Pennsylvania’s Energy Future

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THE ISSUE
Pennsylvania is rich in energy resources with a significant history of energy production and innovation. Following the tremendous increase in natural gas production in the past decade, how Pennsylvania moves forward to utilize its full array of energy resources to improve the near and long-term economic growth matters for all its citizens. The CSIS Energy and National Security Program together with the Smeal College of Business at Penn State convened a group of local stakeholders to understand the issues and challenges facing Pennsylvania.

Pennsylvania has long been regarded as an energy abundant state with a significant history of energy production and innovation. It has been one of the leading producers of coal for over 200 years and hosted the country’s first commercial oil well and the world’s first ever full-scale commercial nuclear power plant. Today, it is the third largest energy producer in the country overall, ranking as the second largest producer of natural gas and third largest supplier of coal and electricity. This reputation has only strengthened in recent years thanks to the rapid increase in production of natural gas from the Marcellus Shale play underlying Pennsylvania and the surrounding states. The Marcellus Shale play is the largest gas field in the country, estimated to hold proven reserves of around 77 trillion cubic feet, and together with the Utica and Devonian plays represents one of the largest natural gas and natural gas liquids basins in the world. Pennsylvania was also one of the first states to advance an alternative energy portfolio standard to further develop ample renewable resources like wind and solar. Like all resource-advantaged states, the challenge for Pennsylvania is how to utilize its resources to improve the near and long-term economic, social, and environmental outcomes for all its citizens.

Pennsylvania sits at the nexus of opportunities and challenges associated with many of the most fundamental transitions underway in the energy sector.

Pennsylvania is also strategically important to the regional and national energy landscape. Its importance stems in part from the diversity of energy resources, integration with surrounding markets, and its mix of legacy assets and newly emerging resources. At the national level, Pennsylvania serves as an important test bed for taking an abundant natural resource like natural gas, the supply of which could far exceed local and regional demand and connect...
that resource to new outlets of demand both in the region and around the world. Pennsylvania also sits at the nexus of opportunities and challenges associated with many of the most fundamental transitions underway in the energy sector, as the industry shifts towards a more distributed and digitalized energy system with modern technologies, innovative new business models, and opportunities for new industries to emerge. Right now, Pennsylvania serves as a microcosm of a number of these energy trends. Consequently, how Pennsylvania chooses to manage its energy resources and harness growth to underpin new economic opportunities has broad implications not only on the state and local levels but on regional and national levels as well.

ENERGY IN PENNSYLVANIA
Pennsylvania is home to a diverse energy sector that has historically been identified with coal mining and nuclear power generation but has in recent years been dramatically shaped by changes in the production and outlook for natural gas. The application of hydraulic fracturing and horizontal drilling to unlock shale resource potential at scale has transformed the U.S. energy landscape. Once a net natural gas importer, the United States is now poised to be a net natural gas exporter and one of the largest holders of natural gas resources in the world. Endowed with the Marcellus Shale natural gas field—currently the most productive in the world—Pennsylvania has become the second largest producer of natural gas in the United States, exceeding 5.5 trillion cubic feet in 2016, second only to Texas (see Figure 1). In Pennsylvania, natural gas production is almost 10 times larger in 2017 than it was in 2010. By 2040, Pennsylvania is expected to provide 40 percent of total U.S. gas production.

Approximately 40 percent of the natural gas extracted is rich in natural gas liquids (NGLs), and 70 percent of these NGLs are ethane and propane. These NGLs could have the potential to stimulate the state’s economy through the construction and operation of petrochemical facilities that utilize these feedstocks to produce widely used plastic materials. The first plant to take advantage of these resources is already under construction, and some studies have shown the resource base could support up to four additional world-scale facilities. Additionally, while Pennsylvania’s proved oil reserves are minimal, the state is home to more than half of the East Coast’s refining capacity.

