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ON
ENERGY INNOVATION
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Chairman Murkowski, Ranking Member Manchin, honored Committee Members, thank you for the opportunity to discuss energy innovation and economic development. My name is Dr. Brian Anderson, and I am the Director of the U.S. Department of Energy's (DOE) National Energy Technology Laboratory (NETL).

NETL's research and development (R&D) campuses are located in Morgantown, West Virginia; Pittsburgh, Pennsylvania; Albany, Oregon. NETL also operates field offices in Anchorage, Alaska and Houston, Texas. The mission of NETL is to discover, integrate, and mature technology solutions to enhance the Nation's energy foundation and protect the environment for future generations. For more than 100 years, NETL has advanced technology development and enabled fossil fuel utilization to produce the clean, reliable, and affordable energy needed to increase domestic manufacturing, invest in our Nation's energy infrastructure, improve electrical grid reliability and resilience, expand domestic energy production, educate America's future scientists and engineers, revitalize the workforce, and support U.S. energy and national security goals.

As the only government-owned, government-operated (GOGO) laboratory in the DOE complex, NETL supports DOE goals by maintaining nationally recognized technical competencies and collaborating with partners in industry, academia, and other national and international research organizations to nurture emerging technologies. NETL possesses requisite authority over and actively implements R&D projects for DOE's offices of Fossil Energy (FE), Energy Efficiency and Renewable Energy (EERE), Cybersecurity, Energy Security and Emergency Response (CESER), and Electricity (OE). The laboratory's research portfolio includes more than 900 projects and activities, with a total award value that exceeds $6 billion inclusive of private sector cost-sharing of $3 billion. NETL also implements mission-driven programs and performs objective technical and economic analyses to inform technology readiness and decision-making.

Today, I would like to speak about how the work being performed at NETL provides opportunities for economic development through not only performing leading-edge fundamental and applied research, but through NETL's unique role as a GOGO laboratory in pushing technologies toward commercialization. We maintain critical awareness of the needs of the energy industry and work closely with the Office of Fossil Energy to design and map technology development pathways that fill in critical gaps. Not only do we play a critical role in the energy innovation ecosystem in the Appalachian Region and the Pacific Northwest due to the location of our laboratory facilities in West Virginia, Pennsylvania, and Oregon, but we fill a critical need in the energy innovation ecosystem nationally and internationally through our program management and execution. My testimony today will highlight a few technologies that will make an impact in rural communities across the country as well as our efforts to work regionally through our Regional Workforce Initiative.

NETL is constantly working to upgrade and expand research capabilities through well-planned infrastructure investments that align with our mission and contribute to short- and long-term goals of

DOE. The Laboratory has recently invested in new and upgraded facilities that enable development of cutting-edge energy technologies. On June 14, 2019, NETL held a Dedication in Morgantown, WV, to highlight two recent investments:

- The Reaction Analysis and Chemical Transformation (ReACT) facility pushes the boundaries of reaction science to boost efficiency. It features fuel-flexible, 24/7 operation of modular chemical reactors, as well as high-speed imaging, thermal analysis and online gas monitoring capabilities.
- The Joule 2.0 Supercomputer is among the fastest, largest and most energy-efficient supercomputers in the world. The upgraded supercomputer provides 8 times the computational power from Joule 1.0, its predecessor, allowing researchers to perform calculations, models and simulations 8 times faster and enabling NETL to deliver innovative energy technologies more quickly, effectively and at a reduced cost to the market.

Accelerating the Pace of Energy Innovation through Collaboration

American energy innovation is the result of public-private partnerships. Along with the other 16 DOE National Laboratories, NETL has had significant energy innovation breakthroughs:

- Sharply curtailing power plant air emissions through the introduction of some 20 innovative technologies, such as low nitrogen oxide (NO_x) burners, flue gas desulfurization (scrubbers) and fluidized bed combustion. These innovations have deeply penetrated the marketplace, substantially controlling harmful power plant emissions and benefited energy production and air quality, and;
- Jump-starting the shale gas revolution by conducting early-stage technology R&D and field tests, which industry later adopted and advanced to achieve cost efficient extraction.

How we have accomplished these, and other successes is markedly different from the other 16 national laboratories. As a GOGO, a significant portion of our project portfolio includes R&D conducted through partnerships, cooperative research and development agreements, financial assistance, and contractual arrangements with other national laboratories, universities, research organizations, and the private sector. Together, these efforts focus the wealth of scientific and engineering talent to create commercially viable solutions to national and global energy and environmental problems. As such, our research portfolio is carried out in 50 states, as well as internationally.

