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Marcellus-Utica Shales

The 2015 Playbook



A supplement to

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Marcellus-Utica Shales: *The Playbook*

A supplement to *Oil and Gas Investor, E&P,*
and *Midstream Business*

HART ENERGY
1616 S. Voss, Suite 1000 | Houston, Texas 77057
Tel: +1 (713) 260-6400 | Fax: +1 (713) 840-8585
hartenergy.com

Group Managing Editor **JO ANN DAVY**
E&P

Editors **MARK THOMAS**
E&P

LESLIE HAINES
Oil and Gas Investor

PAUL HART
Midstream Business

Executive Editor,
E&P **RHONDA DUEY**

Contributing Editors **STEPHANIE CRABTREE**

JESSICA GARRISON

FRANK NIETO

BLAKE WRIGHT

Associate Managing Editor,
Special Projects **MARY HOGAN**

Associate Editor,
Special Projects **ARIANA BENAVIDEZ**

Corporate Art Director **ALEXA SANDERS**

Senior Graphic Designers **MAX GUILLORY**
JAMES GRANT

Art Director
Oil and Gas Investor **MARC CONLY**

Production Director **JO LYNNE POOL**

Marketing Director **GREG SALERNO**

For additional copies of this publication,
contact Customer Service +1 (713) 260-6442.

Vice President — Publishing **RUSSELL LAAS**

Vice President — Publishing **SHELLEY LAMB**

Publisher
Midstream Business **DARRIN WEST**

HART ENERGY

Editorial Director **PEGGY WILLIAMS**

President and
Chief Operating Officer **KEVIN F. HIGGINS**

Chief Executive Officer **RICHARD A. EICHLER**

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2015 Unconventional Playbook Series

The Marcellus-Utica Shales Playbook is the 25th in Hart Energy's exclusive series of comprehensive reports delving into North America's most compelling unconventional resource plays. Our lineup of topics addresses the plays everyone is talking about and delivers answers to essential questions on reservoirs, active operators, economics, key technologies and infrastructure issues. Some playbooks also feature a full-color map highlighting fields, drilling activity and significant wells.

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Operators are exploring the Utica-Point Pleasant formations from southeastern Ohio through northwestern Pennsylvania. (Photo by Michael Robinson, courtesy of Hart Energy's Oil and Gas Investor, November 2013)

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WEB EXCLUSIVES

US SHALE GAS PRODUCTION EXPECTED TO FALL

Of the major shale plays, the Utica was expected to show gas production increases in June, July and August, the Energy Information Administration said. Though by September, production in the play was expected to start slipping. UGcenter.com

CHESAPEAKE SURRENDERS 50,000 UTICA ACRES FOR PIPELINE

Chesapeake expects to save up to \$175 million in operating expenses in the Haynesville and Utica shales while Williams plans investments of \$600 million over five years for 200 miles of pipeline. UGcenter.com

REWARD AWAITS THOSE WILLING TO EXPLORE DURING DOWNTURN

Thrust Energy's CEO shared insight during Summer NAPE on the benefits of deviating from the norm and exploring overlooked plays. UGcenter.com

STUDY: UTICA HOLDS 20X AS MUCH GAS AS BELIEVED

West Virginia University researchers estimate that the play's technically recoverable reserves of 782 Tcf put it on par with neighboring Marcellus Shale. UGcenter.com

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The UG Center features information on the wells with the top IP rates in each unconventional play. Information includes flow rates, operators and location.

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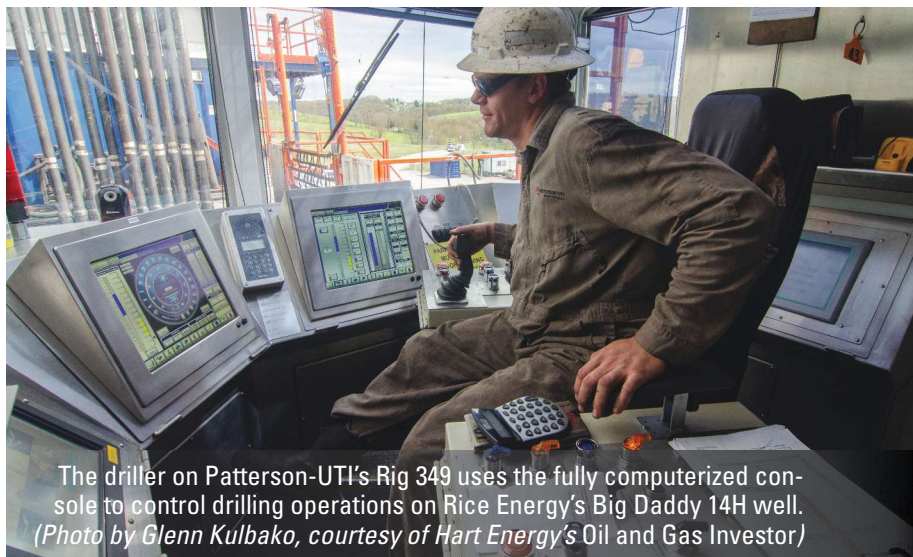
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The driller on Patterson-UT's Rig 349 uses the fully computerized console to control drilling operations on Rice Energy's Big Daddy 14H well. (Photo by Glenn Kulbako, courtesy of Hart Energy's Oil and Gas Investor)

Data-driven Success

In 2014 operators were drilling wells quickly. With the industry downturn, they have the opportunity to drill them smarter.

By Rhonda Duey
Executive Editor

Let's face it: High commodity prices spoiled a lot of people and so did unconventional plays. Once the industry solved the puzzle of combining hydraulic fracturing with horizontal drilling in shales, it went on to find some huge plays.

Things look quite different when oil prices drop 50%. Suddenly those less economic wells start to impact the balance sheet. And operators start to take a step back, evaluate their methods and search for ways to make better decisions about their drilling and completions strategies.

That's where reservoir characterization technologies can help.

Most operators today realize that shales are not homogenous blankets of sediment but rather vary greatly, even at the nanoscale. Having acreage in the core of the play is of crucial importance, and a more thorough understanding of the reservoir is needed to drill and frack in the right places.

Unlocking the Marcellus and Utica

Range Resources gets the credit for "discovering" the Marcellus, although "unlocking" is probably the better term. It commercialized the play through large-scale slickwater fracturing and horizontal drilling since it was a well-known source rock in the Appalachian Basin. According to Bill Zagorski, vice president of geology for Range, the company had put together a large acreage position in Washington County, Pa., and had seen shows while drilling through the Marcellus to a deeper target. "In 2003 and 2004, I came across a lot of the evolving information on the Barnett Shale through a colleague of mine in Texas," Zagorski said. "While we didn't originally get the acreage specifically to target the Marcellus, once we found out where the Barnett was going, we had the 'OMG'

moment—we've got a big play here, and we have an opportunity to test it."

The decision came at a critical turning point for the company. CEO, then COO, Jeff Ventura was trying to retool and grow the company from being a high-risk exploration player to a player in more repeatable resource plays. "While the idea was highly exploration-minded and risky, especially at that time, it was exactly what he was looking for in terms of a foundation to build the company on," Zagorski said. "The Marcellus was the best play in the Appalachian Basin that fit the Barnett model at the time."

The company put together an aggressive land position, particularly in what are now the sweet spots of the play in southwestern and northeastern Pennsylvania. This was a major game-changer for the region, Zagorski said. "The established operators were drilling vertical wells, mostly in conventional targets, drilling them as cheaply as possible and completing them as cheaply as possible," he said. "The idea of cost-containment and getting a decent well on the margin was how a lot of the independents were working. The standard vertical completion that was successful in the Barnett in 2004 was at a scale completely unheard of here."

Range didn't skimp on its first Marcellus wells. It used the exact designs that were being employed in the Barnett on them. To Zagorski, that approach/decision by Ventura was crucial to the early success of the Marcellus play. "If we had used half the frack size on it, we likely would have gotten half the results or maybe less," he said. "That would have changed both how the company and the industry perceived the success or lack of success."

Range has gone on to achieve considerable success in the Marcellus, Upper Devonian Shale and Utica plays and recently drilled a well in the Utica



The Marcellus Shale has numerous outcrop shows, which help explorationists define the subsurface characteristics. (Photo by Terry Engelder, Penn State)



Cableless systems such as Inova’s Hawk system are ideal for the terrain found in the Marcellus and Utica plays. *(Photo courtesy of Inova)*

Point Pleasant play in southwestern Pennsylvania that had a record IP of 59 MMcf/d. It currently has 400,000 prospective acres in that play. Part of the company’s success can be chalked up to its use of the best available technologies along with engineering and geological data.

“As plays mature, you need different technologies and approaches,” Zagorski said. “When we first started developing the Marcellus, things like understanding the geologic play concept regionally to identify the sweet spots in the play required different data than designing and improving completions did. So early on we participated in a lot of coring and core consortia.” He added that the company is still using those data.

Other data have proven to be critical to the success of the play as well.

Geophysics

Range ran one of the first 3-D seismic surveys in the Marcellus, and Zagorski said the data were critical to help understand the geology of these developing

fields. “We were able to map out the geohazards, and it assisted us in our field planning as well as understanding the mechanical behavior of the wells,” he said. Range shot several proprietary surveys and participated in multi-client surveys. Zagorski estimated that up to 90% of the company’s Appalachian Marcellus play acreage is covered by 3-D seismic.

Scott Singleton, former ResSCAN manager for ION Geophysical’s Ventures Group, developed a workflow that emphasizes the link between geophysics and engineering. He said the shale plays have stood the concept of asset teams on its head.

“Oil companies started this philosophy of having an integrated E&P team that consisted of members of geology, geophysics and engineering,” he said. “In the Gulf of Mexico that’s the way they do it because of the millions of dollars that are spent.

“People trained in that philosophy were thrown into the onshore unconventional arena, and the engineers run the play. It’s a production-driven play.”

ION’s shale clients are not the chief geophysicists but rather the drilling, completions and production engineers. Companies like ION are using rock property information from seismic data to determine which areas are more brittle and likely to crack under hydraulic pressure. They also map faults in the subsurface that might leach off frack fluid.

One of the challenges of shooting 3-D seismic surveys in the region is the difficult topography, characterized by dense vegetation and hilly terrain. Inova Geophysical has designed its Hawk system to overcome these challenges. The system is a cableless autonomous node system in which the nodes record the data and store them until they’re collected.

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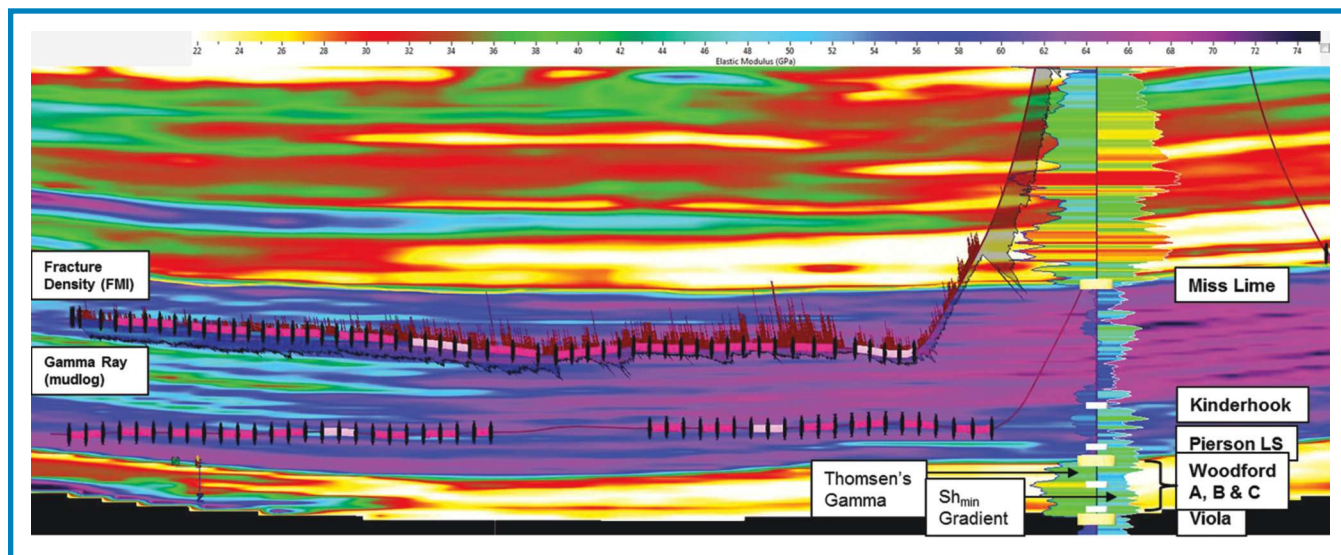
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Geomechanical rock property (Young’s modulus) is derived from seismic inversion followed by well log-based facies inversion to enhance resolution. Logs and tops are identified on lateral and vertical wells. Perf zones (black) and stages (pink) are shown on laterals. For the horizontal scale, the lateral is 4,800 ft long. For the vertical scale, the Mississippi Lime (including Kinderhook and Pierson) is about 200 ft thick. *(Images courtesy of ION)*

Dennis Pavel, strategic director of acquisition products for Inova, said the system has operational advantages on large-scale 3-D seismic in this terrain not only over cabled systems but also over cableless radio-based systems. “This system has no radio infrastructure,” he said. “There’s no wireless network connecting ground equip-

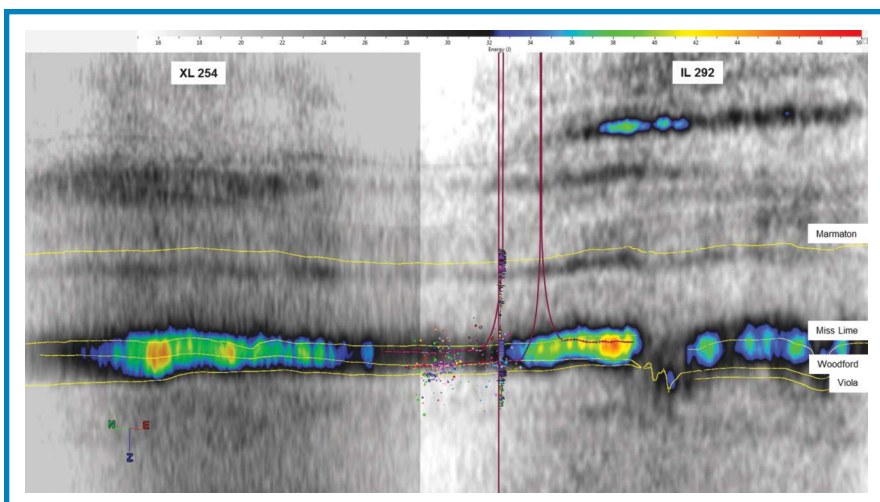
ment to a central location. Those systems can be difficult to operate in dense foliage and hilly terrain because you’ve got to maintain radio connectivity to have real-time performance similar to a cable system.”

Culture also is an issue in the region, and Pavel said that routing a cable across a road or through small towns can lead to damage and downtime. “Contractors are more favorable toward cableless systems in that environment,” he said.

The system consists of the digitization electronics, a GPS receiver for timing, a sensor and a battery. Pavel added that the acoustic source most often used in the area is dynamite, but a combination of dynamite and Vibroseis might be used in areas where roads are more prevalent.

The company also has developed a small-scale vibrator that is physically smaller than typical vibrators and is more maneuverable, making it well suited for use in areas that are difficult to access.

Singleton added that wide-azimuth seismic is an absolute must to determine



This image shows an inline/crossline cutaway of compressional (P) and shear transverse energy within the reservoir, horizons defining the reservoir and a well pad containing a vertical well and three laterals. The P velocity log is shown on the vertical well, as are microseismic events from completions.



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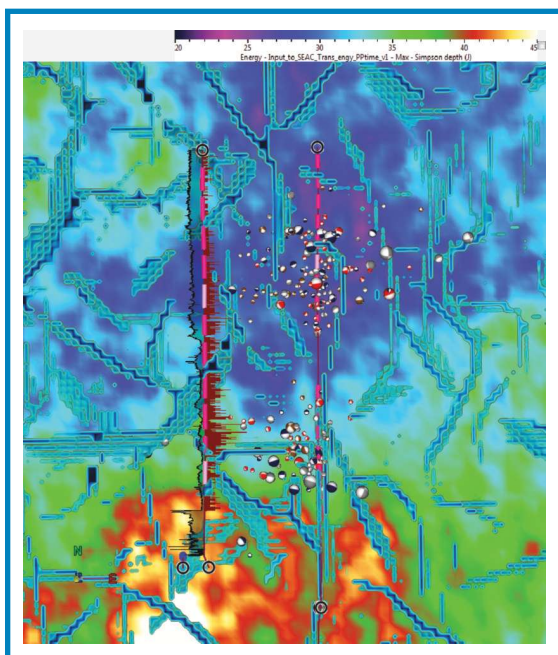
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When viewing the compressional and shear transverse energy, bright colors indicate large magnitude. The left lateral shows the LWD gamma-ray log results (dark gray) and formation micro-imager fracture density (red), while the right well shows microseismic events with their associated focal planes, sized by magnitude and colored by Hudson event type (open equals purple, closed equals blue, shear plus open equals red, shear plus closed equals orange, and undefined equals green). Fault traces (in 3-D) from seismic fault detection are in green. For scale, the left lateral is 4,800 ft long. *(Image courtesy of ION)*

Young's modulus and Poisson's ratio. These help determine the brittleness of the rock.