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Prior to the rise of natural gas, the state was dominated by the coal and nuclear sectors, and Pennsylvania remains the second largest nuclear electricity generator in the United States with nine reactors spread across five active nuclear power plants. Their share of the electric power market has, however, come under increasing pressure from abundant natural gas supplies, leading to the cancellation of future nuclear investments and the expected shutdown of at least one active plant. In 2005, coal accounted for more than half of the state’s net electricity generation and natural gas less than 5 percent; by 2016 natural gas and nuclear each accounted for one-third of the net electricity generation and coal dropped to one-fourth of generation. Coal production and its mining operations represent a valued part of the state’s history and economy for the past 200

Sources: EIA
years, and Pennsylvania remains one of the nation’s most productive with rich bituminous and—a lesser extent—anthracite coal deposits situated throughout much of the state. However, and much like their peers in the nuclear industry, coal producers and coal-reliant utilities are facing intensifying economic pressure from cheap natural gas and environmental regulations, which has thus far led 11 power plants to shut down coal-fired generating units since 2010 and another three to convert to natural gas. While Pennsylvania has the third largest energy-related CO₂ emissions of any state in United States, it has experienced the third largest absolute drop in emissions since 2005.

Due to the state’s deregulated electricity market, practically all electricity is generated by independent power producers (99 percent), while the PJM Interconnection handles transmission. Overall, Pennsylvania generates more electricity than it consumes, making it an important regional electricity exporter. 4 percent of electricity generated in 2016 was from renewable energy sources, which in recent years has seen wind generation overtake hydro and biomass generation. There are currently over 1,300 megawatts of wind power generation installed in Pennsylvania on 24 wind farms. Pennsylvania also has significant untapped wind potential, with some estimating that the state’s wind resources could support as much as 109,000 MWs. The state also has 28 wind-related manufacturing facilities. The renewable power sector will need to see significant growth in the next three years, however, if the state is to meet its goal of producing 18 percent of electricity from alternative energy sources including renewables by 2021 as mandated by its Alternative Energy Portfolio Standard.

REFLECTIONS ON PENNSYLVANIA’S ENERGY OPPORTUNITY

On May 31, 2018, the CSIS Energy and National Security Program together with the Center for Global Business Studies in the Penn State Smeal College of Business convened a roundtable discussion to review the ways in which Pennsylvania energy stakeholders are working to harness existing energy opportunities to achieve economic, societal, and environmental benefits for the state and its citizens. The discussion involved over 60 participants from Pennsylvania state agencies and the legislature, private sector and local industry, trade and labor associations, environmental organizations, and Penn State and other universities. The discussion participants were asked to share their thoughts about how well Pennsylvania is harnessing its energy opportunities and suggest areas for improvement.

The discussion involved over 60 participants from Pennsylvania.

The following are some key themes and insights from that discussion:

KEY TAKEAWAY #1
STRATEGIC VISION IS CRUCIAL

Pennsylvania has immense natural resources and technological capabilities in the energy sector and a long-term strategic vision for the state’s energy future would go a long way to helping coordinate the short, medium, and long-term steps necessary to realize that vision. The current energy debate suffers from competing visions of the future in terms of a) overarching policy priority, b) comparative attractiveness of different fuels, and c) how connected (both in physical and market terms) Pennsylvania should be with states and countries outside its borders. The differences in these visions are significant, with some espousing 100 percent renewable electricity by 2050, others seeking to support legacy coal and nuclear plants, and still others creating a major natural gas production, petrochemicals development, and advanced manufacturing hub in addition to deeper gas penetration in electric power and heating service throughout the state.

While these are by no means the only three visions for the energy sector in Pennsylvania, they are representative of a spectrum of views that appear to be present in the ongoing stakeholder debate. The more renewables-heavy plan is driven predominantly by a policy imperative to reduce emissions to address climate change with the creation of renewable energy jobs as a benefit. The coal and nuclear support plan is driven by an energy security argument in the form of electric power sector resilience, with a clear nod to supporting those struggling industries. Finally, the natural gas-centric vision is predicated on economic grounds given the competitive advantage for gas in the electric power sector and the potential to drive a range of economic opportunities including revitalization and modernization of the manufacturing sector. All three visions require infrastructure development and connections into markets outside Pennsylvania in addition to policy and energy stakeholder support to varying degrees. Workshop participants saw a need to reconcile these competing visions and push for a plan that sent the right signals to the markets and various communities about the changes necessary to realize this vision. Workshop participants did not seem to think these visions should be as mutually
exclusive as they are often presented, and that there is room for a positive and proactive approach.

