent years, thus maintaining a diverse generating resource mix.

The Turk Plant represents a new generation of power plant design using a higher temperature and pressure steam cycle that results in the use of less fuel to produce each megawatt hour of electricity. This means that all emissions, including sulfur dioxide ($SO_2$), nitrogen oxides (NOx), mercury, and carbon dioxide ($CO_2$), are lower than conventional coal-combustion processes per unit of electricity produced. The Turk Plant was placed in commercial service on December 20, 2012.

To ensure our current investments in coal-fired generation can be retained in the future to maintain diversity, we have also invested heavily in the advancement of carbon capture and storage technology. The Mountaineer CCS Project treated a 20-MW portion of flue gas from our 1300-MW Mountaineer Plant, removed the carbon dioxide ($CO_2$), and compressed and injected the $CO_2$ into two deep underground formations more than 7,000 feet below the surface of the plant property. The project successfully operated from 2009 to 2011, and permanently stored nearly 40,000 tons of $CO_2$ in deep saline reservoirs, with continuing post-closure monitoring. A second phase of that project, which would have advanced the technology to a 235-MW commercial scale, was deferred due to the failure to raise funding.

AEP also has pursued the development of Integrated Gasification Combined Cycle (IGCC) technology. IGCC represents a major breakthrough in efforts to improve the environmental performance of coal-based electric power generation. IGCC technology integrates two proven processes - coal gasification and combined cycle power generation - to convert coal into electricity more efficiently and cleanly than any existing uncontrolled power plant. IGCC also has the potential to be equipped with carbon capture technology at a lower capital cost and with less of an energy penalty than traditional power plant designs, but only after the carbon capture technology has been proven at a commercial scale. We recognize others in our industry who have continued the pursuit of this technology and support their efforts.

**THE ROLE OF DIVERSITY**

Diversity plays an important role in reducing the potential exposure of our company and customers to fluctuations in markets, costs, regulations, and electric demand. Diversity within the electric power sector can refer to a variety of practices that reduce these exposures. Perhaps the most important measure of diversity for the electric power sector is the practice of fuel diversity.

The U.S. has an abundance of energy resources that can be used to generate electricity, including coal, natural gas, uranium, wind, solar, water, biomass and geothermal. These fuel sources each have a unique cost profile based on both supply and demand of the fuel as well as the unique generating technology required to turn chemical, solar or kinetic energy into useful electrical energy. However, each fuel type and technology present different risk characteristics in terms of availability, reliability, cost, and performance. As such, fuel diversity among these energy resources will lower the overall risk of the generation portfolio and provide for a more reliable and cost effective electric supply.

Generating technologies are specific to the fuel or energy resource used to produce electricity to our electric grid. Developing capacity diversity within our generating system is important because it allows for the use of the lowest cost resources when possible while enabling rapid response to changes in demand that occur throughout the day. Capacity diversity is achieved by constructing baseload, intermediate and peaking facilities in addition to intermittent facilities (e.g. wind and solar), which may or may not be available to generate electricity at any given time. When properly deployed, each type of resource can synergistically operate during the various fluctuations in supply and demand to reliably support customer needs and requirements. Generally speaking, baseload facilities (coal, nuclear, hydro, and more recently gas) are designed to run around the clock with low fuel costs and provide the bulk of electricity to the grid. Intermediate and peaking facilities are designed to run primarily during periods of higher electric demand. However, policies that could prevent the construction of new baseload facilities or force their retirement could cause significant shifts to this mix; reduce capacity diversity; and increase risk of availability, reliability, and cost of electricity.

**IMPORTANCE OF FUEL DIVERSITY**

The importance of fuel diversity cannot be overstated given its implications for assuring economic and energy security. Too great a reliance upon any one energy source (particularly those with a history of price volatility) creates a significant risk exposure to electricity price escalation and supply disruptions. As has been proven repeatedly across the globe, such exposure can lead to severe impacts on the supply and price of electricity for residential, commercial, and industrial customers.

For example, the recent catastrophe in Japan serves as a sobering reminder of what can happen if a single energy source is abruptly removed from use. In 2011, an earthquake and tsunami devastated shoreline communities and seriously damaged the Fukushima Daiichi nuclear power plant. Resultant radiation leaks and a greatly eroded public faith in safety of nuclear power lead to the shutting down of all of Japan's 54 nuclear reactors for mandatory maintenance and safety checks. To date, only two units are back in service. Heavily populated areas of the country have faced the realities of rolling blackouts, while manufacturing facilities are reducing output, with some making moves to relocate abroad. Meanwhile, natural gas prices in Japan nearly tripled as power producers scrambled to fill the massive void left in their energy infrastructure.