NETL is in a unique position to accelerate the development of technology solutions through strategic partnerships. NETL's vision to be recognized as a knowledge and technology generation center, technology convener, and responsible steward is underpinned by our research discovery, development and deployment philosophy. This philosophy emphasizes robust, early-stage R&D collaboration with universities and our sister national laboratories, coupled with industrial and private-sector partnerships. As the technology concept matures through these partnerships, technology is deployed in the marketplace.

NETL recently entered into an agreement with ExxonMobil and the National Renewable Energy Laboratory to support research and collaboration into ways to bring biofuels and carbon capture and storage to commercial scale across the petrochemical, transportation fuel and manufacturing sectors. ExxonMobil will invest up to $100 million over 10 years and stimulate collaborative energy research projects. This unique agreement provides us a conduit to work collaboratively between the laboratory and industry at the cutting edge of innovation, to be able to take technologies from our laboratories and move them into the market space and bring them to scale. The investment will facilitate the expansion of key NETL research programs aimed at advancing low-carbon energy systems, including carbon capture and storage, carbon dioxide (CO_2) utilization, enhanced oil recovery, oil and gas research, high-value products from natural gas and more.

NETL also maintains a Regional Workforce Initiative (RWFI) which facilitates the lab's engagement with more than 400 individual regional and national stakeholders and other federal agencies. The RWFI promotes workforce and related economic development efforts associated with technology development and innovation in the areas of energy and advanced manufacturing. NETL recognizes that a properly trained workforce promotes the successful deployment of new energy technologies.

Enabling Technology to Drive Energy Innovation

Accelerating technology solutions for our nation's most pressing fossil energy challenges has been at NETL's core since 1910. Today, our workforce continues to solve critical issues and promote crosscutting innovation that advances the entire energy sector, maintain our energy dominance in an affordable way, and drive economic prosperity. Key emerging energy innovation at NETL is focused around:

High Performance Computing, Simulation and Modeling

The laboratory's unique computational capabilities crosscut all NETL core competencies and combine theory, computational modeling, advanced optimization, experiments, and industrial input to address complexities and advance energy processes. This next-generation computing enables the development and delivery of novel fossil energy innovation (including fuel cell development, gasification and combustion reactors, functional materials for carbon capture, and the extraction of rare earth elements from coal and coal by-products) in an efficient way while saving time, money, and materials.

NETL has over 30 years of experience in designing and troubleshooting problems involving multiphase flows. The capabilities include: (1) development of multiphase computational fluid dynamics (CFD) modeling tools, (2) controlled experimentation across multiple time and size scales using advanced diagnostics, and (3) solving multiphase flow problems using high-performance computing. NETL created an open-source, multiphase flow CFD software suite for modeling reacting multiphase systems known as Multiphase Flow with Interphase eXchanges (MFiX). MFiX has been used to advance many fossil energy technologies, including coal gasification, chemical looping combustion, and carbon capture. Additionally, it has been used to model and study devices across DOE, such as the Office of Environmental Management nuclear waste cleanup efforts at the Hanford Site in Richland, Washington, and the Integrated Waste Treatment Unit at the Idaho National Laboratory (INL) site. Both efforts eliminated the time, risk and cost of testing multiple reactor designs under a range of operating conditions at full scale. The new design was successfully tested at full-scale preventing a long-term delay to the start-up operations saving $100's million in additional costs.

A major tenant of our computational science efforts is to shorten the timeline for scaling up and testing new processes. This enables new innovations to move to market much faster and therefore to meet the demands of a rapidly changing economy. This focus of NETL's work will help economic development efforts as many of our rural communities need these innovations in the near term.

Advanced Manufacturing

A major effort of the Department of Energy's Office of Energy Efficiency and Renewable Energy has been to develop tools for advanced manufacturing. These tools, placed into the hands of industry, can be deployed at scales very conducive to stimulating economic development.

Efficiencies in the manufacturing sector are being enabled through advanced manufacturing techniques by incorporating automation, advanced materials, and sensors. These technologies can be implemented in all manufacturing facilities, regardless of size or sector. Advanced materials can enable manufacturing equipment to run efficiently at higher capacity, and sensors can collect massive amounts of data related to the performance and condition of equipment. Conditions can be monitored and optimized for longevity, and predictive maintenance can be scheduled when it is convenient, rather than having a catastrophic event shut down the entire facility.