**KEY TAKEAWAY #2**

**NATURAL GAS AND PETROCHEMICAL POTENTIAL IS ENORMOUS**

Pennsylvania’s economy is the same size as Saudi Arabia’s, and like Saudi Arabia it has enormous hydrocarbon resources. In fact, natural gas production in Pennsylvania is on par with some of the largest gas producing countries in the world (see Figure 2). Pennsylvania has the potential to be a major producer and exporter of petrochemicals if it develops the necessary infrastructure and downstream opportunities. Several studies and groups referenced the unprecedented potential to capitalize on the significant natural gas and natural gas liquids production to spur a sustained economic boost for Pennsylvania and the region. Of all the energy opportunities facing Pennsylvania, workshop participants spent the most time discussing the enormous opportunity to improve the Pennsylvania and regional economy through the development of natural gas. As stated earlier, one study indicated the region has enough resources to support four ethane crackers on top of the one announced by Shell in 2016, which is expected to produce 1.6 million tons of polyethylene a year. An additional economic plan estimated that Pennsylvania could earn an additional $60 billion in GDP and 100,000 jobs in the next ten years from the development of natural gas through petrochemical investment (as well as gas for power generation in Pennsylvania and for export). While the natural gas production story in Pennsylvania is often well-recognized, the story of the natural gas liquids (NGL) production is less well-known.

The surge in NGLs is due in large part to the development of U.S. unconventional oil and gas out of the Marcellus Shale region (see Figure 3). NGLs like ethane and propane are used for the production of plastics and chemicals. Pennsylvania’s abundant supply is cost-competitive with other large petrochemical producing areas like the Gulf Coast in the United States, the Middle East, and Canada. This hub-based approach to petrochemical development could offer import benefits to industries throughout the region that are reliant on plastics, chemicals, and other materials, as well as provide the region with additional opportunity for exports. Many participants in the workshop highlighted the central role that natural gas could play as an economic engine for Pennsylvania and the surrounding region. The obstacles to realizing this vision were focused on in much of the discussion: infrastructure, downstream market development, local labor and skills development, taxation issues for natural gas, and connecting technical and innovation centers of expertise at universities with commercial opportunities throughout the natural gas value chain.

**KEY TAKEAWAY #3**

**MUCH MORE CAN BE DONE TO TAP INTO RENEWABLE ENERGY AND ENERGY EFFICIENCY**

Pennsylvania also has a significant untapped clean energy market, which some have estimated at a $16-20 billion
investment opportunity. Of this, $7-9 billion could be directed to the development of distribution energy technologies such as rooftop solar systems and building efficiency improvements. Better financing of clean energy projects could also bolster job growth, adding to the existing 72,417 jobs in the energy-efficiency, renewable energy, storage, and microgrid fields. The state’s clean energy economy continues, however, to be constrained by several factors, including the high upfront cost of clean energy systems and retrofits, an uncertain long-term capital supply, and high transaction costs.

Pennsylvania was once viewed as an early adopter of renewable energy friendly regulation because it was one of the early states to enact an Alternative Energy Portfolio Standard (AEPS). The target and definition of the current AEPS falls far behind other subsequent renewable portfolio standards launched in other states. The current AEPS has the benefit of incentivizing a wide variety of alternative electricity sources beyond renewables. But as a consequence of how it is structured, the pull for renewables into the market is quite limited. For example, the carve-out for solar energy is .5 percent of the 18 percent AEPS target. Bills have been introduced to strengthen the renewable energy component of the target but have struggled to pass. Renewable energy proponents have in recent years focused on trying to create new vehicles to enable access to financing for a wide variety of renewable energy projects, green infrastructure, and energy efficiency projects. In June, the PA state legislature and governor signed a Property Assessed Clean Energy (PACE) program to incentivize financial arrangements to encourage energy efficiency improvements for commercial and residential applications.

On July 17, 2018, the Pennsylvania Energy Programs Office released a draft plan as part of the Finding Pennsylvania’s Solar Energy Future project, which is a statewide planning program to increase the use of solar in Pennsylvania by 2030. The draft includes several recommendations including setting a target for retail electricity sales from instate resources and making modifications to the AEPS.

**KEY TAKEAWAY #4**

INVESTING IN PEOPLE IS CRITICALLY IMPORTANT

According to the recently released U.S. energy jobs report, 110,000 Pennsylvanians were employed in 2017 by the traditional energy sector in the electric power and oil and gas sectors, plus an additional 65,000 in energy efficiency. While over 50 percent of employers had hired new employees within the past year, concerns are mounting that the current labor market possesses neither the skills nor depth needed to fill new energy jobs. The Carnegie Science Center found that the local labor force does not have a sufficient STEM education background or set of technical skills to supply employees to an industry that is predicted to make 7,000 new hires by 2020. Pennsylvania has embarked on several initiatives and programs to incentivize the creation of a workforce with the skills to work in, adapt to, and create a new energy future for Pennsylvania.