ARKeX is another company that has done surveys in the Marcellus/Utica area. The company offers airborne full-tensor gravity gradiometry (FTG) surveys on both a proprietary and multi-client basis and has shot two multi-client surveys in the region. The first survey was a joint venture with Global Geophysical, which provided seismic data that were integrated with the FTG data.

Neil Dyer, CTO of ARKeX, said that the joint survey was over the first part of the Appalachian fold belt and indicated very faulted deformation. "What the FTG survey delivers is a very clear and quite straightforward-to-interpret map of the position of the reactivated normal faults that form the shoul-

ders of these little thrust blocks," Dyer said. "More importantly, the transfer faults don't express very clearly in seismic data. Most of the seismic data look rather flat and can image straight through those shear zones, but there's an enormous disruption across them. This represents as much of a threat to a stimulation as a normal fault would in that it's a place where you can lose all of the pressure." Operators that access these data can use them to determine which directions and to what length they can safely drill their laterals, he added.

Austere times are slowing the development of further multi-client surveys. Dyer said that's unfortunate. "There's such an amount of information in there about the material properties that have to be in place between the Salina Formation, which underlies the Marcellus, and the surface," he said. "Even if people are doing 3-D seismic first, they need to know about the surprises those boreholes are going to deal with. Since the drillers are working on a constrained cost basis, they don't want surprises."

Companies like ARKeX are hoping to sell a compelling value proposition to potential clients, not just interesting-looking data. "The development of an efficient, responsible, well-designed exploration program can't take place without some investment in science," he said. "We are offering people an opportunity to integrate some more laterally thought-out exploration methods into their budgets to make every kilometer of seismic worth shooting and every borehole worth drilling. We intend to minimize the number of dud investments people make based on a poor decision."

In terms of processing, Singleton said that prestack depth migration (PSDM) is now being used on land. The technique has long been used offshore to image beneath salt, but it's difficult on land due to statics and shallow velocity layer problems. However, having targets in depth rather than time has its benefits in the eyes of the drilling engineers.

"Land has the benefit of lots of well control," he said. "You can use tops and make sure your velocity model is accurate. It's becoming more commonplace."

Logging

High-quality well logs are a necessity in the Marcellus and Utica plays, and Range has relied on a com-

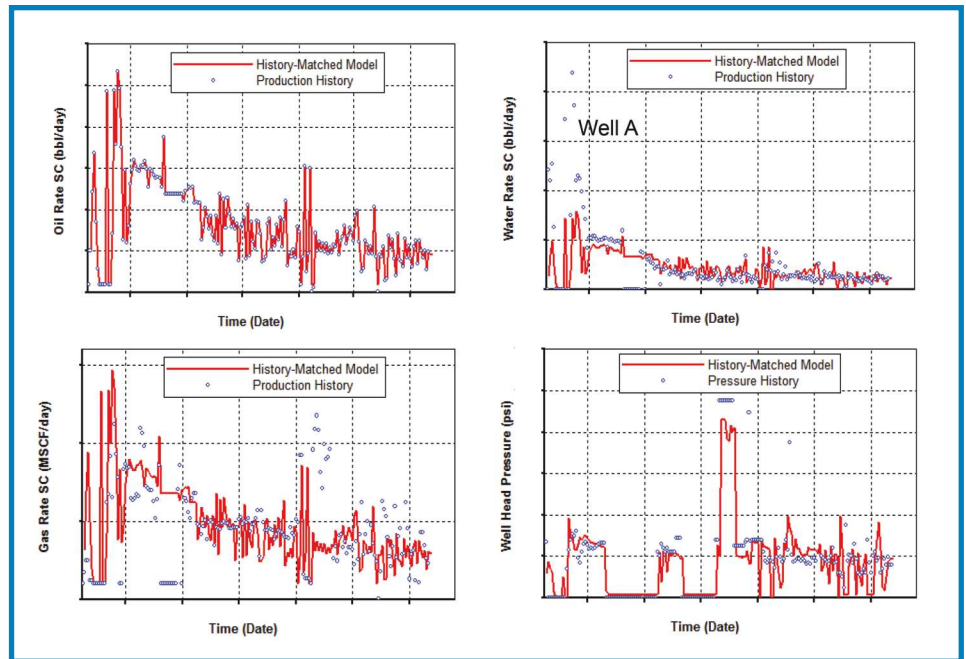
prehensive suite of logging tools from the beginning. “Running an accurate log suite and then having that tied to sidewall or whole cores was critical to us understanding the basin and the sweet spots at both the regional and field/pad level,” Zagorski said.

In particular, Range relied on elemental capture spectroscopy logs and shale gas analysis suites to understand lithology, porosity and permeability. Formation micro-imager logs were helpful as well to gain a better understanding of the natural fracturing density, type and orientation. But most recently the company has been relying on a combination of focused ion beam scanning electron microscope (FIB SEM) modeling from core data combined with nuclear magnetic resonance (NMR) logs to help it land laterals.

“We think landing the lateral is the single most critical driver of all of the shale plays, and particularly in the Marcellus, it’s just phenomenally critical,” Zagorski said. “It can make a 100% difference in the quality of your well just by making a 10-ft or 15-ft vertical section difference in landing point. You just don’t frack into it.”

The company began sampling and analyzing its whole core and sidewall core data using the FIB SEM approach and discovered that many times the conventional suite of logs wasn’t always correctly indicating zones with the best porosity and permeability. Range sampled its entire field using FIB SEM technology and redefined the best zones. More recently it has determined that NMR logs provide similar information.

“The NMR responds to the hydrogen nuclei in the pore fluids,” said Natalie Uschner, senior petrophysicist for Schlumberger. “It provides a measurement of porosity independent of lithology. With the tool’s enhanced precision capabilities, one can estimate pore size distribution, better evaluate hydrocarbons in place and calculate the permeability in the unconventional.”



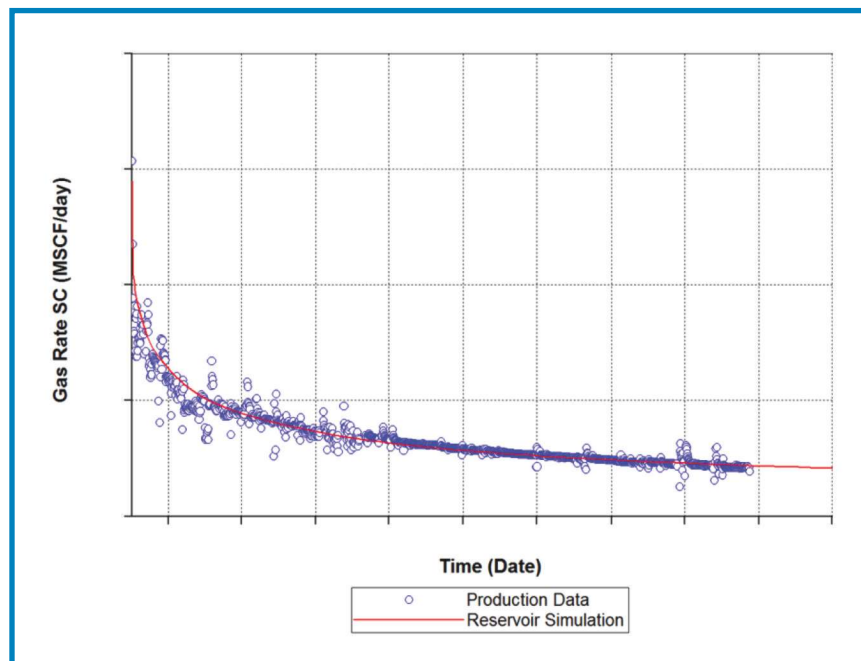
The figure shows a history-match of actual production data in blue and simulated production data from the microseismic-calibrated reservoir model in red. (Image courtesy of MicroSeismic Inc.)

Added Steve Hall, vice president of the Northeast region at Schlumberger, “It’s always a balance between the economics and the benefits. As the confidence increases in one of the technologies, you see it adopted and utilized more and more.”

Completions

At Schlumberger the focus of reservoir characterization is based on three components—reservoir quality, completion quality and drilling quality. Reservoir quality can be determined through wireline logs, LWD or cores to establish porosity, permeability, total organic carbon and saturation. Completion quality is established by the use of sonic acoustic logs. These provide shear and compressional measurements that allow interpreters to derive geomechanical rock properties such as Young’s modulus and Poisson’s ratio.

“From a completions standpoint, the geomechanical properties, in particular the *in situ* stress values, are going to be used to design the staging and perforating for a lateral,” said Malcolm Yates, stimulation domain manager for the U.S. North region with Schlumberger’s well service division. “The idea is to locate stages and perforations in like-stressed rock.”



A history match of actual production data in blue and simulated production data from a microseismic-calibrated reservoir model in red shows an excellent match between simulated and real results. *(Image courtesy of MicroSeismic Inc.)*

He added that in wells where this information is lacking, only two-thirds or less of the perfs contribute to production.

This sonic information also is used for drilling quality, Yates said, determining the optimal mud weight windows and how the drillbits will perform under certain geomechanical environments. In addition, the sonic information can be used to tie in reservoir quality to understand how the formation will respond so that MWD/LWD services can be successfully used to geosteer in these environments.

John Harkrider, chief engineer at Sigma³, said his company doesn't do completions; instead, it evaluates the best methods to get the best results. "What we bring to the table is an unbiased geoen지니어ing perspective where we want to integrate the petrophysical data, the geomechanical data and our understanding of the fracture mechanics into our completions design," he said. "Integration is the key word."

Completing a shale well requires a completely different mindset than completing a conventional well, he said. For one thing, the "law of capture" no longer applies—these reservoirs lack anything resem-

bling permeability, so a company drilling an adjacent lease is not going to drain an operator's reservoir.

"A gas molecule in 1-nanodarcy rock takes 10,000 days to move 1 m [3.3 ft]," he said. "The law of capture is no longer the issue. That molecule is going nowhere."

The low-price environment has its advantages as well, Harkrider said, even though not every operator wants to "pay for the science." "We do have some operators who will pay for the science, and usually it's the ones who have gone through the process in which they had something that was broken. These low prices will flush out some of the bad things. With \$100 oil you can be really stupid and still make money. At \$50 we're starting to see a little bit more of the clientele of operators paying more attention to the science end of things.

"I think operators are starting to say, 'OK, this is the new reality. If the price is going to be \$50 and we need to complete in an area where lifting costs are \$70, what can we do to reduce the cost? What kind of science can we apply?'"

One technology that is seeing plenty of use in the region is microseismic, the use of geophones to record the sounds created during a hydraulic fracturing operation. This has helped bridge the gap between geophysicists and completion engineers, Singleton said.

He added that Range was among the first companies in the Marcellus to embrace microseismic technology and has been successful integrating it with other types of data. It also donates datasets to universities and consortia.

"This has been a tremendous help to figure out what is going on with that play," Singleton said.

Peter Duncan, chairman and founder of MicroSeismic Inc., is not surprisingly a huge proponent of microseismic. His company did its first work in the Marcellus in 2009 and determined that the play lent itself extremely well to the technique because it has the right elastic parameters to give a noticeable response. "The Utica and Marcellus rocks are some of the best rocks we've ever monitored," he said.

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The company recommends the use of buried arrays in the area due to the trees and hills, though uptake has been slow. “Putting in a buried array is a commitment to a certain schedule on your development that people have a difficult time making in this environment,” he said. But the fact that the Utica underlies the Marcellus in some areas makes a buried array a good strategy—Gulfstar Petroleum installed an array in the Marcellus and monitored 30 wells, he said. “When [the company] went to develop the Utica, it turned the array back on and started using it for its Utica wells. It’s very capital-efficient in that stacked play to use buried arrays.”

Duncan likened the uptake of microseismic technology to the uptake of 3-D seismic in the 1980s. “If you drill a well and are disappointed with the results [and] you haven’t monitored that well, you don’t know what went wrong,” he said. “People say, just like they used to do with 3-D, ‘I’m going to wait until I drill a good well, and then I’ve got the economics to justify doing monitoring.’”

“My response is, ‘My word, what if you drill a bad well? You might kill the play, and it might be for the wrong reason.’”

This very thing happened in a field in East Texas. The operator was getting fewer hydrocarbons than predicted and was going to condemn the property. A detailed microseismic analysis indicated that the well had only completed over a small portion. The company changed its completion strategy and drilled a really good well.

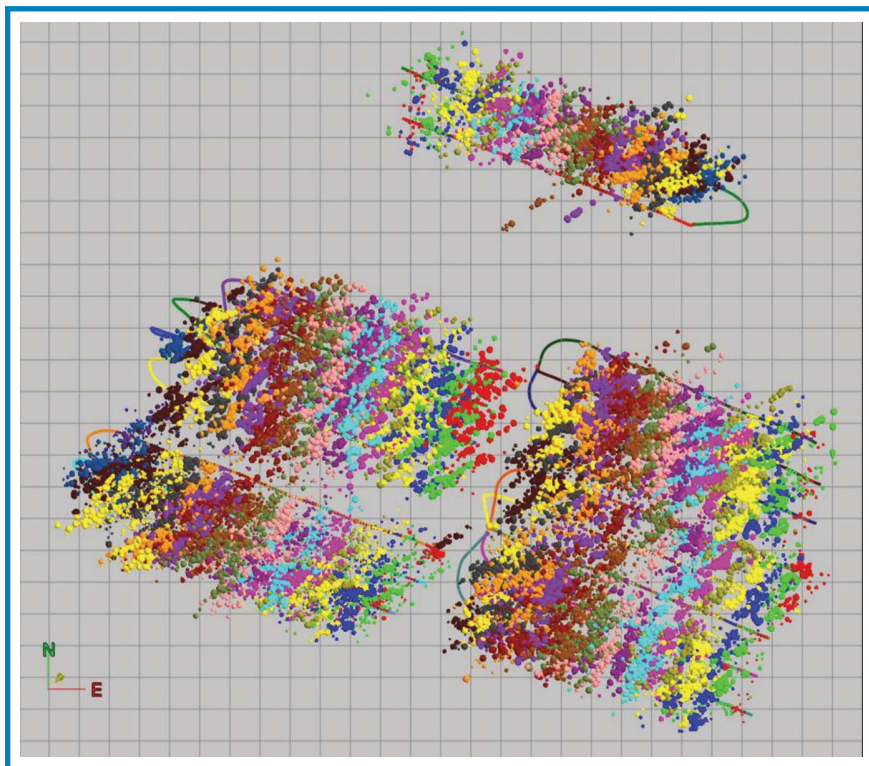
The technology has seen numerous improvements since it was first introduced in the early 2000s. Full moment tensor analysis now indicates how the rocks broke as well as when and where they broke, providing key information about the subsurface. Finding the “how” of the event requires multiple monitor wells, or operators can use a surface or near-surface array.

MicroSeismic Inc. has done work for Range and other companies where it predicted production and history-matched it four years later, getting a good match. “If you start to believe the models, you can predict production,” he said. “This helps them decide which wells are better.” It also helps them tweak their completion scenarios for future wells.

One area Duncan is pushing is putting microseismic data in the context of 3-D data. “They really are complementary views of the same structure,” he said. The company is doing a study in the Eagle Ford Shale where it shot into its microseismic array with an active source before and after the completion. In one case, a company was unsure about the microseismic data in a section in the middle of its lateral. Once it was overlain with the 3-D seismic, it was obvious that that portion of the lateral was directly on top of a graben.

“All of a sudden everything fell into place,” he said. “It increased the confidence in the microseismic data, and it helped to calculate the different rock properties outside and inside the graben.

“You miss such an opportunity if you don’t use all of the data that you have.” ■



This figure shows microseismic results for a Marcellus development. (Image courtesy of MicroSeismic Inc.)



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Statoil's rig in Wetzel County, W.Va., targets the Marcellus Shale.
(Photo by Ole Jørgen Bratland, courtesy of Statoil ASA)



Marcellus, Utica Producers Take a Wait-and-see Approach

As some companies scale back operations amid the low-price environment, others focus on efficiency and view the slowdown as an opportunity for planning their next steps in the play.

By Mary Hogan

Associate Managing Editor

Stretching from West Virginia through to Pennsylvania, New York and eastern Ohio, the Marcellus Shale is estimated to contain between 500 Tcf and 800 Tcf of natural gas, according to a two-year study released in 2015 by West Virginia University's Appalachian Oil and Natural Gas Consortium titled, "A Geologic Play Book for Utica Shale Appalachian Basin Exploration." In 2011, the U.S. Geological Survey estimated the play also contains about 3.4 Bbbl of recoverable NGL.

Lying beneath the Marcellus, the Utica Shale also contains large quantities of hydrocarbons, with the 2015 study by the Appalachian Oil & Natural Gas Consortium putting total recoverable resources at 782.2 Tcf of natural gas and 1.96 Bbbl of recoverable crude oil.