The emergence of natural gas resources has revolutionized the national and global energy ecosystem for the foreseeable future. The full potential of the shale-gas revolution includes a hundred-fold socio-economic benefit realized through adding value to this abundant domestic raw resource. The technologies developed to fully leverage shale gas, particularly the methane component, will provide the foundation for a future energy economy. Emerging natural gas resources can provide economically competitive power, transportation fuels, and chemical commodities with a reduced environmental footprint compared to conventional processes.

NETL is pushing the boundaries of yet-to-be explored research with the ReACT Facility. The facility will accelerate scientific investigations leading to development of more efficient energy conversion innovations for producing more energy from less expensive and abundant fossil fuels while reducing CO_2 emissions. NETL is working with DOE's Advanced Manufacturing Office (AMO), American Institute of Chemical Engineers (AIChE) Rapid Advancement of Process Intensification Deployment (RAPID) Institute, West Virginia University, University of Pittsburgh, and Shell to intensify modular production of value-added chemicals from natural gas.

NETL is driving advanced manufacturing applications in the energy innovation ecosystem to encourage economic development, specifically in rural areas around the nation. Research in advanced manufacturing techniques enable distributed, small-scale product development for innovators. The Appalachian region has historically had strong ties to the manufacturing industry. With the convergence of advanced manufacturing research there is potential to take DOE investments and apply additive manufacturing, smart manufacturing, and advanced sensors and controls to conventional manufacturing processes, such as in the petrochemical industry. This truly embeds DOE innovation in the Appalachian region and other rural regions.

The Appalachian Region is poised for a manufacturing renaissance in conjunction with the advances in technologies in the natural gas production sector due to the low cost of natural gas and natural gas liquids. One does not have to look far to see announcements of multi-billion-dollar investments in the region. However, as these low-cost feedstocks turn into low-cost value-added products, the placement of advanced manufacturing tools into the hands of entrepreneurs and small- and medium-sized businesses in communities across the region is how the Department of Energy's efforts in advanced manufacturing will truly help these economies bloom.

Sensors, Controls, and Cybersecurity

Ensuring that our American economy continues to thrive with low-cost, reliable energy is one of the most impactful goals of the National Energy Technology Laboratory. Our advanced sensors and controls efforts provide pivotal insights into optimizing plant performance and increasing plant reliability and availability. NETL tests and matures novel sensor and control systems that are operable in coal-fired power plants; capable of real-time measurements; improve overall plant efficiencies; and allow for more effective ramp rates. Given the crosscutting nature of sensors and controls, these technologies will also benefit natural gas power generation and other harsh environment applications.

Reliable energy infrastructure, with a specific focus on cybersecurity, is a top technical priority of the power generation industry. DOE, Department of Defense, and the broader security community continue to make substantial investments in both R&D and operations to keep the Nation's energy infrastructure safe. NETL pursues projects that address fossil energy's cybersecurity needs. Projects range from cybersecurity threat gap analyses, automated situational awareness technologies, data integration tools, and Blockchain technologies to harden potential targets.

Breakthrough Innovations in Coal Technologies

NETL supports science and technology development leading to commercialization of low-cost, reliable power for the American people that spurs economic development while mitigating technical and environmental risks. Key to this mission is maintaining leadership in the development of new technologies for energy generation, energy transmission, and fossil resource utilization, which are all critical to domestic economic competitiveness and energy security. NETL is beginning research on the Coal FIRST (Flexible, Innovative, Resilient, Small, Transformative) initiative, which enables industry to develop the coal plant of the future, which will provide secure, stable, reliable power with near-zero emissions, including CO_2. The next-generation coal technology consists of units that are small, highly efficient, with low emissions and water usage, and are able to operate flexibly in conjunction with intermittent resources, i.e., renewable generation.

Carbon Capture, Storage, and Utilization

The Carbon Capture Program supported more than 180 second-generation R&D projects that have reduced the cost of carbon capture by nearly 50 percent and reduced the energy penalty (the amount of generated energy used by carbon capture technologies) by nearly 20 percent. NETL used its revolutionary computational framework to screen more than a million mixed matrix membranes (MMM) and to identify promising MMMs for post-combustion carbon capture. MMMs based on NETL Polymer 3 are projected to decrease the cost of carbon capture from $63 to $48 per metric ton of CO_2 removed. These membranes are now being scaled up for demonstration using actual flue gas at the National Carbon Capture Center in Wilsonville, Alabama, advancing their commercial feasibility. We are maturing numerous technologies toward commercialization by both increasing performance and decreasing systems costs.