The jobs discussion focused on two primary pools of candidates: students and unemployed workers from other portions of the energy sector. Universities and organizations within the energy sector (government as well as private sector) are implementing programs to connect students with real-world experience in the energy sector and energy stakeholders to the technical expertise within universities and colleges. One example is the work being done by Penn State’s Marcellus Center for Outreach and Research which seeks to build a common understanding of jobs and skills needed in the natural gas industry in Pennsylvania while also providing insight and information to companies and government agencies about how to manage environmental and community impacts of natural gas development. Another example is the work being done by the Pennsylvania public utility commission to attract students and other qualified professionals to jobs in the utility industry.

The state of Pennsylvania also has a number of programs designed to train and retrain workers who have lost a job in one industry to get a job in other portions of the energy sector. According to one recent study, worker retraining programs are one part of a menu of policies and strategies that are necessary to help revitalize communities that have been hard hit by a combination of declining demand for coal and increased use of technology for coal production and manufacturing.

**KEY TAKEAWAY #5**

UNIVERSITIES CAN PLAY A MAJOR ROLE IN FOSTERING A SKILLED WORKFORCE AND INVESTMENTS IN INNOVATION

Energy production in Pennsylvania continues to grow and diversify as the deployment of technologies and new business models help to unlock a wider array of energy resources. This is taking place during a time of rapid technological change for the energy industry. Developing the state’s energy resources and taking advantage of the state’s innovative capacity is an important part of ensuring the state’s ability to compete in the changing energy and economic landscape. This requires a large, capable, and diverse workforce, as well as ongoing investment in research and innovation.
In addition to government efforts and training incentives, companies in Pennsylvania and across the region are investing in human capital and workforce development. Companies, universities, and educational groups are developing projects and providing funding for STEM and workforce programs to raise the overall number, and level, of STEM education backgrounds and technical skills for future employees. Growing these university-private sector collaborations across the state is a key area for further development. Universities, associations, and even the public utility commission all view energy as an area for building out existing and creating new worker education and retraining opportunities that can be expanded. As Pennsylvania continues to develop its energy resources, it makes sense to periodically evaluate the breadth and scope of these programs to assess effectiveness and any skills gaps that may continue to occur.

**KEY TAKEAWAY #6**

**ENERGY LANDSCAPE WILL CONTINUE TO CHANGE AND INFLUENCE PENNSYLVANIA'S ENERGY FUTURE**

Pennsylvania energy stakeholders have been in the energy industry a long-time and have seen a great deal of change over the years. The last decade of transformation to the energy sector is in some ways a continuation of the energy story that Pennsylvanians have long embraced. The energy sector will most likely continue to experience changes on several fronts, including technological change (e.g. advanced manufacturing, batteries, and digitalization), economics (e.g. relative costs of fuels, reduced cost of renewables), the policy landscape (e.g. federal and state), and geopolitics (e.g. trade and competitiveness dynamics). These changes have and will continue to shape the decisions of investors, businesses, and policymakers in ways that advance or sometimes hold back certain types of energy development or technology deployment in Pennsylvania. All in all, however, the energy stakeholders represented at the workshop expressed their interest to utilize the significant resource advantages in the state, in particular gas and renewables, to create new opportunities and felt positive about the changing energy landscape. Many participants voiced the perspective that further change would bring even more opportunities along with the challenges outline above.

Energy stakeholders throughout Pennsylvania have prioritized a strategic focus to turn energy into an economic opportunity for the state and the region. As our discussion demonstrated, there is broad agreement on developing the state’s strengths—first-in-class energy resources and diverse and capable workforce—to promote and engage in the growth opportunities. A combination of regulatory, policy, commercial, social, and environmental factors will continue to influence the pace, scale, and timing of investment in resource development and related economic growth. As Pennsylvania further strengthens its energy and economic development strategy through stakeholder engagement, policy planning, and economic development plans, having a strategic vision for where the sector is going and what must be done to support those changes will help Pennsylvania successfully navigate this pathway.

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