Domestic energy disruptions and their consequences are clearly evident by such disasters as Hurricane Katrina in 2005, where nine oil refineries were shut down for an extended period of time and 30 oil platforms were either damaged or completely destroyed, dramatically hampering oil and gas production. United States natural gas prices spiked following the disaster and for months afterward remained more than double the price over the previous year.

There is another unique feature to coal that must be considered from an energy security perspective. Coal is a solid and physically stable energy resource that can be safely stockpiled at the power plant site. A typical power plant takes advantage of this feature by keeping an inventory of 30 to 60 days of supply of coal at the plant site. This is an incredibly valuable characteristic when considering the risks associated with supply interruptions of other fuels, such as natural gas. If storms, natural disasters, or other forces interrupt major gas pipeline infrastructure, gas-fired power plants immediately cease to produce electricity and cannot resume production until infrastructure repairs are made. Coal plants, on the other hand, can continue to operate if the major fuel supply is compromised. Similarly, nuclear power enjoys the benefit of large reserves of fuel capacity on the plant site. This is a factor of fundamental value to any energy security solution and has national security benefits as well – particularly given the abundant reserves of coal in the United States.

**HOW AEP HAS DIVERSIFIED ITS FUEL MIX**

AEP has a long history of using a variety of fuels within its generation mix and has increasingly has sought to diversify its resources. Much of AEP's eastern service territory, due to its proximity to Appalachian coal, has typically been served by coal-fired generation. These large coal reserves have served AEP's customers well, resulting in some of the lowest costs for electricity in the country and fueling industrial and economic expansion. However, the advent of nuclear power allowed AEP to begin to diversify away from coal in the 1970's and further diversification occurred in the 2000's with natural gas combined cycle generating facilities being added to the system, in addition to purchases of wind power, due in large part to government tax incentives. Over the past twelve years AEP has added more than 5,000MW of natural gas fuel diversity, which has enabled our company to switch between fuel sources based on price fluctuations of fuels over time.

In AEP's Western service territory, diversification occurred in an opposite manner. Due to local natural gas and oil production in the region, these fuels represented AEP's dominant generation sources up through the 1970's. However concerns over dwindling oil and gas supplies and discovery of enormous coal reserves in the Powder River Basin of Wyoming lead to coal-fired facilities being developed in Texas and Oklahoma in the late 1970's and early 1980's. This diversification has continued in recent years through both the addition of new and highly efficient natural gas combined cycle and natural gas simple cycle generation as well as our state-of-the-art Turk Plant.

As a result of this fuel diversity, AEP has been able to switch between fuel sources based on price fluctuations of fuels over time. This diversity has served us well and has allowed us to keep our electricity rates low. For example, AEP responded to the spikes in natural gas pricing during the mid-2000's allowed by increasing its use of cheaper coal to serve our customers. Similarly, recently depressed natural gas pricing have allowed us to keep our electricity prices low by using additional natural gas where more cost effective than coal. As a result, AEP's natural gas consumption has increased by 130 percent since 2009.

While we value natural gas as a critical component of our generation energy mix, AEP is concerned that the United States has reached an important crossroads in terms of fuel diversity planning. EPA's regulations have led to the premature shut down of some of our existing coal fired facilities, while not allowing the construction of new coal-fired facilities, as discussed later. This effectively precludes further use of a low-cost, abundant and domestic resource, coal, within the U.S. generating mix and will force AEP and others to increasingly rely on natural gas for generating electricity – which has a long history of price volatility.

AEP is concerned that a prolonged "dash" to gas will lead to over reliance on one fuel and have adverse consequences for the balance and diversity of the power sector and the economy. For example, the increased use of natural gas to generate electricity puts stress on a natural gas supply system designed to meeting peak winter heating needs by requiring increasingly larger supply and flow rate to power plants, which currently represent a minority share of U.S. natural gas demand. As an example, ISO New England just told the Federal Energy Regulatory Commission on February 7 that it was concerned about "increasing reliance on natural gas-fueled generators at times when there is an increasingly tight availability of pipeline capacity to deliver natural gas from the south and west to New England." This increased reliance has contributed to rapid price spikes in the cost of natural gas in that area, which translates into much higher wholesale electric prices.