The Carbon Storage Program is focused on developing and advancing technologies to enable safe, cost-effective, permanent geologic storage of CO_2 both onshore and offshore in different depositional environments. NETL is funding the Brine Storage Test (BEST) led by the University of North Dakota Energy and Environmental Research Center (EERC) (Grand Forks, ND), with GE Global Research, Computer Modeling Group, and Schlumberger Carbon Services. EERC is conducting a field validation test of a design developed previously for NETL. The field validation effort will be integrated with an operating commercial saltwater disposal facility located near Watford City, North Dakota.

The Carbon Utilization Program promotes R&D that utilizes CO_2 to generate value-added products, providing revenue generation to partially offset carbon capture costs from the utility and industrial sectors. NETL has designed and demonstrated a novel copper-based nano-catalyst enabling the conversion of CO_2 into high-value fuel- and polymer-precursors. A new nano-porous copper-oxide catalyst for electrochemical CO_2 reduction had 10 to 60 times better selectivity compared to commercially available copper materials. This is a significant breakthrough that uses inexpensive material to selectively convert waste CO_2 into useful chemicals such as fuels, alcohols, hydrocarbons, carbon monoxide, polymers, and plastics.

Advanced Materials for Extreme Environments

Improving alloy design to increase high temperature capability is critical for accelerating the development of next-generation technologies, including combustion, turbines, gasification, drilling, and other applications. eXtremeMAT is an NETL-led project addressing materials challenges associated with existing and next-generation fossil power systems. eXtremeMAT harnesses the unparalleled computational and experimental materials science expertise and capabilities of DOE national labs to develop improved heat resistant alloys for FE components and predict long-term materials performance in existing and future fossil energy power systems. The eXtremeMAT team includes NETL and partner laboratories Ames Laboratory, Idaho National Laboratory, Lawrence Livermore National Laboratory, Los Alamos National Laboratory, Oak Ridge National Laboratory, and Pacific Northwest National Laboratory.

NETL's Albany, Oregon campus is a leader in developing structural materials for extreme environments. This capability is anchored by its substantial alloy fabrication and performance testing facilities, which deliver high-performance, affordable materials that enable diverse energy technologies. NETL researchers specialize in the design, synthesis, fabrication and manufacturing, performance assessment, and performance prediction of corrosion- and heat-resistant alloys and ceramics and refractories for structural and environmental protection applications. The Albany site enabled a commercial specialty metals industry in the region.

The NETL-sponsored Advanced Ultra-Supercritical (AUSC) Component Testing project is accelerating the commercial deployment of advanced, coal-based power generation processes that will achieve higher efficiency, lower emissions, and longer life of existing and new power plants. AUSC power plants are 25 percent more efficient than average power plants, and 10 percent more efficient than state-of-the-art power plants. Phase 2 of this project aims to develop a domestic supply chain for these components. It also establishes the foundational materials and manufacturing processes necessary for redesigning existing power plants that can withstand severe cycling modes and for new power plants based on supercritical CO_2 with even higher efficiencies.

Rare Earth Elements from Coal and Coal By-Products

NETL is also exploring the potential for extracting rare earth elements (REE) from the full spectrum of coal and coal-based materials, including but not limited to coal (anthracite through lignite materials), coal refuse/wastes, clay and shale over-/under-burden materials, raw acid mine drainage (AMD) fluids and sludge, power generation ash and ponded ash. We are implementing the program through a robust research effort conducted in our research facilities in Morgantown, West Virginia; Pittsburgh, Pennsylvania, and; Albany, Oregon, and with research partners across the United States, a number of which are in the Appalachian states of Kentucky, West Virginia, Pennsylvania, Virginia, Ohio, North Carolina, and Alabama, as well as in North Dakota, Utah, and throughout our western and mid-western states, and with our sister National Labs – Los Alamos National Laboratory, Lawrence Livermore National Laboratory, Idaho National Laboratory, and Pacific Northwest National Laboratory. NETL will have the third of our first-of-a-kind, domestic extraction, separation and recovery facilities tentatively operating in the August-September 2019 timeframe, producing small quantities of REEs from coal-based resources that include coal refuse, acid mine drainage, and power generation ash. These rare earths will be in the form of oxides and/or salts, which in the future could either be directly used and/or further converted into rare earth metals for use in alloying and production of intermediate and/or end-use commodity and/or national defense products.

Future demand for rare earths and critical minerals is expected to grow as these are used in computers, cell phones, batteries, catalysts, and other products increasingly required by global international markets. Our research program has exceeded its original technical goals set for it in 2014-2016 and shows that our coal-based resources may offer promise for providing a reliable domestic supply of rare earth elements.