Despite the high resource potential of the Marcellus and Utica, with gas prices hovering in the \$2 to \$3 range, the region has seen a few large multinationals significantly reduce their operations. In addition, some other companies are scaling back slightly, reducing rig count but maintaining production levels for the most part thanks to improvements in completion effectiveness.

For those who choose to stay in two of the most prolific gas plays in the U.S., finding less expensive, more

effective technologies and techniques has become crucial to staying economic and remaining a key player.

Anadarko Petroleum Corp.

With about 654,000 gross (254,000 net) acres targeting the Marcellus Shale in Pennsylvania, Anadarko commands one of the largest leasehold positions in the play. The company's acreage includes both operated interests in Centre, Clinton and Lycoming counties and nonoperated interests in Potter, Tioga, Bradford and Sullivan counties, according to the company's 2015 Marcellus fact sheet.

In 2014, Anadarko's net sales volumes for the play averaged about 570 MMcf/d, and the company invested more than \$90 million in local infrastructure improvements. In second-quarter 2015, the company dedicated \$11 million in capital investments to its Marcellus operations but is not currently operating any rigs in the play, according to its second-quarter 2015 operations report. Sales volumes for second-quarter 2015 averaged 431 MMcf/d (72 Mboe/d), representing a decrease from second-quarter 2014's average sales volume of 589 MMcf/d (100 Mboe/d). Anadarko said the second-quarter 2015 average sales volume was "impacted by voluntary curtailments due to planned third-party

pipeline construction on Transco’s Leidy line for the Leidy Southeast project.”

Antero Resources

Focused solely around production in the Marcellus and Utica shales, Antero Resources estimated an increase in 2015 net daily production of about 40% over 2014’s average net daily production of 1 Bcfe/d. The production increase to more than 1.4 Bcfe/d comes despite the company trimming its drilling and completion budget for 2015 by 33% to \$1.6 billion, according to Antero’s 2015 capital budget and guid-

ance press release. Of that amount, the company allocated 60% to its activities in the Marcellus Shale and the remaining 40% to its Utica Shale developments.

Antero currently holds about 410,000 net acres prospective for the Marcellus Shale in northern West Virginia and southeastern Pennsylvania, serving as operator for 100% of its activities. The company currently is operating seven drilling rigs targeting the play and has completed and brought online 413 horizontal wells, according to an August 2015 company overview. In second-quarter 2015, net production amounted to about 1.24 Bcfe/d.

The company’s holdings also include about 149,000 net acres prospective for dry and rich gas and condensate in the Utica Shale, with acreage located in eastern Ohio. Operating 100% of its activities targeting the play, Antero is currently operating four rigs and has completed and brought online 68 operated horizontal wells, according to the company overview. In second-quarter 2015, the company reported net production of 244 MMcf/d, which included 11.9 Bbbl/d of liquids.

Antero also plans on drilling a well targeting the dry gas Utica play in third-quarter 2015. The well is set to be drilled in Tyler County, W.Va., with the company holding 181,000 net acres prospective for the dry gas Utica there, in addition to 43,000 net acres in Ohio prospective for the dry gas Utica, according to the company overview.

Cabot Oil and Gas

In the midst of low natural gas prices, Cabot Oil and Gas still has its sights firmly set on the nearly 200,000 acres it holds in the dry gas window of the Marcellus Shale. Cabot’s acreage is located primarily in Susquehanna County, Pa.

For 2015, Cabot has allocated about \$430 million, or 60%, of its drilling and completion capital to its activities in the Marcellus Shale, down by about half from the \$850 million allocated to the play in 2014. The company has identified about 3,000 possible drilling locations targeting the play and in 2015 plans on drilling about 70 net wells.

Cabot estimates 2015 average gross production to be between 1.7 Bcf/d and 1.8 Bcf/d, which represents an increase from average gross production of 1.54 Bcf/d in 2014. The company has hedges in place



With operations in the dry gas producing area of the Marcellus, Cabot is able to utilize line gas from nearby producing wells to directly power its drilling and hydraulic fracturing operations. *(Photo courtesy of Cabot Oil and Gas)*

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The company reported internal rates of return of more than 50% at \$2/MMBtu realized price, according to an investor presentation. A focus on efficiency has resulted in a 20% reduction in well costs relative to 2014. In addition to the focus on maximizing efficiencies and cost savings, the company also is testing downspacing pilot programs across its acreage position, which could result in an uplift in drilling inventory and estimated resource potential if successful.

Cabot is currently operating three rigs in the Marcellus, a decrease from six in 2014, as the company responds to lower natural gas prices. However, Cabot anticipates an acceleration of activity in the play over the next three years as new takeaway capacity is built to take natural gas to new markets outside of Appalachia.

Chesapeake Energy Corp.

With 1 million net acres targeting the Utica Shale, Chesapeake remains one of the most active players in the region. The company calls the eastern Ohio Utica one of its “biggest growth areas,” according to its website and reported net production of 110,000 boe/d. Chesapeake also holds about 230,000 net acres prospective for the Marcellus Shale in Pennsylvania, with net production of 832 MMcf/d.

In December 2014, the company sold 413,000 acres prospective for the two plays in West Virginia and southern Pennsylvania to Southwestern Energy Co. for about \$4.98 billion, holding on to what it considers its core acreage.

Due to the low oil-price environment, the company reduced 2015 capex earlier this year from an initial estimate of \$3.75 billion to \$3.25 billion, as compared to 2014 capex of \$5.8 billion. In the Marcellus, Chesapeake plans on maintaining current levels of production, with one rig currently running through year-end 2015 and one frack crew, according to the company’s first-quarter 2015 investor presentation. In the Utica, the company currently is running five rigs, with plans to reduce that number down to two in third-quarter 2015. In addition, four frack crews currently are in place, with plans to reduce that number down to 2.5 throughout year-end.

Chevron

Chevron has positioned itself as one of the larger operators in the Marcellus and Utica shales, holding 718,000 net acres prospective for the Marcellus and 364,000 net acres prospective for the Utica. The company’s acreage primarily lies in southwestern Pennsylvania, eastern Ohio and the West Virginia panhandle, according to its 2014 annual report.

Chevron reported 2014 average net production of 269 MMcf/d of natural gas for the two plays. In the Marcellus, the company drilled 85 development wells in 2014 and operated four drilling rigs. “Development is proceeding at a measured pace, focused on improving execution capability and reservoir understanding,” the company said in its 2014 annual report. In the Utica, the company drilled six exploratory wells targeting the play in 2014.

According to *Marcellus Drilling News*, in February 2015 the company listed for sale 17,000 acres in Bedford, Blair and Cambria counties in Pennsylvania. The company continued to pare back its Marcellus holdings, listing for sale another 11,700 acres in Clearfield and Cambria counties in May 2015, followed by 6,630 more acres in Centre County, Pa.

EOG Resources

EOG Resources holds about 71,000 net acres targeting the gas window of the Marcellus and Utica shales, according to an August 2015 corporate presentation. The company’s acreage mainly lies in Bradford, Clearfield, Elk and McKean counties in Pennsylvania, according to *fracktrack.org*.

In its August presentation, EOG identified its Marcellus and Utica shale holdings, along with additional acreage in plays targeting natural gas production, as holding option value for natural gas price recovery. Within the past few years, the company has reduced its activities targeting the Marcellus and Utica shales, saying in its 2014 annual report that it has “focused on maintaining base production in the Marcellus Shale.” The company reported net production of 30 MMcf/d of natural gas in 2014 and said its plans for 2015 in the Marcellus include focusing on “infrastructure projects that will support additional development in the coming years.”

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EQT Corp.

With a significant foothold in Appalachia, EQT Corp. continues to count the Marcellus Shale as a key driver of growth. The company's holdings in the play amount to about 600,000 acres, located in central and southwestern Pennsylvania and northern West Virginia, according to a July 2015 analyst presentation. Total resource potential for the company's Marcellus acreage amounts to 31 Tcf, with 23.3 Tcf in proved, probable and possible reserves.

In the wake of the low commodity price environment, EQT decreased its 2015 capital budget to \$1.8 billion from an original estimate of \$2.5 billion, with \$1.7 billion slated for production activities, according to the company's revised 2015 operational forecast.

In central Pennsylvania, the company is in the early stages of acreage delineation and holds 80,000 acres with 620 drilling locations identified. In 2015, EQT plans to drill and complete nine wells with activity spaced across Clarion, Armstrong, Jefferson, Elk, Cameron and Clearfield counties. EUR per well averages 7.4 Bcf, and the company will use 5,400-ft laterals and 124-acre spacing, according to the analyst presentation.

EQT holds 140,000 acres targeting the dry gas region of southwestern Pennsylvania, in Allegheny, Washington and Greene counties. With 1,560 locations identified, the company plans on drilling 79 wells in 2015, using 5,400-ft laterals and 89-acre spacing. EUR per well averages 11.3 Bcf, according to the presentation.

The company's holdings in northern West Virginia target both the wet gas and dry gas windows with 90,000 acres and 33,000 acres, respectively. In 2015, EQT plans on drilling 45 wells targeting the wet gas window across Wetzel, Tyler, Doddridge and Ritchie counties using 5,400-ft laterals and 94-acre spacing. EUR per well is estimated at 11 Bcf. Also during 2015, the company plans on drilling seven wells targeting the dry gas window across Monongalia, Marion, Taylor and Harrison counties, using 5,400-ft laterals and 109-acre spacing. EQT estimates EUR per well at 9.4 Bcf, according to the presentation.

In addition, EQT seeks to target the dry Utica Shale, with plans to drill three wells in 2015 at a depth of 13,500 ft. The company has identified

3,000 possible locations across 400,000 acres in Pennsylvania and northern West Virginia, according to the presentation.

EV Energy Partners LP

EV Energy Partners (EVEP) currently holds 173,000 net acres in Ohio and Pennsylvania, which the company believes may be prospective for the Utica Shale. The company has a small interest in a joint venture (JV) between Chesapeake Energy Corp., Total E&P U.S. and EnerVest Ltd., which mainly operates in the wet gas window of the play, according to an August 2015 corporate presentation by EVEP. To date, the JV has drilled more than 500 wells and has expanding oil window activity.

EVEP's Appalachian Basin holdings have estimated net proved reserves of 5.1 MMbbl of oil, 94.4 Bcf of natural gas and 2 MMbbl of NGL, according to its 2014 annual report. As an MLP, the company prefers to develop more mature plays in its portfolio. Therefore, the company has announced plans to continue looking at opportunities to sell off Utica acreage.

"We continue to pursue additional forms of monetizations, and we cannot at this time predict the type of transaction or transactions we may enter into or the type or amount of consideration we may receive," the company said in its 2014 annual report. "We may not be successful in our efforts to monetize the Utica Shale properties, it may take longer to complete a transaction than we expect, or we may decide to delay the monetization of all or a portion of the Utica Shale properties."

Gastar Exploration Ltd.

The Appalachian Basin's Marcellus and Utica shale plays make up one of two focus areas for Gastar Exploration Ltd., with the company also active in the Mid-continent region. Overall, Gastar holds about 50,500 total net acres in the Appalachian Basin, with 37,700 net acres targeting the dry gas Marcellus Shale in Marshall and Wetzel counties in West Virginia, according to a May 2015 investor presentation. In addition, the company holds 9,200 net leased acres targeting the dry gas Utica Shale and has an additional 1,900 net acres pending, with Utica holdings underlying the company's core Marcellus position.

First-quarter 2015 net production for Gstar's Appalachian operations totaled 6.76 Mboe/d, representing 54% of total net production during the quarter. In addition, the company reported proved reserves in the region of 68.1 MMboe, representing 67% of total proved reserves. Gstar reported a PV-10 value of \$353.5 million for its reserves in the region. Internal rates of return amount to 15% for the company's Marcellus operations and 9% for the company's Utica operations. In the Marcellus, the company has identified about 62 drilling locations, and in the Utica, Gstar reported about 55 drilling locations, according to the investor presentation.

In 2015, Gstar plans on spending \$19 million of its total capital budget to complete seven gross (3.5 net) Marcellus wells using enhanced reservoir evaluation and stimulation and one gross (0.5 net) Utica well, according to the company's first-quarter 2015

results. The company's development plans do not include drilling activity in the two plays during 2015, with Gstar possibly resuming drilling activity the following year if economic conditions warrant.

Gulfport Energy Corp.

With 243,000 net acres targeting the Utica Shale, Gulfport Energy Corp.'s total production in 2014 grew by 255% from production in 2013. Despite lowering its capital in 2015 to \$630 million to \$690 million from 2014's capital budget of \$1.1 billion to \$1.2 billion, the company anticipates continued growth. Gulfport estimates 2015 production to increase by 115% to 125% from 2014 production, according to the company's August 2015 investor presentation.

The company's holdings comprise 5% oil, 17% condensate, 14% wet gas and 64% dry gas and account for net proved reserves of 907 Bcf and net probable



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reserves of 300.3 Bcf. Gulfport currently operates four rigs in the play in addition to also having one nonoperated rig in the dry gas window. For 2015, the company allocated \$416 million to \$446 million in operated E&P capex to its Utica operations, with plans to drill 32 to 36 net wells and turn to sales 42 to 46 net wells, according to the investor presentation. The company also has allocated \$125 million to \$140 million in nonoperated capex to the play, with additional plans to have four to six net wells drilled and seven to nine net wells turned to sales on its acreage by other operators. Average second-quarter 2015 net production of 458 MMcf/d makes up 97% of Gulfport's total net production.

The company's growth doesn't stop there. In April 2015, Gulfport entered into an agreement to acquire Paloma Partners III LLC, which holds 24,000 net acres in the dry gas Utica. The deal is expected to close in third-quarter 2015, with Gulfport set to add one rig in fourth-quarter 2015 in the acquisition area, according to the investor presentation. In addition, the company entered into an agreement to acquire about 35,325 net acres from American Energy—Utica LLC, targeting the dry gas Utica. The sale closed in June 2015, and Gulfport plans on adding one rig at the start of 2016.

Halcón Resources

Halcón Resources has leased about 128,000 acres targeting the Utica and Point Pleasant formations, with most acreage either HBP or with an allowance of five years to drill a well with renewal options for an additional five years, according to the company's 2014 annual report. The company is located in both Ohio, in Trumbull and Mahoning counties, and in Pennsylvania in Mercer and Venango counties.

At year-end 2014, the company reported average net production of 550 boe/d, with 10 producing operated wells and three shut-in wells "waiting on pipeline/market evaluation," according to the annual report. Halcón said it does not plan on drilling any additional wells in 2015 and as of the end of second-quarter 2015 has held to that plan, mainly dedicating resources to its core plays, El Halcón in the Eagle Ford Shale and the Bakken/Three Forks formations.

"We continue to monitor area competitor activity and new technologies that might allow for lower

cost development and increased recoveries from this hydrocarbon-rich basin," the company said in its 2014 annual report.

Hess Corp.

Operating in Jefferson, Belmont, Harrison and Guernsey counties, Hess Corp. holds 90,000 acres prospective for the Utica Shale. That acreage includes the portion held by the company's 50:50 joint venture (JV) with CONSOL Energy. Although Hess decreased its 2015 capital budget in the Utica to \$290 million, compared with a budget of \$500 million in 2014, the company still intends to drill several wells throughout the year, according to a capital guidance press release.

In the wet gas window of the play, the JV is operating two rigs on 47,000 acres and plans on bringing 25 to 30 wells online by year-end.

In second-quarter 2015, total net production of 22 Mboe/d comprised 2 Mbbbl/d of oil, 7 Mbbbl/d of NGL and 82 MMcf/d of natural gas, according to a second-quarter 2015 presentation. Total production for the quarter represents an increase over production levels from second-quarter 2014, which totaled 7 Mboe/d and comprised 1 Mbbbl/d of NGL and 37 MMcf/d of natural gas. As of the end of second-quarter 2015, Hess reported 30 wells on production targeting the Utica Shale.

Magnum Hunter Resources Corp.

Completion activities for Magnum Hunter Resource's Marcellus and Utica operations will command the company's attention in 2015. In the midst of continuing low oil prices, the company adopted a 2015 upstream capital budget of \$100 million, allocating \$70 million to its Appalachian Basin holdings, according to a June 2015 investor presentation. The budget represents a reduction of about 75% from the company's 2014 upstream capital budget of \$400 million, with \$260 million dedicated to the two plays in 2014.

As it continues to monitor the commodity markets and regional supply and demand, Magnum Hunter has "suspended substantially" all of its drilling and completion operations, the company said in its first-quarter 2015 financial results.

Despite this halt in drilling operations, the company plans on bringing online 11 wells in the Appalachia region in 2015, including three targeting the Marcellus and eight targeting the Utica, according to the investor presentation.