There are additional concerns surrounding the synchronization of electricity and natural gas markets as supplies of power and natural gas are secured on a different time basis. This disconnect may prevent facilities committed to provide electric power from securing the gas supplies they need to operate. This picture is further complicated by the interdependent nature of the natural gas supply and electric generation industries. As more of the power generation comes from gas, the impact of simultaneous peak electricity demand and peak consumer heating demands converge, creating a scenario where gas deliverability capability can become a bottleneck. This is particularly true in the winter when shorter days and colder temperatures increase demands for heating and lighting. While adequate supply of gas may exist, delivering at the rate needed during peaks could be constrained. Additional coordination between these two industries is needed, in addition to fuel diversity, which will reduce this interdependent risk. We are engaged in developing solutions with all of our stakeholders.

The dash to gas and the potential problems created in its wake has come at the same time that other countries around the world are increasingly turning to coal to fuel their economies. China is currently far and away the largest consumer of coal, and in fact is consuming almost as much coal as the rest of the world combined.[1] Additionally, Europe is increasingly returning to coal to fuel its electric sector, with much of the imported coal coming from the United States.[2] Consequently, any policy, direct or indirect, to restrict coal use within the U.S. is unlikely to have a significant impact on reducing global coal consumption. The more significant impacts will be felt however by the U.S. economy, particularly in regions of the country which rely on coal production for economic stability and low-cost electric generation.

**REGULATORY BARRIERS TO FUEL DIVERSITY**

There are numerous barriers to fuel diversity within the electric generation fleet; however our most pressing concerns are the new federal environmental regulations and the lack of an energy policy promoting diversity and therefore energy security. As an example, the proposed $CO_2$ NSPS for new sources effectively prohibits the construction of new coal-fired facilities for the reasons discussed in the next section. These proposed $CO_2$ performance standards come in the wake of other new environmental regulations, most notably the Mercury and Air Toxics Standards. Due to these new EPA rules and other factors, electric utilities have already publicly announced their plans to shut down 335 coal-fired generating units, totaling about 47,000 MW. Additional coal plant shutdowns are expected as companies finalize their air toxics compliance plans.[3] Once these additional plant retirements are combined with already announced retirements, it is likely that over 20 percent of the U.S. coal fleet will be shut down within the next few years.

[1] *See* http://www.eia.gov/todayinenergy/detail.cfm?id=9751 .
[2] *See* http://www.economist.com/news/briefing/21569039-europes-energy-policy-delivers-worst-all-possible-worlds-unwelcome-renaissance.
[3] *See* ACCCE paper, entitled "Coal Unit Shutdowns" (February 14, 2013).

Due to these regulations, our nation's electric grid will become increasing reliant on natural gas for new generation capacity, likely eliminating both diversity and flexibility in new power plant builds. Federal policy should support fuel diversity, not preclude it.

**EPA REGULATION OF GHGs IS THREATENING DIVERSITY**

Notwithstanding our lengthy history of environmental conservation and support for federal GHG reduction efforts, AEP has long maintained that the Clean Air Act (CAA or Act) is not a practical or cost-effective way to limit GHG emissions and any system to regulate GHG emissions should be developed by Congress. To this end, we have supported over the past decade ambitious federal legislation to reduce GHG emissions on an economy-wide basis through flexible market-based mechanisms. Although not enacted into law, these bills would have established a declining economy-wide cap on GHG emissions and achieved substantial GHG emissions reductions in an efficient and cost-effective manner through an emissions trading system.

In the absence of federal legislation to reduce GHG emissions, and in response to the 2007 Supreme Court decision of *Massachusetts v. EPA*, the EPA has begun to regulate GHG emissions using its existing CAA authorities. The EPA has already established a rule requiring new and modified major stationary sources to obtain pre-construction permits and install "best available control technologies" for their GHG emissions under the New Source Review (NSR) provisions of the Act.[4] In April 2012, EPA proposed a New Source Performance Standard (NSPS) for $CO_2$ emissions from new electric generating units (EGUs) under Section 111(b) of the CAA.