High Value Products from Coal and Coal Feedstock

Globally, coal is used mainly in electricity generation, steel production, cement manufacturing, as a liquid fuel, alumina refineries, paper manufacturing, and the chemical and pharmaceutical industries. However, a number of chemical products can be produced from the by-products of coal. NETL is developing and utilizing carbon materials to maximize the economic value of domestic coal, thus increasing and diversifying the Nation's energy production and applications.

From a technical perspective, coal is also a desirable manufacturing feedstock because it naturally contains the graphitic and aromatic carbon structures many materials require for improved strength, corrosion resistance, thermal/electrical conductivity, and enhanced optical properties. In comparison, these carbon structures are not prevalent in natural gas, biomass, or petroleum feedstocks and must be created during the manufacturing process using complex, expensive, and energy-intensive methods.

There are a number of specialized products for which coal is an essential ingredient. Among them are:

- Activated carbon – used to purify liquids and gases in a variety of applications, including municipal drinking water, food and beverage processing, odor removal, and industrial pollution control.
- Carbon fiber – extremely strong and light-weight (half that of aluminum) it is being increasingly used as a material in construction, sporting goods, aerospace, automotive, and wind turbine blades.
- Carbon Electrodes – coal-based coke, pitch, and carbon nanomaterials can be used to produce electrode materials for a range of applications such as aluminum production, batteries/energy storage, and supercapacitors.

NETL has established a Coal-to-Products research program with technical thrusts in coal-based manufacturing technologies to develop carbon fiber and additive manufacturing technologies; materials discovery and development to utilize coal for manufacturing carbon nanomaterials and other novel carbons; and systems analysis and engineering to characterize the impact coal-based manufacturing will have on current and future markets. In the last year, NETL and Oak Ridge National Laboratory signed a memorandum of understanding (MOU) and have initiated collaborative R&D activities in the area of coal to carbon products. In addition, NETL established partnerships with Ramaco Carbon (Cooperative Research and Development Agreement or CRADA), Russell County Industrial Development Authority (MOU), and Virginia Carbonite (MOU) to help accelerate commercialization of high-value carbon products from coal.

Breakthrough Innovations in Oil and Gas Technologies

The Laboratory's Oil and Natural Gas R&D effort incorporates four primary program objectives: 1) increasing recovery of the nation's unconventional resources like shale gas and tight oil, 2) enhancing oil recovery from our conventional reservoirs, 3) reducing methane losses from the nation's natural gas production and transportation infrastructure, and 4) increasing our understanding of the productive potential of methane hydrates, an enormous source of methane trapped in the sediments of our Arctic and deep water offshore regions. Our program combines public/private research partnerships that engage industry, research universities and technology developers with the in-house research pursued by NETL scientists and engineers, to accelerate the development of technologies that can help achieve these objectives.

Unconventional Resources

Beyond the fact that two of NETL's three laboratory facilities are located in West Virginia and western Pennsylvania, NETL's oil and natural gas research program has several high-profile projects centered in the Appalachian region. The Marcellus Shale Energy and Environment Laboratory (MSEEL) is a field "laboratory" that includes multiple wells located at two proximate sites including the Morgantown Industrial Park. NETL partnered with Northeast Natural Energy, West Virginia University and Ohio State University to construct and operate a long-term field-based research project to improve recovery efficiency and minimize environmental implications of development in the Marcellus Shale play.

Beginning in 2015, the research team began collecting baseline environmental data to support subsequent analyses of conditions before, during and after site development. The team drilled two horizontal Marcellus wells and a vertical science well for observing subsurface well experiments. The wells were cored, and a wide range of subsurface data were collected during drilling and subsequent long-term production testing. The comprehensive data set collected by NETL enabled the researchers to derive significant conclusions about the effectiveness of various Marcellus well completion designs, the true impacts of development on air and surface water, and the utility of distributed acoustic and temperature sensing systems in the subsurface.

In 2018 the field laboratory was expanded to include a nearby well pad at which six Marcellus wells have been drilled to approximately 20,000 ft (measured depth). Three of the wells have installed fiber optic sensors to help confirm and build upon the findings from the first drilling pad. The operator, Northeast Natural Energy, and other companies drilling Marcellus Shale wells in the basin, have already begun to apply the research findings from MSEEL to improve well performance and increase natural gas recovery in their operating areas.