The company holds about 430,000 total net acres in the Appalachian Basin, with about 80,000 net acres located in the Marcellus Shale and about 128,000 net acres prospective for the Utica Shale. Magnum Hunter reported total proved reserves in its Appalachian acreage of 817.5 Bcf and proved producing reserves of 313.8 Bcf, with a PV-10 value of \$765.8 million as of Dec. 31, 2014. The company has drilled and completed 62 gross wells to date targeting the two plays, including 20 wells in Tyler County and 36 wells in Wetzel County, W.Va.; and five wells in Monroe County and one well in Washington County, Ohio.

The company recently tested and placed on production three horizontal Utica Shale wells at its Stalder pad, in addition to completing and testing the first Marcellus horizontal well on the pad, according to the investor presentation. Other notable activity includes seven planned laterals at the Stewart-Winland pad, with four wells having been drilled and completed on the north unit, including three targeting the Marcellus and one targeting the Utica. Long-term development plans call for drilling three wells on the pad's south unit, all of which will target the Marcellus. The company also fracture-stimulated a Utica well at the pad, which tested at a rate of 46.5 MMcf.

Noble Energy Inc.

Noble Energy Inc. teamed up with joint-venture (JV) partner CONSOL Energy Inc. in the develop-



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ment of about 700,000 gross acres targeting the Marcellus Shale. The JV's acreage lies in both the wet and dry gas windows of the play in southwestern Pennsylvania and northwestern West Virginia, according to Noble's 2014 year-end results. Noble has been operating the rigs targeting the wet gas window, with CONSOL operating the rigs targeting the dry gas window.

In 2014, Noble drilled 91 wells, with the JV drilling a total of 179 wells during the year, according to Noble's fourth-quarter 2014 and year-end 2014 results. In its second-quarter 2015 results, Noble reported a 70% increase in production vs. second-quarter 2014, with average production of 427 MMcf/d of natural gas equivalent. Production for the quarter comprised 86% natural gas and 14% condensate and NGL.

During second-quarter 2015, Noble averaged two operated and two nonoperated rigs, drilling 20 operated wells and starting production on 19 operated wells. In addition, Noble said in its second-quarter 2015 results that CONSOL had drilled 15 wells and started production on 11 dry gas wells. At the start of 2015, Noble set capex at \$2.9 billion, with \$1.8 billion split between its Marcellus and Denver-Julesburg Basin operations, according to the company's 2015 guidance. Moving forward into second-half 2015, however, "the JV partnership is aligned to continue reducing drilling activity in the basin," according to Noble's second-quarter 2015 release. Noble plans on eliminating the one active horizontal rig it currently has drilling, with CONSOL eliminating the two horizontal rigs it is currently using, in fourth-quarter 2015.

PDC Energy Inc.

PDC Energy Inc. holds about 67,000 net acres targeting the Utica Shale, with about 50% of that acreage HBP. Acreage lies in southeastern Ohio and targets both the condensate and wet gas windows of the play. As of year-end 2014, the company's proved reserves in the play totaled 5 MMboe, according to PDC's 2014 annual report. Drilling activity comprised 11 horizontal wells in 2014, with PDC tripling production volumes in the Utica from 617 boe/d in 2013 to 2.2 Mboe/d in 2014.

As a result of the current low-price environment, the company has suspended its drilling program in the play but will continue some completion and production activities. PDC currently has 23 producing horizontal wells and spent a portion of its \$35 million 2015 Utica capital program to complete its four-well Cole pad in Guernsey County, according to its second-quarter 2015 report. The company's plans also include processing 119 sq miles of seismic data derived from an area in Washington County, Ohio.

Another major area of focus for the company is its four-well Dynamite pad, which PDC drilled and turned in-line by year-end 2014. The company reported the pad's performance as 15% higher than the average EUR of 680 Mboe after 150 days, according to an August 2015 presentation by PDC.

For the remainder of 2015, PDC plans to "develop production, reservoir and completion analyses from its recently drilled wells and incorporate the data into its future drilling programs," according to the company's 2014 annual report.

Range Resources Corp.

With more than 1.5 million total net acres stacked in Pennsylvania, predominantly in the southwestern portion of the state, Range Resources has emerged as the one of the largest operators in the Marcellus and Utica plays. The company pioneered the Marcellus in 2004 and drilled the industry's first horizontal Utica/Point Pleasant well in 2009. Of the company's total acreage, 640,000 net acres target the Marcellus and 400,000 target the Utica, according to a June 2015 company presentation.

Earlier this year, the company reduced its capital budget from \$1.3 billion in 2014 to \$870 million in 2015 to account for lower commodity oil prices. Of the current budget, about 95%, or \$836 million, is allocated to Range's Appalachian Basin operations in Pennsylvania. Despite the reduced capital budget, the company will target 20% production growth in 2015 by concentrating its operations in the prolific Marcellus and seeking to develop additional completion efficiencies, according to a January 2015 press release about Range's updated capital budget. Among those efficiencies, the company reported a decrease in unit costs of

40% and a decrease in Marcellus well costs of 57% in southwestern Pennsylvania, according to the company presentation.

Production for the company's northern Marcellus Shale division increased 15% over the prior year to an average of 231 MMcf/d, according to Range's second-quarter 2015 financial results. The company anticipates running one to two rigs in the area, with plans for the remainder of 2015 also including turning 11 wells to sales.

The company's southern Marcellus Shale production also increased in second-quarter 2015, rising 35% over the same quarter in the prior year. Development plans in the region include drilling two additional dry gas Utica wells in 2015, in addition to turning 32 Marcellus wells to sales in the dry gas window of Washington County, Pa., according to the company's second-quarter 2015 financial results.

Rex Energy

With a revised 2015 capital budget between \$135 million and \$145 million, Rex Energy will maintain its foothold in the Appalachian Basin, allocating about 90% of that amount to its activities in the region, according to a June 2015 corporate presentation. The company plans on spending between \$124 million and \$134 million on its Marcellus and Utica shale operations in the Butler Operated Area and Ohio Utica Warrior prospect.

Current drilling plans include running one full-time rig in the basin to drill between 29 and 31 gross operated wells, including plans to drill 10 in the Legacy Butler area, 16 to 18 in the Moraine East Area and three in the Ohio Utica Warrior prospects. The company also plans on completing between 27 and 31 gross operated wells in the basin in 2015, including 17 in the Legacy Butler area and eight to



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12 in the Moraine East Area. Net resource potential for the two plays includes 2.3 Tcf for the Legacy Butler Operated Area targeting the Marcellus, 3.6 Tcf for the Legacy Butler area targeting the Upper Devonian, 4.7 Tcf for the Moraine East Area targeting both the Marcellus and Upper Devonian, 0.8 Tcf for the Ohio Utica Warrior North prospect and 0.3 Tcf for the Ohio Utica Warrior South prospect, according to the presentation.

Rex recently entered into the Butler Operated Area joint venture with ArcLight to develop 16 wells in the Moraine East Area and 16 wells in the Legacy Butler Operated Area. According to the corporate presentation, the initiative reduces 2015 operating capex by \$60 million.

The company also has a sizable nonoperated position targeting the Marcellus in Westmoreland, Clearfield and Centre counties in Pennsylvania, with about 28,500 gross (11,300 net) acres, according to the corporate presentation.

Rice Energy Inc.

Rice Energy holds acreage in three of the most economic counties in the Appalachian Basin, including Washington and Greene counties in

Pennsylvania and Belmont County in Ohio. For 2015, the company adopted a capital budget of \$890 million, down from its 2014 capital budget of \$1.1 billion, according to its 2014 annual report. Of that amount, Rice plans on spending \$340 million for drilling and completion activities in the Marcellus Shale and \$220 million for its Utica Shale operations.

Rice Energy holds about 89,000 net acres targeting the Marcellus in southwestern Pennsylvania, with 495 net undeveloped locations identified, according to a June 2015 investor presentation. Development plans for 2015 include drilling 39 gross horizontal operated Marcellus wells and bringing online 31 net wells. In second-quarter 2015, the company's Marcellus production averaged about 403 MMcf/d, according to the investor presentation.

In southeastern Ohio, the company holds about 56,000 net acres targeting the Utica Shale, with 98% of acreage located in Belmont County in the dry gas window. In addition, Rice has identified 356 net undeveloped locations in the play. Development plans in 2015 call for drilling 13 net operated horizontal Utica wells and bringing online eight net wells in addition to drilling nine net Utica wells



A frack job is underway on a Rice Energy well in Pennsylvania. (Photo courtesy of Rice Energy)

and bringing online two net wells on the company's nonoperated properties. Rice plans on reducing its rig count in the two plays to three for the remainder of 2015, with two operating in Pennsylvania and one in Ohio.

Seneca Resources Corp.

Seneca Resources Corp., the E&P subsidiary of National Fuel Gas Co., has made its Appalachian Basin acreage a priority as it focuses on production from the Marcellus and Utica shales. The company holds 790,000 net acres prospective for the Marcellus, located in Pennsylvania, according to an August 2015 investor presentation. The company reported proved reserves of 1.9 Tcfe as of Sept. 30, 2014, and annual crude oil production of about 3 MMbbl.

In 2014, the company's east division, which oversees more than 3,000 shallow wells and 150 deep wells in the Appalachian region, saw production of 139.3 Bcfe. Seneca estimates 2015 production from the region will be between 135 Bcfe and 139 Bcfe, according to the presentation. Within the east division, the company has divided its holdings into the western development area, with 720,000 acres, and the eastern development area, with 70,000 acres.

In 2015, Seneca is focusing production from the western development area on its holdings in the Clermont/Rich Valley region in Elk, Cameron and McKean counties. The western development area has 860 locations where operations remain economic at prices between \$2.19/MMBtu and \$2.45/MMBtu and between 200 and 250 horizontal locations identified, with 40 wells currently online in the Clermont/Rich Valley region. The company reported production capacity as 150 MMcf/d and the average IP rate as 7.7 MMcf/d. Further plans in the western development area call for drilling two Utica test wells in 2016, according to the presentation.

Within the company's eastern development area, the Covington area in Tioga County, Pa., has 47 producing wells with an average IP rate of 5.2 MMcf/d. The Tract 595 area, also in Tioga County, has 44 producing wells with an average IP rate of 7.4 MMcf/d, and the Tract 100 area in Lycoming County, Pa., has 57 producing wells with an average IP rate of 16.8 MMcf/d.

Southwestern Energy Co.

In recent months, Southwestern Energy has built a sizeable stake in the Marcellus and Utica shale plays. In December 2014, the company purchased an inter-



Southwestern Energy holds about 443,000 net acres in southwest Pennsylvania and West Virginia and about 312,773 acres in its northeastern Appalachian region. (Photos courtesy of Southwestern Energy)



In 2015 Southwestern Energy plans on drilling 88 to 92 wells in its northern Appalachian region and 50 to 55 wells in its southwestern Appalachian region.

est in 413,000 net acres in West Virginia and southern Pennsylvania from Chesapeake Energy Corp. for about \$4.98 billion. In January 2015, the company acquired 20% of Statoil's working interest, amounting to 30,000 acres in West Virginia and southwestern Pennsylvania for about \$394 million.

In February 2015, Southwestern purchased an additional 46,700 net acres targeting the Marcellus Shale in Susquehanna County, Pa., for about \$288 million from WPX Energy, according to a WPX press release. Southwestern added substantial production with the acquisition, which accounts for about 50 MMcf/d of natural gas produced from 63 operated horizontal wells.

The additions to the company's southwestern Appalachian holdings target natural gas, NGL and oil reserves, with net production at year-end 2014 reported as 370 MMcf/d, according to the company's website. The company holds about 443,000 net acres in southwestern Pennsylvania and West Virginia, according to an August 2015 corporate update. In the northeastern Appalachian region, Southwestern

Energy holds about 312,773 net acres, with production as of June 2015 totaling about 1.2 MMcf/d, according to the August 2015 presentation.

In 2015, the company plans on drilling 88 to 92 operated horizontal wells in the northern Appalachian region, with total 2015 net production estimated at 363 Bcf to 366 Bcf, according to Southwestern Energy's second-quarter 2015 earnings release. Development plans for the southwestern Appalachian region include drilling 50 to 55 gross wells, which will mainly target the wet gas window of the Marcellus. Net production in the region for 2015 is estimated to be between 139 Bcf and 142 Bcf, according to Southwestern Energy's second-quarter 2015 earnings release.

Statoil ASA

The Norwegian energy giant has made its mark in the Marcellus with 512,000 total net acres targeting the play, including 91,000 acres operated by Statoil. In 2008, the company teamed up with Chesapeake Energy in a joint venture, gaining 585,000 acres in



Statoil's Marcellus operations in Wetzel County, W.Va., make up part of the company's 512,000 net acres targeting the play. (Photo by Ole Jørgen Bratland, courtesy of Statoil ASA)

the Marcellus, or 32.5% of 1.8 million acres controlled by Chesapeake, according to Statoil's 2014 annual report.

In February 2015, the company sold 30,000 acres targeting the Marcellus to Southwestern Energy for about \$394 million, with the acreage located in West Virginia and southwestern Pennsylvania.

Statoil reported 2014 average production from its Marcellus holdings of 128.8 Mboe/d. Operated acreage lies in northern West Virginia and on the edge of eastern Ohio, and nonoperated acreage is primarily located in northern West Virginia and Pennsylvania, according to the company's Marcellus fact sheet.

Future development plans will consider price development and continued improvement in operational efficiency, Statoil said in its 2014 annual report.

Talisman Energy Inc.

Canadian producer Talisman Energy Inc. was recently acquired by Spanish energy giant Repsol in an \$8.3 billion deal finalized in May 2015. The company is an active player in the Marcellus Shale, holding about 170,000 net acres in Pennsylvania, according to Talisman's 2014 year-end financial results. Production averaged about 461 MMcf/d in 2014, and the company drilled 30 gross wells targeting the play in the Friendsville region.

Ultra Petroleum

In 2014, Ultra Petroleum sold about 155,000 net acres in Pennsylvania as part of a deal to acquire acreage in the Pinedale Field in Sublette County, Wyo., from SWEPI LP, according to Ultra Petroleum's 2014 annual report. After the transaction, Ultra still owns 184,000 gross (91,000 net) acres prospective for the Marcellus Shale located in Lycoming, Clinton and Centre counties in north-central Pennsylvania.

Ultra's 2014 drilling activity included six horizontal wells targeting the Marcellus Shale. In light of the current low-price environment, however, the company's 2015 development plans will shift away from its Marcellus holdings to other areas of its portfolio with better returns on investment, according to the annual report.

Ultra's second-quarter 2015 production from the play averaged about 20.88 MMcf/d, with cumu-

lative production of 1.9 Bcf for the quarter, according to the company's second-quarter 2015 results. Required maintenance on a pipeline caused net production during this period to decrease by 2.2 Bcf, with service being restored by the end of the second quarter.

WPX Energy

In October 2014, WPX Energy outlined a multiyear strategy that seeks to aggressively divest assets not falling within its three core areas of the Williston, San Juan and Piceance basins. As such, the company has worked to quickly sell its interests in the Appalachian Basin.

In February 2015, WPX completed the sale of about 46,700 net acres prospective for the Marcellus Shale in Susquehanna County, Pa., to Southwestern Energy Co. for about \$288 million, according to a press release from WPX. Encompassing 63 operated wells, these operations produce about 50 MMcf/d of natural gas.

In May 2015, WPX also sold marketing contracts and released transportation capacity in the Marcellus Shale for more than \$200 million. After these two transactions, the only Marcellus Shale operations that remain for WPX include those in Westmoreland County in southwestern Pennsylvania, according to the release. The company has plans to sell these assets as well.

XTO Energy

XTO Energy, a subsidiary of Exxon Mobil Corp., commands a solid stake in the Marcellus Shale with 576,533 acres prospective for the play. Areas of operation include Montoursville, Clinton, Centre, Clearfield, Jefferson, Clarion, Indiana, Armstrong, Butler, Allegheny, Cambria, Westmoreland, Washington, Fayette and Somerset counties in Pennsylvania, according to the company's website. In addition, the company holds 81,452 acres prospective for the Utica Shale, with acreage located in Belaire and Monroe counties in eastern Ohio.

XTO currently is running one rig as part of its Marcellus operations and reported gross production of 240 MMcf. In the Utica, the company operates one to three rigs with gross production of 40 MMcf, according to XTO's website. ■

Drilling operations take place in the Marcellus Shale. (Photo courtesy of Range Resources)



Economics to the Forefront in the Marcellus-Utica

Operators and service companies continue to push the envelope of technology and lower well costs to keep the resource play viable during the downturn.

By Blake Wright
Contributing Editor

Weak commodity prices and the gloom of a protracted downturn in the U.S. oil and gas industry have cast a pall over markets across the Lower 48 where operators have either sought to plow through the trough, albeit with lower activity levels, or halt work all together until things improve. According to Baker Hughes, the U.S. land rig count stands at just under 900 rigs, down more than 1,000 units from this time last year and well off the 2008 peak of more than 2,000 active rigs. No region has shown much immunity to the downturn, including the resource-rich Marcellus-Utica in the northeastern U.S. Oil and gas prices looked to be on the rebound this spring, but the summer months have seen pricing back down once again, fueled by weaker demand in Asia and uncertainty in the Middle East.