Both of these existing regulatory programs are based on a framework that was never intended to apply to GHG emissions from stationary sources. Both programs impose source-specific emissions control requirements that lack the kind of flexibility that would encourage widespread, cost-effective implementation

[4] The NSR permit requirements include a rigorous technology review requirement to ensure the installation of state-of-the-art air pollution control equipment and extensive public notice and comment procedures.

of a broad suite of emission reduction techniques and technologies. When the CAA was enacted into law over 40 years ago, its primary focus was on reducing emissions of certain air pollutants with recognized, localized health effects. A major part of the Act established national ambient air quality standards for criteria pollutants such as $NO_x$, ozone, $SO_2$, PM, and lead. These ambient air quality standards were implemented through facility-by-facility emission limits that ensured that health-based standards were met on a local basis in each state. In 1990, Congress added specific provisions to address new science that suggested that $SO_2$ and $NO_x$ emissions also presented other broader regional or interstate concerns that could not be adequately or cost-effectively addressed without giving regulators new tools under the existing CAA. Congress provided those tools, first with the $SO_2$ cap-and-trade program for remedying acid rain across broad geographic regions and second with new authority to remedy interstate transport of air pollution that significantly contributes to nonattainment.

However, concerns regarding the relationship of global climate change and GHG emissions present a totally different set of issues (*e.g.*, both national and global emissions and ultimately global GHG concentrations are relevant) that the existing framework of the CAA was never intended to address. As such, regulation of GHGs under the existing CAA authorities is likely to be ill-designed, inflexible, and significantly more costly than a more flexible approach, while doing little to address the global issue of climate change. In short, this approach is very expensive and provides little impact on global GHGs. Therefore, if this nation wants to move forward with effective GHG regulatory programs, congressional action is necessary to provide the tools required to ensure flexible, cost-effective regulation of GHG emissions on an economy-wide basis.

AEP does not support EPA's proposed $CO_2$ NSPS for EGUs and has submitted extensive comments to the Agency about its concerns with the EPA proposal. EPA itself acknowledges that its proposal will not alter current plans for new generating facilities by noting that the proposal merely reinforces what the market currently encourages and what EPA assumes will continue in the future – that in an era of record-setting low natural gas prices and abundant shale gas reserves, the logical fuel of choice is natural gas. But the proposal treats **current** market conditions as if they are reliable constants **in the future**. History tells us a very different story; that fuel diversity is a critical component of stable energy costs, and that relying on a single fuel creates significant vulnerability to major fluctuations in market prices.

Furthermore, we believe that EPA's proposed rule is unlawful, is based on faulty information, and would hinder the very efforts to develop clean coal technology that Congress, EPA, and AEP have worked so long and so hard to further. AEP is particularly concerned that the proposed rule will likely impede the development of CCS technology and hinder the progress that will be needed for coal to continue to play a vital role in America's energy policy. A summary of the current state of CCS technology is included later in this testimony, which supports EPA's own conclusion that CCS is neither commercially demonstrated nor economically viable for coal-fueled EGUs. Notably, this is the same conclusion that numerous other public and private efforts have reached, including President Obama's Interagency Task Force on CCS, the Secretary of Energy's National Coal Council, and the Department of Energy's research and development programs.

**THE PROPOSED NSPS HAS CONSIDERABLE FLAWS**

The specifics of EPA's recently proposed NSPS standards for new EGUs further support our concerns that the CAA is not the proper vehicle to address GHG emissions. The proposed regulations do not represent a balanced or cost-effective solution. For example, EPA has taken the extraordinary step of combining two separate well-established NSPS source categories that set different standards for different fuels for all other types of emissions, and proposed a single NSPS limit for $CO_2$ emissions that applies to **all** new fossil-fueled EGUs from those two categories.[5] The proposal requires that both new coal-fueled and natural gas-fueled EGUs meet a $CO_2$ emissions limit of 1,000 pounds per megawatt-hour (lb/MWh). AEP believes that the proposed regulations are inconsistent with the CAA because they fail to establish standards that can be achieved regardless of the fuel used (a so-called "fuel neutral" standard). Instead, for the first time, EPA has proposed to set one, **uniform**, performance standard for **all** sources within the combined EGU

[5] The proposed rule combines the NSPS source categories of Subpart Da (for fossil-fuel fired electric steam generating units) and Subpart KKKK (for stationary combustion turbines) into a common source category for GHG emissions (Subpart TTTT).