Building on the success of MSEEL, NETL has launched several other such field laboratories in basins around the country. One of these, the Emerging Stacked Unconventional Plays (ESUP) field lab, is located in the Central Appalachian Basin of southwestern Virginia. Here, NETL has partnered with Virginia Polytechnic Institute and State University, EnerVest Operating LLC and others to assess the potential for developing multiple, stacked unconventional play zones that exist in the Nora Gas Field, and also assess the possibility of using non-aqueous hydraulic fracturing fluids such as CO_2 to complete the wells. Understanding how to efficiently develop stacked can reduce surface footprint and infrastructure requirements while maximizing recovery of the Appalachian Basin's resources and boosting the region's economic growth. A project was recently awarded to University of Kentucky Research Foundation to accelerate the development of the Conasauga group, located in Kentucky and West Virginia, as unconventional oil and natural gas plays. The project will gather the additional data necessary and test different well-completion designs in both theoretical models and in a field application at a horizontal well drilled in Lawrence County, KY.

There are also a number of projects where NETL research teams are specifically targeting Alaskan fossil energy resources. One example is a project begun in June of last year in the Milne Point Field on Alaska's North Slope, where the Schrader Bluff formation contains high viscosity, low gravity crude oil that has resisted attempts at waterflooding, also known as secondary recovery. Preliminary laboratory and simulation studies indicated that polymer flooding has great potential to enhance oil recovery from the Schrader Bluff heavy oil reservoirs, but no field tests had ever been performed to test the method, even though studies suggest that successful polymer flooding could increase heavy oil recovery by 50 percent on the North Slope of Alaska and increase America's oil reserves by tens of billions of barrels.

NETL partnered with the University of Alaska Fairbanks, New Mexico Tech, Missouri University of Science and Technology, University of North Dakota and Hilcorp on a four-year pilot polymer flood program at Hilcorp's J-Pad in the Milne Point Field that will extend through fall of 2022. Already, the injection of polymer thickening agents into the waterflood pattern has resulted in increased recovery and the research team is making progress on implementing technologies for cost efficiently separating the polymer-water-crude oil mixture that is produced. Using polymer, Hilcorp now expects to increase crude recovery from 10 to 15 percent of the oil in place at Milne Point to as much as 50 percent. As the company estimates there are 1.3 billion barrels of viscous crude at Milne Point, this new practice will enable the production of hundreds of millions of barrels of Alaskan oil, strengthening the viability of the Trans-Alaska Pipeline System and U.S. energy security.

Methane Hydrates Resources

Methane hydrates are mixtures of methane and water molecules that occur in sediments between 1000 and 3000 feet deep, largely within the boundaries of the Kuparak River and Prudhoe Bay Fields on Alaska's North Slope. The U.S. Geological Survey (USGS) estimates that there are about 85 trillion cubic feet of methane trapped in North Slope hydrates, which could one day become a significant clean energy contribution to U.S. energy demand.

A Stratigraphic Test Well completed in December 2018 confirmed the presence of viable production zones at the Prudhoe Bay oil field. The well was the first stage in a multi-year program to gain a better understanding of the commercial resource potential of methane produced from methane hydrates. NETL partnered with the USGS, Japan Oil, Gas and Metals National Corporation (JOGMEC), and BP to drill a shallow test well from an unused pad in the western part of the field targeting two formations containing this hydrocarbon resource.

The subsurface data being obtained from these experiments will be entered into computer models that estimate production potential for methane production from hydrates over a well's lifetime, based on a variety of production enhancing activities. This research will provide the first long-term methane hydrate production test data set ever obtained and form the basis for a much better understanding of the true potential of a clean energy resource that dwarfs conventional natural gas accumulations around the world. The well itself was completed with permanently deployed Distributed Acoustic Sensors and Distributed Temperature Sensors for long-term reservoir monitoring. The next steps include distributing the data to project collaborators and initiating comprehensive analysis to initiate a long-term production test well, second monitoring well, and surface facilities to process gas, water and solids.

Over the longer term, the research currently underway to accelerate the development of technologies that can improve recoveries from tight oil and shale gas formations, will eventually yield returns when producers seek to develop such unconventional resources in Alaskan sedimentary basins.

Conclusion

In conclusion, science, technology, and research are powerful anchors of regional innovation and sustainable economic growth. They can be applied to meet the technical, economic, and environmental challenges of a diverse, flexible and resilient national energy supply and delivery portfolio. Thank you for the opportunity to discuss some of these cutting-edge innovations, which have applications within and beyond of the energy sector.