The Marcellus rig count is hovering around 50 units, representing a 37% drop over the past 12 months. Lower activity has the prolific natural gas basin staring down its first decline in production since shale reserves began flowing from the area more than 10 years ago. A handful of producers have taken to shutting in production until better times return or at least until adequate infrastructure is in place to move resource out of the area. Those who are still active in the region have posted some

stunning well results recently from the dry gas window of the Utica. EQT revealed in July that a Greene County, Pa., well came on at an initial rate of 72.9 MMcf/d of natural gas during a 24-hour test. That result came on the heels of a far east Utica well in Westmoreland County, Pa., from Consol Energy that came on at about 65 MMcf/d. Those dizzying IPs are just the icing on the cake for the Utica, currently one of the nation's most prolific basins. According to the Ohio Department of Natural Resources, the state's 978 horizontal wells produced 5.5 MMbbl of oil and 221 Bcf of natural gas in second-quarter 2015. That represents a 20% jump in oil volumes and an almost 21% leap in natural gas flows over the first-quarter 2015 tally.

If operators need a bit more silver lining to the graying skies over the play consider the following. With activity reductions come cost reductions. Coupled with the innovations integrated into the play over the last decade, the result is lower well costs, even as operators reach out with longer lateral sections and increased frack stages per bore. Laterals reaching 10,000 ft are not unheard of. All of this increases drilling and completions costs, but in a depressed market, where service costs are down as much as 25% since year-end 2014, it becomes more affordable. Chesapeake boasted

back-to-back sub-10-day wells in the area this spring. Roughly a year ago, operators in the region were routinely looking at 25 to 30 days per well. With efficiencies up and service costs down, it continues to make sense for operators to drill, but it remains a challenging environment to move forward with completions and production.

Offshore manifolds come to Appalachia

Manifold systems are quite common when dealing with multiwell, offshore developments around the world. They are an efficient way to control fluid, electricity and production of several wells from a central hub-style location, instead of dealing with each well's needs individually. Onshore, manifolds have found a home in hydraulic fracturing spreads across the Lower 48. Under much of the same principle as their offshore counterparts, fracking manifolds allow pressure pumpers to pump sand and fluid to a central point for distribution to multiple wells on a pad without having to rig down and rig up. Service specialist Cameron, which launched its CAMSHALE suite of services in 2008, was one of the first to deploy a manifold-style system for this use as well pads onshore started to grow. Of course, changes to the offshore system were needed, and Cameron took a hard look at how to transition the equipment for its new role.



This Cameron Generation I frack manifold (an arrangement of flow fittings and valves installed downstream of the frack pump output header and upstream of each frack tree served by it) used in the Marcellus is an integrated skid design for up to 7¹/₁₆-in. 15,000-psi operations. *(Photos courtesy of Cameron)*

“We looked at the number of pieces of iron going from the manifold or truck to a frack tree and developed a full-sized line [5 in. or 7 in.] that transitions from the manifold to our trees—it’s called the Monoline,” explained David Bonin, Cameron’s director of sales and operations for the eastern U.S. region. “It is basically a line that has the ability to come in at varying degrees. It utilizes flange technology so it is not a screw-type connection. It is a flanged, API-type connection. We started that in 2010/2011. We trialed it down in the gas window of the Eagle Ford and have since brought it up and used it in the Northeast. More people are accustomed to the flanged connection in a high-pressure environment. It makes the location neater, cleaner and less cluttered. Again, from a safety aspect, it reduces your trips, overhead and interaction of people.”



Cameron introduced a new frack fluid delivery system, the Monoline, to Marcellus frack operations. The system uses controlled, bolted connections that promote a higher level of system integrity and safety.

The Monoline configuration allows the freedom of movement needed to accommodate vertical and horizontal misalignment between the frack tree and the frack manifold. Its metal-to-metal seals are designed to minimize potential leak paths and failure points. The overall design looks to increase structural integrity of the entire wellhead as a result of a single, dedicated flowline.

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Another system that was brought over from the contractor’s production lineage was its FLS-R valve. The reduced-torque valve was a proven commodity in high-pressure production service but also has demonstrated that it is very capable of handling a frack job.

Frack emission, well monitoring and dissolvable plugs

Halliburton also is customizing solutions better suited for the Marcellus-Utica area, which includes aligning its workforce to address both its clientele and the lower demand for services during the downturn. The company recently consolidated its position in the area by moving jobs from Homer City, Pa., to Zanesville, Ohio. The company also has shuffled new technology into the area, with a focus on everything from emissions reduction to better downhole communications.

The northeastern U.S. remains one of the more pollution-conscious areas of the Lower 48, especially given the boom of activity over the past several years. More activity means more trucks. More wells mean more completion teams, infrastructure and, ultimately, high emissions. To combat this, Halliburton recently introduced its Tier 4F-compliant frack fleet into the basin via work with CONSOL Energy at its Pittsburgh International Airport project. The fleet is fully compliant with the Environmental Protection Agency’s (EPA) 2015 Tier 4F emissions standard for nonroad, high-horsepower engines.

“We’ve seen a significant reduction in particulate matter through the utilization of this fleet; the engines reduce particulates by 93% and oxides of nitrogen and hydrogen by 63%,” said Des Murphy, business development technology manager at Halliburton. “We have had quite a successful introduction up here in the Northeast with CONSOL Energy, and we are proud. It is a good thing for Halliburton to have been seen as a leader in low emissions technology frack fleets.”

Tier 4F equipment was used to complete fracturing jobs on the first of all six pads on the property.

Halliburton also has observed new movement by operators toward permanent fiber-optic monitoring of wells in the area. Using fiber run on the outside of the wellbore, operators can monitor temperature and acoustics, among other things.

“Once you’ve got that fiber in the ground, you have the ability to monitor your cement job and get an idea regarding cement integrity,” Murphy added. “You can then also monitor your frack job and get a better understanding of your cluster efficiency and how the well is actually treating (i.e., what clusters are



Halliburton’s SandCastle PS2500 proppant storage systems are on location at CONSOL Energy’s Pittsburgh International Airport project. (Photo courtesy of Halliburton)

“We were fortunate that we could take it from the production side of the business and basically reverse it into the frack side of the business,” Bonin said. “Once you install it, if you choose to flow back through it, you can. It is durable enough to take a frack but also dependable enough to be used in the production environment as well. [There are] no significant modifications. We developed a lubrication program that cleanses the body. It’s not there to do anything to help the sealing. It is there to void the body of any buildup contaminants or frack proppant that might get trapped or cause a problem. The only modifications are in the maintenance and how you take care of the valve during the fracking operation. We pioneered that down in South Texas in the conventional gas market. We determined the intervals and type of lubricants to use, because not just any grease is good. Our lubricant is an engineered product. Many people are offering different mechanical solutions. We haven’t had to go that route.”

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taking fluid). Then you can make a real-time decision on whether or when to use a diverting agent to access the full range of clusters. During the treatment you also are able to monitor the wellbore to determine if you are having issues with slipping or leaking frack plugs or communication outside the casing. You also can do post-production monitoring and look at the well over the course of its life to get a good understanding of what zones are producing and which are not. Then you have the opportunity maybe later in the well's life to go back and stimulate those zones that hadn't been producing."

While acceptance of permanent fiber-optic monitoring has grown, its uses also have expanded to include interference testing between adjacent wellbores to determine the optimal well spacing to prevent "well bashing" impacting production.

Halliburton also has been on the cutting edge of the dissolvable plug market. Use of dissolvable plugs is a relatively new technology that is generating a lot of interest in terms of an option for not having to intervene with coiled tubing once the well has been completed. The company publicly introduced its Illusion Frac Plug this summer. The 10,000-psi-rated plug can be installed at any position in the wellbore and will dissolve completely, leaving an unrestricted well for production. The new technology, currently available in 4.5-in. and 5.5-in. casing sizes, has been run in shale plays like the Eagle Ford, Bakken and Woodford and will likely make its northeastern U.S. debut soon.

"The plugs function as normal frack plugs to isolate each stage during the frack treatment, then they will dissolve out over time," Murphy said. "It will allow production to come out of the wellbore without having to go in and perform a cleanout with coiled tubing. They have only just recently been introduced here by Halliburton, but it is something that is gaining a lot of interest with our clients up here."

Longer laterals also are resulting in more hybrid-type completions in the region, where an operator might have some type of sleeve completion in the lower section of the wellbore and then move back to the regular plug and perforate up the remainder of the wellbore. These hybrid completions are attractive partly due to the fact that it is hard to get

coiled tubing to clean out a wellbore that is extended reach.

"You just can't get the coiled tubing down and get the weight on the bit to be able to drill the plugs out," Murphy said. "So you see some form of sleeve completion in the lower section and the regular plug and perf in the other section back toward the heel of the well."

Refrack attack

The concept of the refrack has been around for as long as fracturing but has started to gain new traction in the unconventional resources plays. When operators came to the Marcellus roughly a decade ago, they were still learning the lay of the land, drilling shorter laterals, using fewer stages and less proppant and searching for the sweet spots in the rock. Today, it is clear that was not the best approach. Enter refracking and an opportunity to restimulate those older regional wells using today's knowledge base.

"A lot of people are definitely going back, taking a look at some of these earlier wells and the ones that are underperforming and working out why that is," said Halliburton's Murphy. "Wells in really good rock that are laid in there well might be suffering from poor stage spacing, poor fluid design or lack of proppant. These are wells that they can go back in and quite effectively restimulate... and for much cheaper than drilling a new well. We've had a lot of experience with recompletions up here."

The proof, of course, is in results. Not many refrack jobs have occurred in the region to date, but Halliburton has been involved with roughly a dozen thus far. Earlier this summer, CONSOL Energy presented results of a seven-well Marcellus refrack program from 2014 at an industry seminar in Houston.

"We improved their EURs anywhere from 65% and 123% after we did the refrack," Murphy said. "It was a significant win for them, proving that old wells can be economically restimulated and [the company can] actually get a lot of value out of them. It comes down to selecting the right wells to begin with. Some wells aren't laid well in the producing rock. There is no use in restimulating a well that is never going to perform no matter what you do. It

takes a lot of due diligence up front to select the right candidates for these refracks. The next step is designing the best possible refrack methodology. We feel that we have the methodology down to a fairly decent art using our Pressure Sink Mitigation and also our AccessFrac Refrac technique utilizing our diverting technology. We have a very robust and competent methodology to refrack those wells, and production results are backing that up as well.”

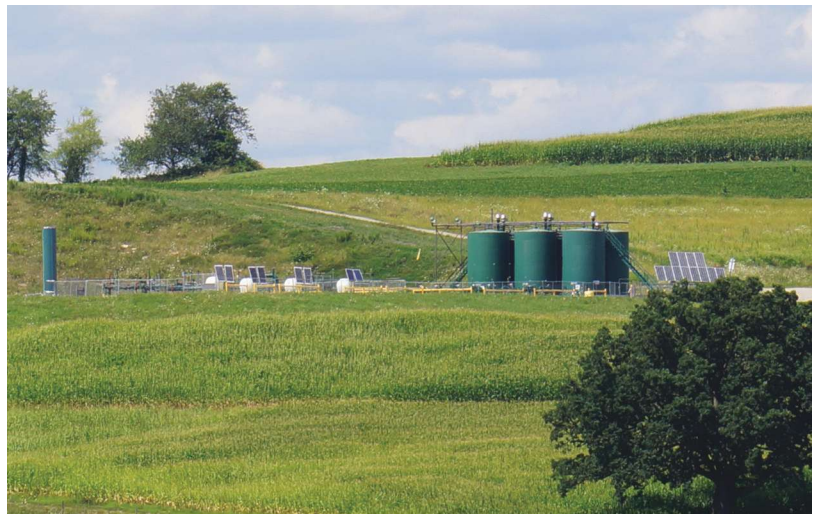
An operator’s perspective on technology

Not everyone sees refracking as sustainable business in the region, including the area’s most seasoned operator, Range Resources. Range has been in the Marcellus since the beginning, when in 2004 the company applied a modern-style Barnett Shale-type hydraulic fracturing job on a well in southwestern Pennsylvania. Range COO Ray Walker has been involved in the downhole stimulation side of the business since 1979. Then he was a Halliburton engineer that helped design and pump the very first hydraulic fracturing job ever done on a shale well—in 1982 in the Barnett Shale for shale pioneer Mitchell Energy.

“I think refracturing is one of those things that there is clearly a place for, but we as petroleum engineers or E&P companies have a whole tool box full of tools—and refracturing is just one of those tools,” Walker explained. “In my opinion, it is a very specific application where an operator encountered issues during the initial completion and did not achieve optimal stimulation of the zone. [The operator] then goes back at a later date to restimulate the well with a new and better fracturing design. That is generally when it works. I don’t think it is going to be a big deal in the Marcellus because I think the industry has done a pretty effective job employing very up-to-date completion technologies. I don’t think it is going to be a big business, but that doesn’t mean there aren’t other areas out there (that I’m not as familiar with) where it might have more impact. I think when you analyze the work that’s been done across the industry, you’ll see that it is going to be successful in very specific applications. It is certainly not going to be a

panacea across the whole industry. There is just no way.”

Range has 920 employees with more than 500 in Pennsylvania, so the company has a lot invested in the area with tremendous stacked-pay potential of its Marcellus, Utica and Upper Devonian holdings. The company had seven rigs running in the area during the summer, counting both lighter, cheaper “air” rigs that drill the tophole sections of their wells and the heavier rigs brought in to drill the curve and lateral. With the downturn have come cheaper service rates. In southwestern Pennsylvania, the same well the company was drilling at year-end 2014 cost about 25% less on average during first-half 2015. The operator’s cost and efficiency improvements in southwestern Pennsylvania have been substantial, according to numbers released by the company in late July. Over the past five years, while lateral lengths have increased 114%, well costs have



Production from multiwell pads is common in the Marcellus Shale.
(Photo courtesy of Range Resources)

tumbled 57%. Drilling costs, including the cost per foot of lateral drilled, have dipped more than 70%, while completion costs are down about 42%.

“If you look at how drilling and completion technology has evolved, of course, there are the big things like horizontal drilling, the light sand fracks or the water fracks and many other developments,” Walker said. “We’ve seen many changes, including a whole array of things on the drilling side allowing us

to drill wells today in a fraction of the time that it used to take. Wells used to take us 30 to 45 days to do a 2,500-ft lateral in the early days. Today, I think we're averaging close to 18 days for an 8,500-ft lateral well. There have been all sorts of drillbits and mud systems developed [and] technologies that manage the weight on the bit and torque on the drillstring—all of those things directed at increasing efficiencies and saving money."

Range knows that the challenges of the region extend beyond drilling and completions. Logistics and water management also weigh heavy on operators in the area. Hydraulic fracturing jobs on many of the wells in the area take a lot of water. The wells also don't produce much water. With disposal sites in Pennsylvania being negligible, operators had few choices—either truck it in and out or recycle and reuse as much as possible.

"Pennsylvania only has a handful of approved injection wells," Walker said. "The geology is just not there to do what we do in other states. It is almost impossible to get an [injection] well permitted there. It is just hard to do the engineering to come up with a zone that you could theoretically inject water into. The EPA governs the process, but it is just so technically difficult you cannot really do it in Pennsylvania. We recognized that there would have to be other and better ways to deal with the produced water. Water has been handled a lot of different ways since the early days. The solution was to just keep reusing it. The wells don't make a lot of water, and it is easy enough to put it in impoundments or tanks and just reuse it again. That's been a process that we've worked on for years. Range was the first company to do it in Appalachia, and now it is something the whole industry is adopting in

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places like South Texas, West Texas, Oklahoma and North Dakota.”

Walker estimated that 90% or more of operators in the area are using some form of recycled water in their fracks, making up volumes as needed with freshwater.

Keeping an eye on things downhole

Efficiency is a big part of the equation for Weatherford and its SecureView casing and cement evaluation service. The ability to run multiple diagnostic tools down a wellbore at one time and provide logs of the inner casing, outer casing, cement strength and cement bond has made SecureView service one of the top Weatherford offerings in the Marcellus-Utica area.

“We are now probably the only provider that can actually run four or five tools downhole all at once and gather all the information needed for comprehensive analysis of casing and cement integrity,” said James Henderson, MidCon sales coordinator for Weatherford in Pennsylvania. “SecureView service has helped us with many of our customers and has been very successful in this region. Running multiple SecureView tools downhole in combination gives customers a high-definition evaluation of their entire cased-hole system in one trip.”

The UltraView tool is the company’s casing and cement evaluation monitor that supplies 360-degree, real-time coverage. It uses two ultrasonic transducers—with one transducer dedicated to casing and cement inspection and the other dedicated to fluid inspection. The BondView cement bond tool for horizontal applications uses a monopole transmitter along with 3-ft and 5-ft receivers to provide traditional amplitude, travel time, signature and variable-density-log measurements. The FluxView tool offers full-radius casing inspection using a powerful samarium-cobalt (SmCo5) magnet. Casing defects create localized disturbances in the magnetic field that cause magnetic flux to leak from the casing. An active Hall-effect sensor array in the FluxView tool measures the magnetic flux to locate casing defects. The CalView high-resolution, high-sample-rate, multisensory caliper tool provides an accurate internal casing profile using an array of precision-calibrated feeler arms. Each arm provides

an independent radial measurement.