source category that is potentially achievable only by units burning fuels with the lowest inherent emissions (*i.e.*, natural gas).[6]

Under the proposed regulations**, all** new baseload and intermediate demand fossil-fueled EGUs would have to achieve an emission rate equivalent to EPA's estimate of the emission rate achievable at a new natural gas combined cycle unit. However, due to different fuel characteristics, plant designs, and operational considerations between coal and natural gas power plants, a coal-fueled power plant cannot meet a $CO_2$ emission rate equivalent to natural gas without some form of technology capable of reducing $CO_2$ from the power plant emissions. This proposed regulation is instead fuel discriminatory in that it prevents the construction of **any** new coal-fueled units without a defined, plausible plan for CCS implementation. CCS is not currently commercially available or economically viable at this time, as described later.

EPA supports its fuel discriminatory standard by stating that the rule would not impose any additional costs on the economy because under current economic conditions, no new coal-fueled units will be built. While AEP agrees that **current** market conditions generally do not support development of new coal-fueled units, this result is driven primarily by current low prices of a very volatile commodity, natural gas. Natural gas prices have fluctuated over the past decade between $2 and $13 per MMBtu on a monthly average basis. Average prices over most of the last decade have been above $6 per MMBtu. Most 10-year projections show gas prices in the range of $4 to $6 per MMBtu. By contrast, most coal prices in the US are less than $3 per MMBtu. In light of the significant historical fluctuation of natural gas prices, it is reasonable to plan for some continued variation in natural gas prices over the long-term even though shale gas reserves appear to be plentiful at this time. If, for example, natural gas prices were to increase modestly to levels seen only a few years ago, electric generating companies could opt to build new coal units based on economics,

[6] In past NSPS rulemakings for power plants, EPA has used one of the following two methodologies. The first is to set different performance standards based on lowest emission rate achievable through application of "best demonstrated technology" for each specific type of fuel burned (*i.e.*, coal, oil, natural gas). The second is to set a single performance standard for all fuels based on the emissions control levels achievable through application of the "best demonstrated technology" at *all* power plants, regardless of the fuels used. Under the latter approach, EPA has set the single performance standard based on the lowest emissions rate achievable by EGUs using coal. However, as noted above, EPA has never adopted a single NSPS for all fossil-fueled power plants based on an emissions rate achievable only by the fuel with the lowest inherent emissions (*i.e.*, natural gas).

absent the proposed $CO_2$ NSPS requirements. However, with EPA's proposal to adopt a $CO_2$ emissions standard based on the performance of natural gas combined cycle units, electric generating companies are unable to build coal-fueled units without assuming unreasonable risks, and therefore generally have no choice but to build gas units instead.

AEP believes that it is not prudent for EPA, or any other agency, to adopt federal policies that foreclose the use of coal in the future development of baseload generation. Locking exclusively into new natural gas baseload generation over the long term could increase an over reliance on natural gas for power generation to the detriment of the economy. Rather, maintaining fuel diversity through a balanced portfolio of energy resources that includes coal has been a successful strategy in providing abundant, reliable, low-cost electricity to power the nation's economic growth and high standard of living. The continued reliance on a diverse portfolio of fuels is clearly the wisest course of action to safeguard against the risk of market price fluctuations of natural gas or any of our energy resources over the long-term.

By contrast, foreclosing the option to use of coal over the long-term could burden U.S. consumers with additional and unnecessary costs as U.S. energy providers replace retiring older generation sources and try to keep up with rising demand over the coming years. Further, as EGUs begin to rely more heavily on a single fuel source for electric generation, we run the risk that the energy prices will become increasingly volatile over the long term, with implications for the entire economy.

Nuclear energy also faces daunting challenges. According to an MIT study "The Future of Nuclear Power", nuclear energy faces four unresolved problems: high relative cost; perceived adverse safety, environmental, and health effects; potential security risks stemming from proliferation; and unresolved challenges in long-term management of nuclear wastes. From a new plant construction perspective, risks associated with cost escalation, scheduling, and sheer project size suggest that very few new nuclear plants will be built. Compounding this with the fact that existing nuclear power plants are facing expiration of their operating licenses over the coming years or decades, there is a real threat that nuclear energy will not be a viable participant in a long term diverse energy portfolio.

**AEP'S WORK TO ENSURE DIVERSITY**

AEP believes that technological solutions are critical to reducing emissions as well as improving the reliability, efficiency, and availability of electricity production. More than a century of technology innovation qualifies AEP as an industry leader and expert in these topics. Nonetheless, as a consequence of our first-hand experience and intimate understanding of CCS technologies, AEP is convinced that CCS is many years from providing a commercially viable solution to capturing and permanently storing $CO_2$ emissions due to the numerous technical, financial, legal, and regulatory challenges that must first be addressed. However, these solutions will need to be developed to ensure fuel diversity can be maintained with the possibility of a carbon-constrained world.

Additionally, there are a number of other new and innovative technologies that convert coal to electric power and other products while producing a pure stream of $CO_2$, not requiring the added processes to capture and purify $CO_2$ emissions. While still in the developmental phase, these emerging technologies are showing tremendous promise at the laboratory and pilot-plant level. In many cases, these new technologies, such as chemical looping applications, are revolutionary as opposed to evolutionary in nature and could usher in a new generation of technology solutions that are lower in cost, perform at higher energy efficiencies, and provide more flexibility in fuel selection.

With respect to CCS, AEP partnered in 2007 with Alstom to design, build, and operate the world's first integrated CCS project on a coal-based electricity generating plant. The validation project began operation on September 1, 2009 and continued through May 31, 2011. Over that time period, the installed chilled ammonia process captured more than 50,000 metric tons of $CO_2$ and injected nearly 40,000 metric tons of that $CO_2$ into deep saline reservoirs beneath the plant site. Because the system was built as a validation platform, with all the flexibilities necessary for systematic process adjustments, the operators were able to fine-tune and control all process streams and energy inputs to thoroughly evaluate the technology. Once completed, the AEP/Alstom team possessed a comprehensive understanding of the integrated CCS processes and specifics about the operation of each system within the process. This in-depth knowledge includes a detailed understanding of key process parameters such as energy penalty, reagent loss, $CO_2$ capture rate, and all aspects of geologic $CO_2$ sequestration. The success of the validation project positioned the team to receive a grant from the U.S. Department of Energy to move forward with an engineering study and preliminary design of a commercial-scale CCS project at the same facility.

The lessons learned from these efforts uniquely position AEP to comment on the current status and future prospects of CCS technology deployment, including operational performance and cost specifics, as well as the significant remaining developmental challenges that must be addressed before CCS can be considered commercially available.

"Commercially available" technologies are those that can be purchased from a vendor, have been proven at commercial scale on a representative application, and are offered with robust guarantees on performance and reliability. Vendors cannot provide meaningful guarantees without extensive testing at representative scale. Based on this point of reference, no commercially available technologies for the capture of $CO_2$ from coal-based power plants exist today. The Department of Energy's Major CCS Demonstration program currently includes twelve projects that propose to demonstrate $CO_2$ capture along with some form of storage and/or utilization of the captured $CO_2$. If this were a list of twelve successfully completed projects, then it could certainly be argued that the technologies are ready for commercial deployment. However, not one of the projects has been completed, and in fact, none have even commenced operation. Most are no more developed than the work on paper required for conception of the project. Moreover, some that had previously been included on DOE's list have been cancelled or delayed indefinitely. From a global perspective, the United States leads all others in work completed and proposed for future CCS projects. But today, the technologies to capture and sequester $CO_2$ are not commercially available, domestically or otherwise.

While several promising $CO_2$ capture technologies are under development, none are ready for commercial deployment. They must be advanced in a systematic and step-wise manner to ensure their technological and economic feasibility. AEP had begun the process of moving the CCS technology to commercial scale with the Mountaineer CCS Demonstration Project, but the lack of an adequate funding mechanism resulted in the company placing the project on hold. Even if AEP's project had remained on schedule, the CCS technology, like other first-of-a-kind projects, would have been installed without any commercial guarantees from vendors and would have run the risk of not continuously or reliably achieving high $CO_2$ capture levels. AEP's expectation was that a commercial-scale CCS demonstration project was essential *now*, so that in 2020 or later, a reliable commercial-scale $CO_2$ capture system *might* be commercially available and ready for deployment.