The SecureView casing and cement diagnostic service is designed to take the guesswork out of cased-hole problems. Weatherford uses proprietary analysis software to interpret logging data, diagnose casing and cement issues, confirm the extent of any damage, and recommend and implement an effective remediation strategy for affected wells. The strategy can include cased-hole liner systems, solid-expandable systems and casing patches.

A new downhole challenge for the region is in active discussion between operators and the Pennsylvania Department of Environmental Protection:

multiple lateral wells producing from both the Marcellus and Utica formations from the same wellbore.

“They are talking about drilling a Utica well and a Marcellus well using the same wellbore, being able to frack both of them, and using a downhole valve to control production from the Utica or the Marcellus, depending on need,” Henderson said. “There are some discussions. Weatherford has some nice tools that would complement and help with that, but no operator has done that yet up here. Some operators are looking at the feasibility, the engineering and what kind of cost impact it would have. Instead of having 10 wells on a pad, they could reduce that to five.” ■



The Weatherford SecureView service provided an exact cased-hole evaluation for a leaking well in the Wolfcamp Shale. The pulled casing (top) shows damage identical to the damage indicated by the logs (bottom). *(Image courtesy of Weatherford)*

Marcellus' Midstream Growth Spurt

The Marcellus Shale, America's most resilient natural gas play, is causing perpetual midstream growth to match its staggering production levels.

By Frank Nieto

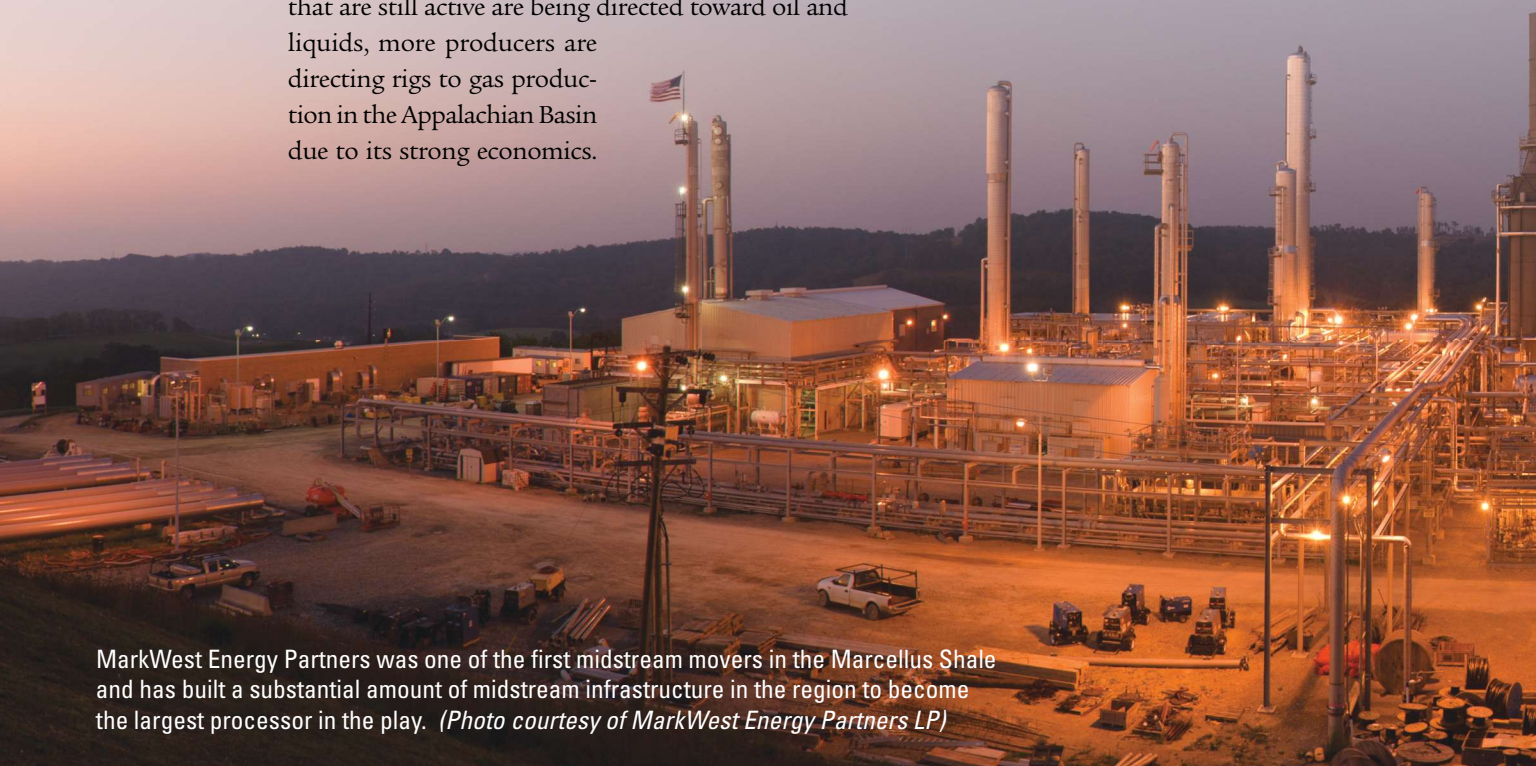
Senior Editor, *Midstream Business*

As any parent can tell you capacity constraint is a fact of life. That cute (and expensive) outfit your child wears today no longer fits tomorrow and needs to be replaced by another outfit. The midstream is learning this lesson well. Despite a commodity price downturn impacting the entire hydrocarbon industry, the midstream remains in a perpetual growth cycle, and no more so than in the Marcellus Shale.

The Marcellus and Utica shales will remain the most important regions for NGL and gas production growth in North America, which will lead to increased midstream development. While most rigs that are still active are being directed toward oil and liquids, more producers are directing rigs to gas production in the Appalachian Basin due to its strong economics.

Indeed, since the start of 2012, the Energy Information Administration (EIA) reported that the Marcellus and Utica shales have accounted for an astronomical 85% of total U.S. shale gas production growth. According to the EIA, gas production increased from 6.3 Bcf/d in January 2012 to 16.5 Bcf/d in July 2015.

"I have not seen a change in the midstream at all," said Daniel Hagan, partner at White & Case, a Washington, D.C.-based international law firm. "The general consensus is that the midstream space is pretty insulated from commodity prices."



MarkWest Energy Partners was one of the first midstream movers in the Marcellus Shale and has built a substantial amount of midstream infrastructure in the region to become the largest processor in the play. (Photo courtesy of MarkWest Energy Partners LP)

If anything, there appears to be even more interest in the midstream among those seeking to enter the sector or current players seeking to increase their foothold. Hagan, who heads the firm's energy markets and regulatory practice, said there remains a great deal of activity, especially on the mergers and acquisitions side of the midstream industry.

"There's been a lot of activity with companies looking to diversify into different geographic areas or services," Hagan said. "There is no shortage of interest from investors in the space. The buyers have either been larger players looking to increase their size and breadth or a lot of new entrants into the market, such as funds and private equity."

Thus far, the largest deal in the Marcellus since the downturn was undoubtedly MPLX LP's \$15.63 billion merger with MarkWest Energy Partners LP, which is expected to close by year-end 2015. The merger will create the fourth-largest MLP and join one of the biggest players in the Marcellus, MarkWest, with one of the Utica's largest logistics companies, MPLX. MarkWest has been one of the fastest movers on Hart Energy's *Midstream Business* annual gas processing rankings with more than half of its nearly 4 Bcf/d coming from the play.

Focus on fee-based assets

This growth is occurring despite the oil and gas industry experiencing the

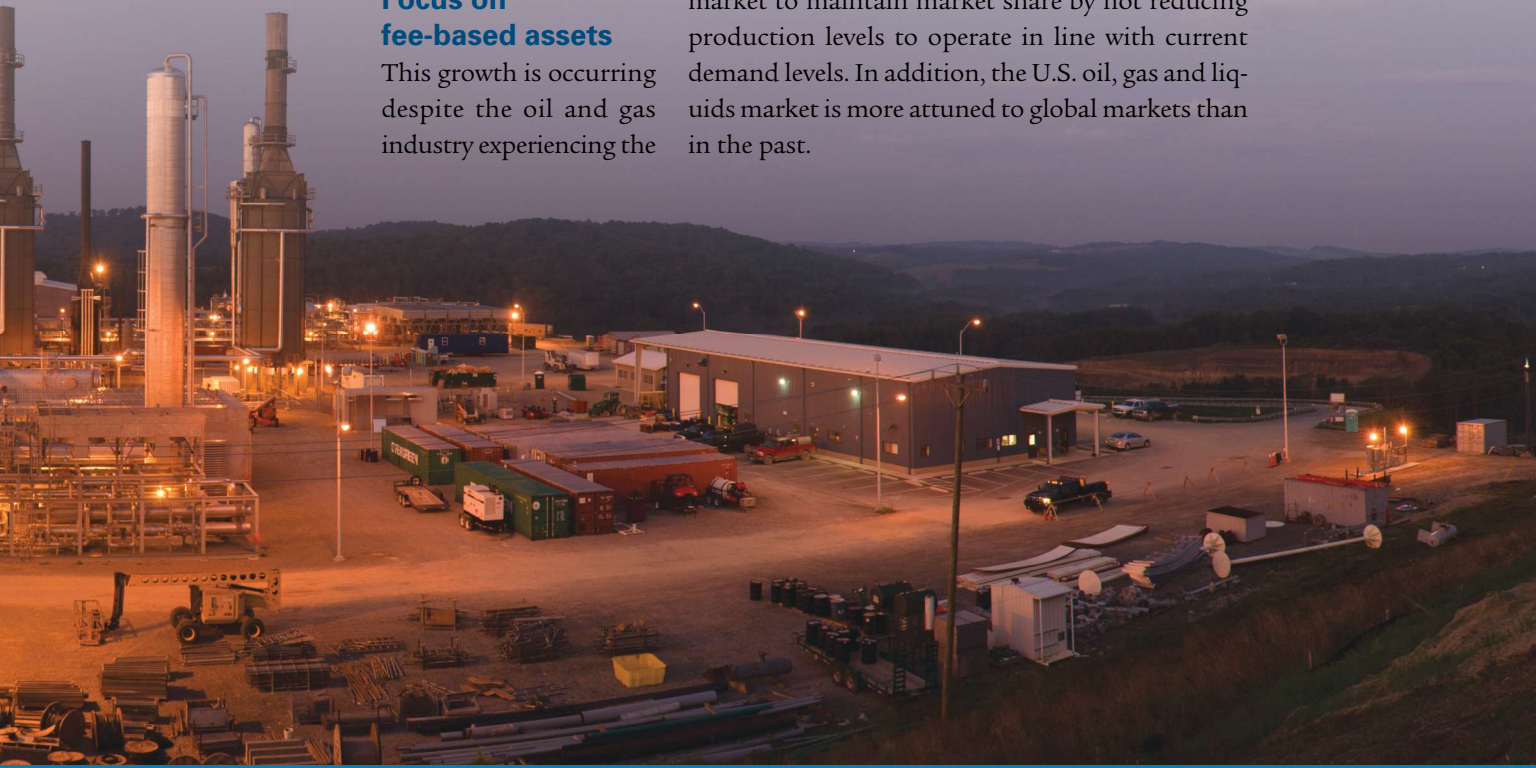
first real downturn of the shale era. Though there was a notable price downturn in 2008 to 2009, it is important to note this was a reflection not of industry supply and demand dynamics but of a global financial crisis that impacted every industry.

"I'd classify this as the first downturn for shale oil more so than a cyclical downturn for the market," said Anne Keller, manager of NGL research at Wood Mackenzie. "This is the first time we've seen a slowdown in the aggressive growth rates associated with shale exploration. It's not necessarily new to see downturns, but it is new to see it on this particular piece of the business for unconventional."

There was a large bright spot from the previous downturn in the form of a lesson learned by the midstream industry: the importance to limit exposure to commodity prices and increase the number of fee-based assets in a portfolio.

The current downturn is 100% based on supply and demand as crude, gas and liquids storage levels have been setting seasonal records throughout the spring and summer. The price of crude and NGL has been cut in half since this latest downturn began.

Multiple dynamics have led to this current downturn. Shale production from single wells is stronger than conventional wells. OPEC further flooded the market to maintain market share by not reducing production levels to operate in line with current demand levels. In addition, the U.S. oil, gas and liquids market is more attuned to global markets than in the past.



Inevitable NGL downturn

Regardless of OPEC actions and their impact on global crude prices, NGL prices were due for a correction, according to Keller. “The absolute [NGL] price would’ve been better if crude hadn’t dropped because it would have been tied to crude in some way, but if we are drilling at the rate we were going at in the fourth quarter, we were looking at the Armageddon scenario of declaring *force majeure* to shut the wells in because we didn’t have anywhere to go with the NGL production,” she said.

This inevitable downturn was reflected by a global oversupply of crude with a similar impact on the gas and liquids level caused by improved drilling efficiencies that have served to overwhelm demand. This was further exacerbated by the midstream playing catch up in many prolific parts of the country such as the Marcellus and Utica shales and important demand centers in the Northeast.

Though new project announcements have slowed down in light of the downturn, the midstream is moving forward with previously announced projects as there have been very few delays and cancellations.

Delays are possible for some backlogged projects if prices remain challenged for an extended period of time; however, it is unlikely that projects in the Marcellus will be greatly impacted given how attractive and economic the play is for both producers and operators.

Pipelines wanted

While midstream infrastructure is in place in the Northeast, the pipeline flow has to be reversed and, in some cases, increased as the region is now no longer just a demand center but a supply center. In many other cases, new pipelines are needed to meet demand.

Consequently, most of the midstream growth in the Northeast has been focused on pipelines, whether through new construction or rerouting of existing systems. There are many pipelines in place that were originally designed to move oil and gas from the Gulf Coast to some of these demand centers that are now being rerouted to account for the new reality in the gas industry. The EIA announced that natural gas pipeline systems are being renovated to allow bi-directional flow of up to 8.3 Bcf/d out of the Northeast.

“Flows on the ANR Pipeline, Texas Eastern Transmission, Transcontinental Pipeline, Iroquois Gas Pipeline, Rockies Express Pipeline and Tennessee Gas Pipeline accounted for 60% of flows to the Northeast in 2013,” according to a Dec. 2 EIA update. “Flows on these pipelines in 2013 were between 21% and 84% below 2008 levels, with the largest percentage decline occurring on the Tennessee Gas Pipeline. In 2014, the Tennessee Gas Pipeline and the Texas Eastern Transmission began flowing gas both ways between states along the Northeast and Southeast region borders.”

In November 2014, Spectra Energy completed its Texas Eastern Appalachia to Market 2014 (TEAM 2014) project that was completed in November, and Williams Cos. Inc. completed its Rockaway Lateral and Northeast Connector, also completed ahead of the winter. All of these projects increased capacity for Marcellus gas to get to the New York market.

The TEAM 2014 project added just less than 34 miles of new pipe loop and related compressor stations in Pennsylvania and modified 41 existing facilities along the Texas Eastern Pipeline system in Pennsylvania, West Virginia, Ohio, Kentucky, Tennessee, Alabama and Mississippi to allow for bi-directional flow on the system. This increased capacity to 600 MMcf/d into the Northeast and Midwest as well as the Southeast and Gulf Coast.

The two Williams projects expanded the Transco Pipeline capacity into New York through the construction of the 3.2-mile Rockaway Lateral that runs from the Lower New York Bay Lateral to the Rockaway Peninsula. This expansion was necessary as the previous pipeline serving Brooklyn and Queens, N.Y., was built between 40 and 60 years ago and was no longer capable of providing reliable service to the 1.25 million customers in the area.

The Northeast Connector will modify three compressor stations in Pennsylvania and New Jersey to expand capacity by 100 MMcf/d on the Transco Pipeline. These two projects are part of the company’s \$5 billion in expansion plans for the Transco system from 2013 to 2017 that will expand capacity by 50%.

Companies also are in the process of planning construction of several other pipelines in the Marcellus, including Columbia Pipeline’s \$2.7 billion

Mountaineer Xpress and Gulf Xpress pipelines that will allow 2.7 Bcf/d of Marcellus and Utica production to move on the Columbia Gulf and Gas Transmission lines; Energy Transfer Partners' 710-mile Rover Pipeline that will move 3.25 Bcf/d of gas out of the Marcellus and Utica to Midwest, Gulf Coast, Canadian and Northeast hubs; and DTE Energy's 44-mile Bluestone Pipeline that will transport nearly 1 Bcf/d of Marcellus production to the Millennium and Tennessee pipelines.

EQT Corp. has one of the longest histories in Appalachia, stretching more than 125 years. Even with this history it is still primed for even more growth. Its midstream arm, EQT Midstream Partners LP, has roughly \$3.3 billion in capex in its organic growth project backlog, with much of these projects backed by EQT Corp. production. These projects include \$1.8 billion for the Mountain Valley Pipeline, \$400 million for Equitrans expansions, \$500 million for wellhead gathering and \$250 million for the Range trunk line.