With the suspension of the AEP project and as similar DOE projects are delayed or discontinued, the date for commercial readiness of CCS technology continues to move further out on the horizon. A reasonable estimate for commercial availability, based on the current state of technology development, is at least ten years away, and this is assuming that current financial and regulatory barriers to demonstration projects are expeditiously removed. Without a clear path forward, we will remain, perhaps indefinitely, ten years or more from commercialization of $CO_2$ capture technology. Numerous studies and projects by public and private organizations also have concluded that the availability of commercially available CCS is at least a decade away, even if a much more ambitious research, development, and demonstration program were implemented. Even then, CCS equipment is large, expensive to install, and highly energy intensive. There is a real risk that project economics could discourage wide deployment of CCS. Revolutionary technology innovations show promise to mitigate these risks and are discussed later in this testimony.

Furthermore, the path to CCS commercialization is filled with significant regulatory and legal barriers. These include issues related to the ownership of, acquisition of, and/or access to geologic pore space, as well as issues surrounding long-term liability and stewardship of geologically stored $CO_2$. The removal of these barriers in many cases will most likely be through the development of state legislation and regulatory programs. Efforts at the state and federal level are underway and in various stages of development, but significant challenges remain before these and other legal and regulatory issues will be sufficiently resolved to support the commercialization of CCS on coal-based generation.

Finally, EPA has proposed an alternative compliance option that will not help coal-fueled EGUs achieve the $CO_2$ performance standard.[7] EPA's averaging approach will not work without much greater certainty pertaining to CCS cost and technology. In fact, this alternative compliance option does nothing to ensure the demonstration and deployment of CCS technologies. As just discussed, CCS is not yet commercially demonstrated for large-scale commercial applications and the high cost of the CCS technology effectively precludes its commercial deployment, even if the technology was ready. As a result, there are many technical, economic, and legal risks with CCS technology that must be addressed **before** an EGU developer would consider investing in a new multi-billion dollar plant. These risks will not be taken if the new plant might have to cease operation after ten years if CCS cannot achieve a regulatory standard developed without any real-world data. Without much greater certainty on the timing and success of CCS commercialization efforts, such risk simply will not be acceptable and will effectively preclude the development of any new generation technology that must rely on CCS to operate. Similarly, it is unlikely that the developer could ever obtain the necessary funding for building the plant until these matters are satisfactorily addressed. Lending institutions and state regulatory commissions will not risk several billion dollars[8] unless they obtain adequate assurances that a CCS technology is capable of achieving the $CO_2$ performance standard and can be installed at the new coal-fueled plant within the initial ten-year period of operation.

Simply put, a utility operator will never select an electric generating technology or unit design that requires a control equipment retrofit of ***unknown*** technology to be installed ten years after initial operation. Work done to date on the advancement of CCS technology has yielded incremental improvements in cost and process efficiency. Substantial "game changing" innovations for CCS cost and performance will require

[7] Under this approach, a new coal-fueled EGU could be built without CCS, provided that the developer of the new power plant commits to achieve the following two requirements. The first is that the new coal plant achieves a $CO_2$ emissions limit of a highly efficient ultra-supercritical coal-fueled EGU (set at 1,800 pounds per MWh) during the first ten years of operation. The second is that the developer commits to install and operate CCS on the new plant by the $11^{th}$ year of operation and achieve a $CO_2$ emissions limit of 600 pounds per MWh during the next 20 years so that the weighted average $CO_2$ emissions rate during the 30-year period would comply with the 1,000 lb/MWh $CO_2$ performance standard.

[8] EIA estimates that the capital cost of a single 650 MW coal-fueled EGU without any CCS technology is approximately $1.9 billion. This means that a new multiple unit coal-fueled plant without CCS would cost well in excess of $4 billion including financing costs.

the integration of new CCS technologies with advanced next generation coal-based systems, such as advanced IGCC, oxycombustion, and chemical looping combustion or gasification. As a result, EPA's proposed rule is likely to delay for many years the development of CCS technology because new coal-fueled generation will not be built and, without the development of such new coal-based units in the future, the incentive to invest in and advance CCS technology will be greatly diminished.