Ethan cracker: Marcellus' Holy Grail

Though operators have been mostly focused on gathering and processing projects in the Marcellus, the big project on most industry observers' minds has been the construction of an ethane cracker in the region. The construction of such a facility would encourage the development of even more infrastructure in the region as it would signal the creation of a new full-range gas and liquids hub.

There have been four projects of varying size proposed, but as of yet no ground has been broken nor dates set for such an occurrence. It is likely that the larger a cracker project is, the longer a company will take exploring it. No cracker project is larger than the world-scale cracker that Royal Dutch Shell is considering building on land it acquired in Beaver County, Pa. The facility would cost about \$4 billion and have the capacity to crack 1 billion pounds of ethane per year. However, the company is in the midst of a lengthy review process that also includes securing various permits and licenses. As such, no project time frame has been provided by Shell.

The downturn impacted Odebrecht/Braskem's large cracker ASCENT project in Parkersburg, W.Va.,



Organic growth potential remains strong as evidenced by EQT Midstream Partners' \$3.3 billion project backlog. Many of these projects will seek to connect newly drilled wells to existing pipeline systems. *(Photo courtesy of EQT Midstream Partners LP)*

as it was announced in the spring that it was being postponed. Officials were quick to state that the project was not cancelled but is under review due to the changing economics in the industry.

Shortly after this announcement, a Thai-Japanese joint venture led by PTT Global and Marubeni announced plans for a multibillion-dollar, world-scale cracker in Belmont County, Ohio. The companies anticipate making a decision on the project in 2016.

Appalachian Resins also is planning a cracker in the region but is taking a different approach as it is planning a slightly smaller facility with a capacity of 600 million pounds per year. The project’s site was moved this summer from Madison County, W.Va., to Monroe County, Ohio.

Powering, heating the East Coast

According to *Bloomberg*, gas production is expected to increase to 22 Bcf/d by 2040, which will help the Marcellus power 65% of the Mid-Atlantic’s new power generation from 2014 to 2024.

“There are a lot of nuclear and coal power plant retirements occurring, which is further increasing demand for natural gas for power generation,” said Kurt Krieger, member at Steptoe & Johnson PLLC.

This will further increase the need for new infrastructure to improve access to the two natural gas markets with the highest premiums in the U.S.—New York City and New England. These are directly linked to Marcellus production.

New York requires more pipeline capacity and needs to retrofit boilers in New York City buildings to convert from fuel oil to natural gas, while New England needs both pipeline capacity as well as improved regulations that will allow utilities to recoup their long-term transportation charges. Both have huge premiums and rely a great deal on heating oil, which is both costly and releases more carbon emissions than natural gas.

This is especially true in New England where only two pipelines running into the region have access to Marcellus gas: Spectra Energy Corp.’s Algonquin Pipeline and Kinder Morgan Inc.’s Tennessee Pipeline. There is additional capacity for both Canadian gas and LNG imports, but neither market is as economically competitive with gas from Appalachia, making both options unattractive for generators during capacity constraints.

New pipeline construction into the region has been delayed due to local opposition as well as a more difficult contracting system for firm supplies compared to other regions of the country.

“There has been a lot of local opposition to the expansion of pipelines and compressor stations in Rhode Island, Connecticut and Massachusetts as more proposals come forward,” said Steve Dodge, associate director of the New England Petroleum Council.

New England has experienced severe price spikes on the gas spot market due to the lack of transportation capacity into the region. “Here in New England, we’re less than a six-hour drive from some of the cheapest natural gas in the world, and we can’t get it here,” Dodge said. “That really is a social injustice if nothing else because



Spectra Energy is among several operators helping to open up the Northeast markets for Marcellus and Utica producers through the construction of several pipeline expansions, including its TEAM 2014, AIM and Atlantic Bridge projects. The company’s Algonquin Pipeline is one of two systems that currently move Appalachian volumes into New England. *(Photo courtesy of Spectra Energy Corp.)*



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there are people really hurting from the very high prices of natural gas and electricity in the region.”

Currently, events have shown that the Federal Energy Regulatory Commission’s Commissioner Tony Clark was spot on while speaking at the 2014 North American Gas Forum. Last fall, Clark said that production in the Appalachian Basin is growing at such a rapid rate with similar demand increases that infrastructure, or lack thereof, is completely undermining the Northeast natural gas market.

“It looks a little like a market, but in practice, it’s an electricity construct that fundamentally does not support the infrastructure that’s needed to deliver the energy that the market seems to be signaling that it needs—new pipes, new access-confirmed forms of generation and LNG contracts. There’s a breakdown in the market construct that isn’t allowing that to happen ...

You have to start building actual infrastructure delivery systems,” he said.

Clark added that this lack of infrastructure is a primary reason for the aforementioned huge premiums for natural gas in New England, which put electric generation prices in that market on par with Hawaii.

“There’s no reason that part of the continental U.S. should have that sort of energy pricing system, but for lack of the infrastructure that’s needed,” he said. “That’s the price that’s paid for lack of adequate gas infrastructure. It’s not that far from Pennsylvania to Boston; it’s really not.”

Given the activity in the play, it is safe to say that while there might be a slight decrease in growth out of the Marcellus, the need for expanded infrastructure is as necessary as new pants are for a child going through their own sudden growth spurt. ■



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The Marcellus and Utica: Why Do They Matter?

Operators return their focus to the dry gas window, where it all began in the Appalachian Basin, with attention to lowering costs and increasing efficiencies amid depressed prices.

By Jessica Garrison and Stephanie Crabtree

Stratas Advisors

Operators in the Marcellus and Utica shales have responded quickly to the changes in commodity prices. After a nearly decade crusade to grow production at record rates, more conservative E&P strategies are being developed and employed to better position operators to weather the depressed price environment and come out well-positioned as prices slowly inch higher. Rig counts are down, but efficiencies are increasing and improving the cost outlook going forward. Many operators have adjusted strategies by decreasing the number of new wells drilled. The environment also has led to some companies scrambling to balance portfolios by selling off less valuable assets, while others take the opportunity to scoop up assets at a bargain to diversify portfolios. Lower prices and growing production also have intensified the need to control costs and improve drilling efficiencies.

Since 2012, the Marcellus Shale has provided more than 85% of natural gas supply growth to the U.S., and production from the region accounts for about 56% of dry gas across the country. The Marcellus' underlying neighbor, the Utica Shale, has quickly grown as a hydrocarbon producer since the onset of its development in early 2013.

Development in the Marcellus picked up after Range Resources drilled its first well in 2004. Producers were initially attracted to the region due to its price premium over the typically lower Henry Hub prices. This play has become essential to the American market as it provides the inexpensive natural gas that

the region depends on for heating in harsh winters as well as the fuel that industry and power generators rely on. However, increased drilling and natural gas production have eventually contributed to an influx of supply. Prices peaked in February 2014 and since then have been in steady decline. With current market trends creating an unfavorable environment for additional E&P, coupled with oversupply and constrained pipeline capacity, the trajectory that seemed to be setting the U.S. up to become a net natural gas exporter could be derailed for the short term. However, if operators refine highly developed portfolios into strengthened, efficient positions, the region will likely withstand the downturn and develop more favorable returns as prices inch higher.

A snapshot of the Appalachian Basin

The Appalachian Basin experienced an influx of new wells in 2011. This led to a backlog of completed wells that had not yet been tied to production. Reducing backlogs has increased production within the basin, and this trend is expected to continue through the remainder of 2015. This contrasts with what currently is being seen in shale plays across the U.S. For example, the Eagle Ford Shale is projected to decrease by about 56 Mboe/d in second-half 2015, and the Bakken Shale is estimated to decrease by 27 Mboe/d. The Appalachian Basin remains strong as a result of the focus on reducing the backlog of completed wells, bringing more production online.

Operators in the region have announced significant production jumps since first-quarter 2015, with Chesapeake announcing a 13% increase. In response to current natural gas prices within the region, Chesapeake has employed voluntary production curtails for the remainder of the year and will continue this strategy throughout 2015 in hopes of moving the company’s gas supply out of the basin’s main market. According to August reports by the Energy Information Administration (EIA), gas prices in the Marcellus have dropped to about \$1.16/MMBtu from \$1.24/MMBtu at Tennessee Pipeline’s Zone 4 and to \$1.26/MMBtu from \$1.34/MMBtu at Transco’s Leidy Line. The Dominion South Hub also has fallen to about \$1.27/MMBtu from \$1.37/MMBtu. Major infrastructure projects such as the Rockies Express Pipeline and Spectra’s OPEN Pipeline are expected to ease the burden of oversupply and move the Appalachian Basin’s gas reserves throughout North America. Additionally, the Nexus pipeline coming online in November will open transportation capacity from the region to the Gulf Coast, where prices are more favorable.

The macro environment

The macroeconomic environment of the Marcellus and Utica formations has been dominated for the last year by decreasing commodity prices and constrained transportation. Economic fundamentals have created a market environment of steadily declining natural gas prices since the onset of 2015. Supply has outpaced demand, and commodity prices have plummeted. With prices continuing to fall, operators have developed strategies in an attempt to strengthen their portfolio positions. In August 2015, the natural gas price averaged about \$2.8 MMBtu, decreasing nearly 30% from the same period in 2014.

Demand could see some upward movement during the peak summer season. However, prices will likely remain depressed

throughout the year due to natural gas storage remaining high relative to previous years (about 2.2% above the five-year average). Although prices have remained unfavorable, production remains positive despite several producers curtailing production, sustaining the supply surplus. Therefore, an increase in natural gas prices is unlikely to be realized in the short term.

Natural gas production in the Marcellus has outpaced pipeline capacity. In July 2009, natural gas production from the play totaled more than 1.5 Bcf/d. By the following fall, production doubled to more than 3 Bcf/d with current 2015 production more than 16 Bcf/d. Infrastructure transporting natural gas out of the play has become strained and has been unable to keep pace with production. The constrained capacity has created bottlenecks and has contributed to the regional price decline. In response to spiking prices in February 2014 as well as bottlenecks at the pipelines, the Federal Energy Regulatory Commission gave the stamp of approval to several pipeline improvements or expansion projects to alleviate congestion. The new pipeline projects include the Williams’ Constitution Pipeline, Iroquois Pipeline’s Wright Interconnect and Texas Eastern’s TEAM 2014 project.

The Williams’ Constitution Pipeline will be developed to transport natural gas from the northern region of the Marcellus in Pennsylvania and distribute it throughout the northeastern U.S. Upon

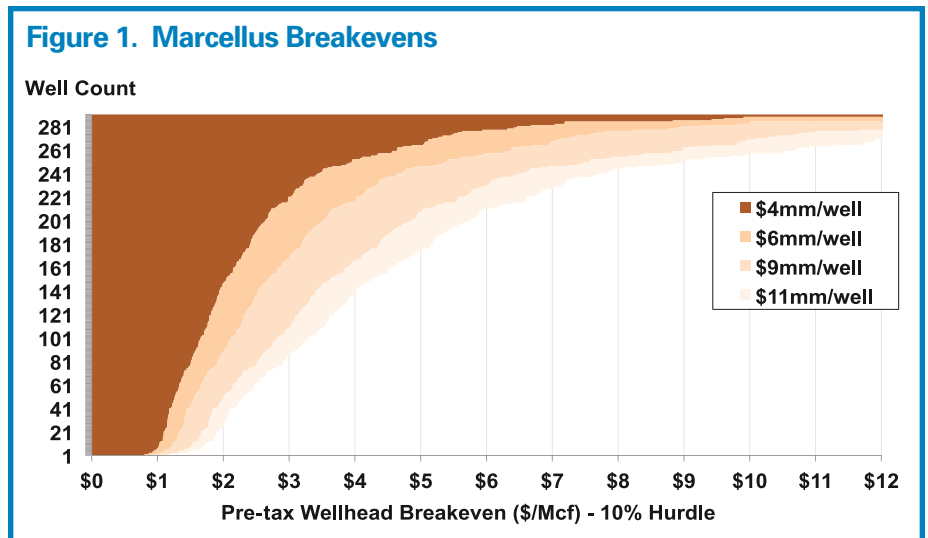
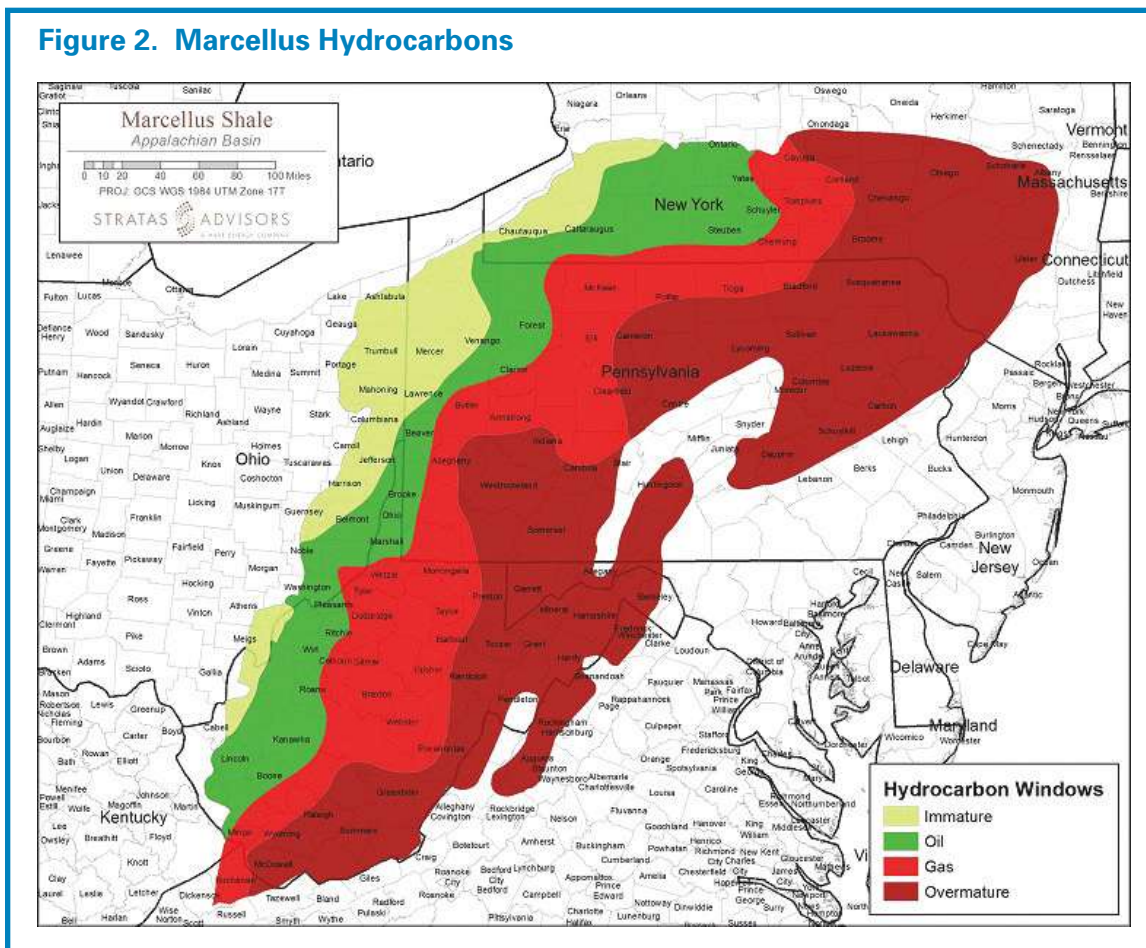


Figure 2. Marcellus Hydrocarbons



completion of the new construction, the project will contribute 124 miles of additional pipeline to existing infrastructure and will bring online 650 MMcf/d of additional capacity to the region. Additionally, Texas Eastern’s TEAM 2014 pipeline project will contribute an additional 600 MMcf/d of capacity. This new construction will facilitate natural gas transportation from the Marcellus across the country. The Iroquois Pipeline Wright Interconnect will compliment both new and existing projects. This project plans to improve existing compression infrastructure in Wright, N.Y., and will join the Constitution Pipeline with the Tennessee Gas Pipeline, improving efficiency of transportation and delivery of natural gas from the region to New England.

Since declining in late 2014, natural gas prices have bounced between about \$2.50/Mcf to \$3/Mcf. While significantly lower than historical prices that

remained above \$4/MMBtu for much of the previous year, many Marcellus wells remain economic. Highlighting the northeastern dry gas region, assuming an average well cost of \$6 million per well and a 0.5 gal/min value, 58% of Marcellus wells are economic at a netback price of \$3/Mcf. This reflects that the majority of Marcellus dry gas wells have robust economics that remain viable even during unfavorable pricing periods. The cost per well in the region is lower when compared to other shale formations throughout the U.S., in part due to the favorable geology of the Marcellus Formation as well as improved drilling methods, including increased laterals, fracture stages and decreased average drilling days (less than a week in some cases). To increase the proportion of wells that are economically viable above 75%, prices would need to rise above \$4.50/Mcf—a price not likely to be realized in the short term.