**THE NEED FOR REVOLUTIONARY TECHNOLOGY DEVELOPMENT**

Throughout the past several decades of the power industry, technologies have taken an evolutionary path of advancement. As needs have arisen or new concepts were developed, existing power plants have adopted technologies as either retrofit installations or in-kind replacements to older technology. But times have changed and an opportunity has arisen. We support commercialization of Small Modular Reactor (SMR) technology for the next generation of nuclear power, which addresses the capital-intensive challenges with conventional nuclear power technology, and strongly encourage a concentrated focus on transformational technology development for fossil fuel power generation. As stated above, the current regulatory climate and market are such that no new coal-fired power plants are likely to be built so long as gas prices remain low. At the same time, there are compelling arguments to maintain a balanced portfolio of energy resources for U.S. electric power generation. Currently, most power generation-related technology development is focused on modifications and retrofit applications to the existing power plant fleet. Yet, most of the existing fleet in the US is over 30 years of age and already carrying expensive and complex retrofit systems, many of which were installed at costs rivaling the original power plant. Any further modification or retrofit will add complexity and most likely reduce the energy efficiency of the power plant. A more fruitful and forward-thinking approach would be to invest in technology that would be ready to replace the existing fleet as it completes its useful life and heads for retirement in the coming decades. Now is the ideal time to adjust the focus of technology development to truly innovative, revolutionary concepts for energy conversion.

While innovation at the laboratory and pilot-scale level is thriving across the U.S., new coal-fueled electric power projects are not advancing to the large scale demonstration phase due to the high cost of these projects. To remedy this problem, the federal government must step in and take a strong leadership role in making revolutionary technologies a commercial reality for the future. A change in focus from predominantly existing fleet applications and near-term solutions to a longer-reaching view is needed. We must invest in technologies that show promise of truly moving the needle in a meaningful manner in terms of cost, fuel efficiency, and environmental performance. The CURC-EPRI (Coal Utilization Research Council – Electric Power Research Institute) Roadmap lays out a plan to enable the needed innovative technology development utilizing annual budgets no greater than those appropriated to the DOE Fossil Energy clean coal programs over the past couple years.

One excellent example of innovation is in the field of chemical looping technology. Chemical looping is not a carbon capture technology, nor is it a combustion technology in the way we typically describe combustion today. In one application of chemical looping, coal undergoes a flameless chemical reaction with a metal oxide, known as an oxygen carrier. The oxide reacts with the carbon in the coal to produce a pure stream of $CO_2$ while the chemical energy in the coal is transferred to the oxygen-depleted (reduced) metal. The $CO_2$ can be compressed and sequestered, or hopefully utilized for a more meaningful purpose. The reduced metal is then sent to an oxidation reactor, where air is introduced to provide the oxygen needed to re-form the metal oxide, generating large amounts of heat. That heat can be used to produce steam for use in the power generating cycle. The metal oxide that exits the oxidation reaction is then “looped” back to react again with more coal and the cycle repeats. Both The Ohio State University and Alstom are global leaders in this promising new technology and have advance the key design elements of the technology to the point where large investments are now needed to move to commercial-scale demonstrations.

With success, this and other new revolutionary technologies will enable our next generation of power plants to use coal with extremely high efficiency, with ultra-low emissions, and produce a pure stream of $CO_2$ with no added energy penalty. Not only will these concepts revolutionize the power generation industry, they can open the vast, yet untapped, oil reserves in this country to Enhanced Oil Recovery (EOR) production by making enormous quantities of low-cost $CO_2$ available for EOR purposes. These technology innovations are essential to a diverse energy future, but they require attention now and focused funding to enable industry to overcome the high cost of commercialization. Encouragingly, as stated in the CURC-EPRI Technology Roadmap, the funding needed to develop and commercialize these concepts is not beyond the levels invested in recent years with DOE's Fossil Energy clean coal programs; this funding just need to be focused on the proper technologies.

**SUMMARY**

AEP has a long history of using a variety of resources to generate electricity to provide low cost and reliable electricity. We are increasingly concerned that federal environmental and energy regulation and policy is constraining fuel diversity to the detriment of those we serve. Particularly concerning is EPA's proposed NSPS, which is a fuel-discriminatory standard that in effect requires nascent, not yet commercially-available CCS technologies to be used on all new coal plants. As such, the proposed NSPS is impractical and not legally justifiable. For these reasons, AEP urges the development of federal policies that promote fuel diversity, including the continued use of coal to generate low-cost, reliable electricity, and encourage policies that seek to use coal and nuclear energy in revolutionary ways that minimize environmental impacts and increase efficiency. The funding to develop and commercialize advanced coal generation technology is not beyond the levels invested in recent years with DOE's Fossil Energy clean coal programs; rather these funding levels just need to be focused on the proper technologies.

Thank you for the opportunity to testify.