Appalachian Basin activity

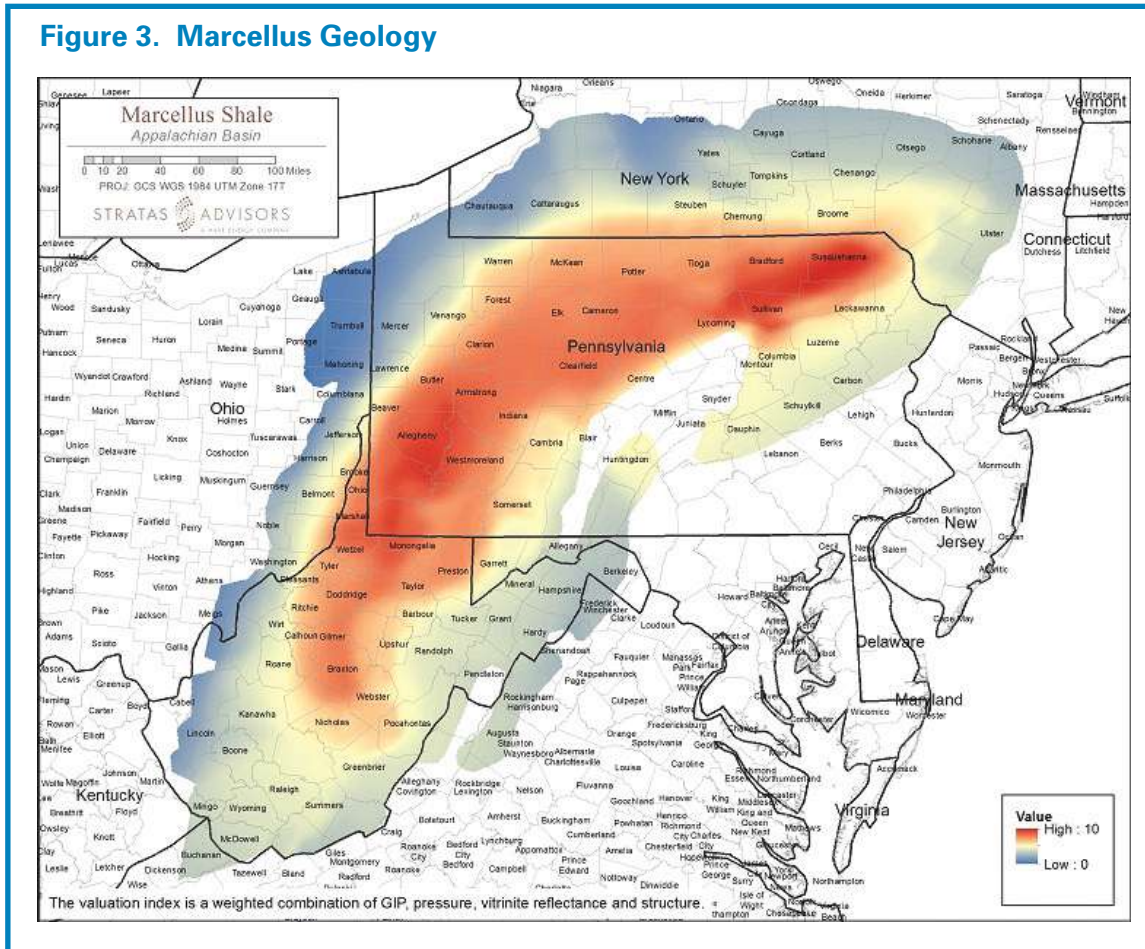
Prior to the natural gas price decline in 2012, most developments in the region were in the dry gas window of the Marcellus. Initially producers found dry gas more favorable due to the ease of getting the product to the market. Operators shifted their strategies and activity from the lower value dry gas window in northeastern Pennsylvania to the wet gas resources including the Utica along the Ohio and southwestern Pennsylvania border. Once too costly to refine for transportation, NGL found in wet gas, including ethane, butane and propane, became more valuable. As the value of natural gas plummeted, operators were willing to take on the cost of processing to bring in a higher price. During the initial development shift in early 2012, the rig count in the dry gas region of Pennsylvania fell from 115 to 78. Within the same period, the rig count grew more than 50% in the Utica, increasing

to 20 rigs from a previous count of 12 rigs.

During the last year, however, the region has seen a reversal of this trend. As NGL composite prices fell throughout 2014 and 2015, operators again adjusted their investment and development strategies. In May 2015, NGL composite prices had fallen more than 50% in just over a year to \$5.25/MMBtu from a high of about \$12/MMBtu in February 2014. Wet gas and the NGL processed from it became less valuable. When the cost to process NGL out of the wet gas for transportation was considered, the dry gas window of the Marcellus became more attractive for capital spending. As a result, operators once again shifted their focus to the northeastern area.

The return to the dry gas window of the Marcellus is reflected in current operator activity in the region. In October 2014, Chesapeake, once a top holder of acreage in the play, sold off more than

Figure 3. Marcellus Geology



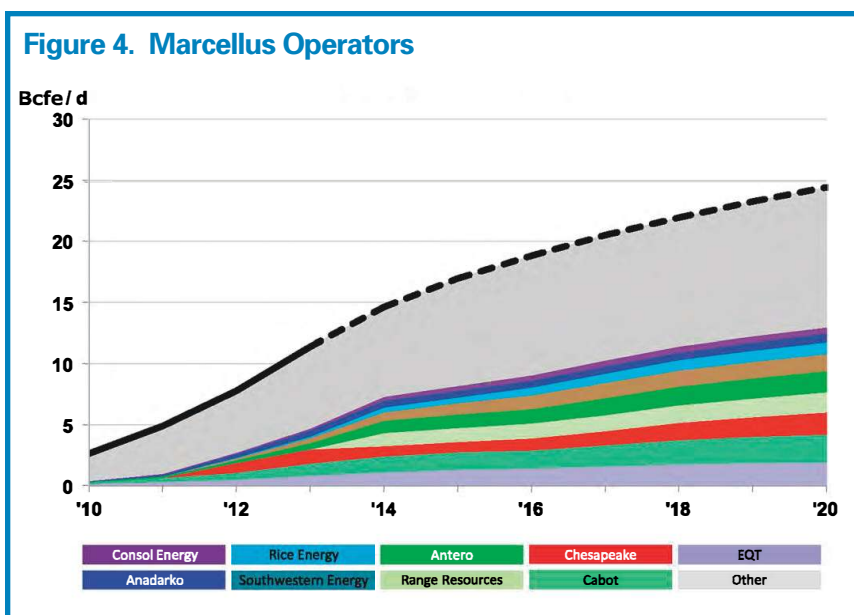
400,000 acres of liquids-rich assets in West Virginia and southern Pennsylvania to Southwestern Energy, a newcomer in the wet gas region of the Marcellus. In a series of additional divestments, Chesapeake has shed much of its southern Marcellus portfolio as the liquids-heavy hydrocarbons typical of the area become less economic than the neighboring dry gas. The shift in the company’s investment strategy signals a shift in focus from building up acreage and production to a focus on cost reduction and maximizing value. The value of the liquids-rich assets has declined due to market conditions, leaving these assets vulnerable to cuts in capex.

Bcfe/d by year-end. During 2015, the rig count in the Marcellus has averaged about 66, while the same period in 2014 saw an average of about 80 active rigs, a decrease of about 18%. However, as rig counts have decreased, drilling and production efficiencies have continued to improve. Currently, marginal production per rig is about 8.3 Mcf/d, nearly doubling the rate in 2012. As reported by the *Energy Observer* in 2014, median IP rates are improving as well. In 2011, IP rates for the Marcellus averaged just below 3 MMcf/d. By 2013 this rate grew to 5 MMcf/d. With improved drilling and operational technology, these IP rates are being sustained longer, with many maintaining for several months.

The Utica was once originally targeted for its oil resources. Upon delineation of its distinct hydrocarbon windows, operators focused on the extraction of the wet gas core. Upon the onset of the depressed commodity prices at year-end 2014, drillers began to shift focus once again and target the distinct dry gas window, which runs along the southern portion of the play boundary, to take advantage of stronger natural gas prices in the current market environment. Although oil and natural gas prices have dropped to unfavorable lows, the higher costs of production and processing associated with wet gas and associated NGL have placed a higher relative value on the natural gas production from the dry

gas window.

Activity in the Utica is seeing strategic shifts in direct response to the lower price environment. Activity in the volatile oil window in eastern Ohio has seen a drastic stall in drilling as the revenue from these plays has decreased with lower crude prices. Throughout 2015, about 90 wells have been drilled in the Utica oil window; however, only 28 are producing. Additionally, in the black oil areas of the Utica, 12 wells have been completed with only three in production, creating an inventory of nonproductive oil wells in the play. The oil window of the Utica has proven difficult to develop. Operators in the area have decreased capital spending; however, drilling



Currently, Marcellus activity is focused in the dry gas window in northeastern Pennsylvania as well as along the southwestern border shared with Ohio and West Virginia. While the rig count has decreased as commodity prices have fallen over the last 10 months, the Marcellus has seen a less dramatic decline compared to the Utica. Rig count in these plays has fallen 25% and 50%, respectively, from the same period last year, with the Marcellus’ less dramatic decline likely due to its favorable economics and geology.

Although rig count is down significantly, natural gas production remains strong. Total production from the Marcellus in 2015 is expected to top 17

has not stalled completely. This is partly due to the relatively lower cost of drilling oil wells in the area, which is about \$6.5 million, according to a second-quarter earnings report from Chesapeake.

Not only are oil wells less expensive in the Utica than in many alternative shale plays, but costs could be falling as cost reductions become a focal point for operators. Chesapeake, a leading producer in the Appalachian Basin, also has reported that average well costs could fall below \$6 million in 2015. More than half of the production in the Utica comes from natural gas, with about one-quarter of production in the form of NGL, followed by about 10% from oil and condensate.

While drilling activity has largely focused on Marcellus resources over the past couple of years, the Utica could see an increase in activity going forward as record IP rates are becoming a trend in the dry gas area of the Utica. In August 2015, the EIA reported that month-over-month production in the play is expected to increase, despite unfavorable economics and reduced drilling activity. Additionally, new geological findings have suggested that total recoverable hydrocarbons in the area could actually be triple that of original estimates. New estimates find that total recoverable natural gas could be about 782 Tcf, with nearly 2 Bbbl of oil.

Beginning in late December 2014 and continuing throughout first-half 2015, several exploratory wells have produced record or near record-breaking 24-hour IP rates. More interestingly, these wells have been drilled primarily outside of what has been considered the core, high-value region of the Utica. In an exploratory well drilled in late December 2014 by Range Resources in Washington County, Pa., 24-hour IP rates averaged 59 MMcf/d, while a neighboring Seneca Resources Corp. well averaged 22.7 MMcf/d. High-value

areas of the formation were previously in the wet gas areas where liquids as well as some oil and condensate were targeted. However, since late 2014, impressive IP rates have been found in the dry gas areas of the Utica, suggesting that another shift could be seen as operators move to the dry gas belt of the Utica-Point Pleasant Formation. This could signal a reevaluation of the high-potential hydrocarbon regions of the play.

Figure 5. Utica Operators

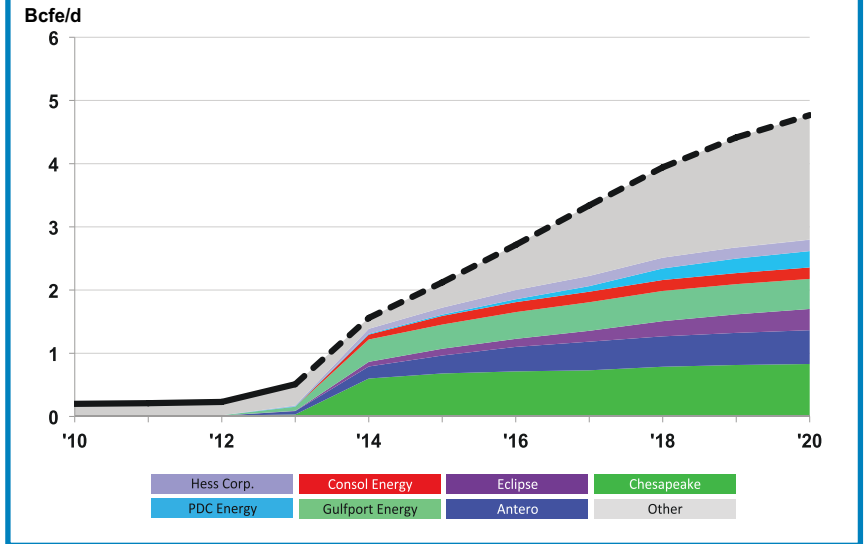
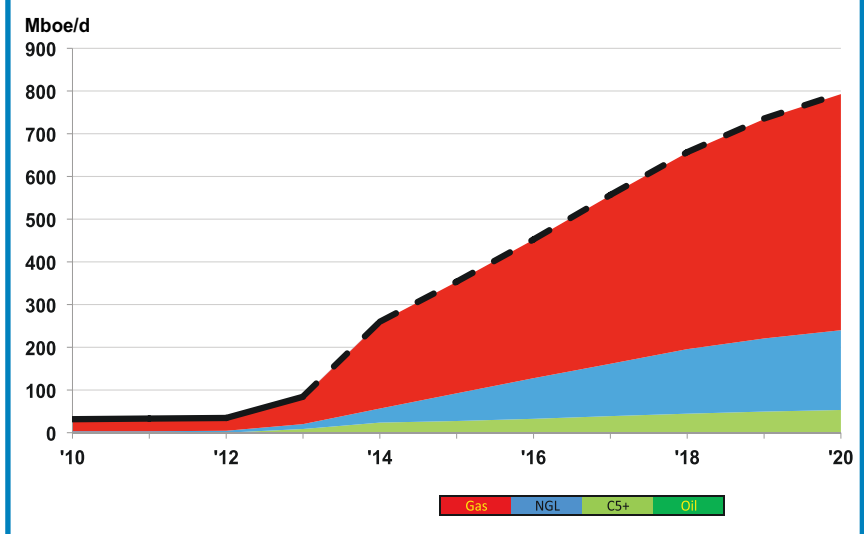


Figure 6. Utica Hydrocarbons



In addition to the impressive IP rates seen in dry gas discovery wells in the Utica, operators have developed additional means of increasing production in more cost-efficient ways. In Pennsylvania, most of the developments targeting the Utica Formation are doing so from existing Marcellus pads, creating stacked pays. This lends financial benefits in a capital-constrained environment as operators can take advantage of existing pad infrastructure and decrease development costs. The region also is seeing operators extending longer laterals and increasing fracture stages as a cost-conscious solution to increase production per well.

The outlook for both the Marcellus and Utica shale plays continues to be robust, despite unfavorable economics.

The Appalachian region has seen realized commodity prices even lower than other regions of the country, exacerbating the effects of lower prices on operators in the Marcellus and Utica. Lower commodity prices have led operators in the play to adjust plans throughout the year. Chesapeake, for example, has implemented curtailed production in the Utica—similar to its curtailment of production in the Marcellus—by pulling back production by about 100 MMcf/d. These voluntary reductions are expected throughout the remainder of the year until additional transportation out of the region is opened up with the new Nexus pipeline. Additionally, this pipeline will allow lower priced natural gas from the Appalachian region to reach higher priced areas along the Gulf Coast, a factor that operators such as Chesapeake hope to capitalize on going into 2016. However, despite the voluntary reductions, production is still on track to increase, according to Stratag Advisors and the EIA's latest reports.

The Appalachian outlook

In an industry characterized by inherently depleting assets, economic and physical volatility as well as huge capital costs and constraints, adaptability is imperative in withstanding the ups and downs of the market. Not only has the declining price environment impacted the number of new wells being drilled, it's also affected the types of hydrocarbons being targeted by new developments. Operators are taking into account the market price for various resources and actively managing portfolios to optimize returns on investment. This propensity to develop technology and rework resources and assets to remain resilient during unfavorable periods seems to constantly be shaping the Appalachian Basin.

The outlook for both the Marcellus and Utica shale plays continues to be robust, despite unfavorable economics. Operators have shifted focus from gaining acreage and production to refining asset portfolios and reigning in capex. This has sparked a trend of increasing productivity through cost-effective means including increasing laterals and fracture stages per well as well as decreasing average drilling days per well. Innovative strategies also have led to the development of dual targeting in stacked pays. The notable trend of targeting Utica dry gas resources from existing Marcellus pads is indicative of the new ways in which operators are finding cost-efficient ways to secure valuable production.

In addition to well economics, infrastructure also is poised to improve the outlook for the region. Since the onset of gas developments in the region, transportation capacity has been highly constrained in the area as production outpaced pipeline capabilities. However, with several impactful improvements and additional pipeline set to come online throughout the remainder of the year and into the upcoming years, this limitation will be mitigated to an extent. Opening up transportation from the lower-priced Appalachian region to higher prices fetched in the Gulf Coast region also will have a positive impact on producers' economics. ■

Additional Information on the Marcellus and Utica Shales

For more details on the Marcellus and Utica shales, consult the selected sources below.

By Ariana Benavidez

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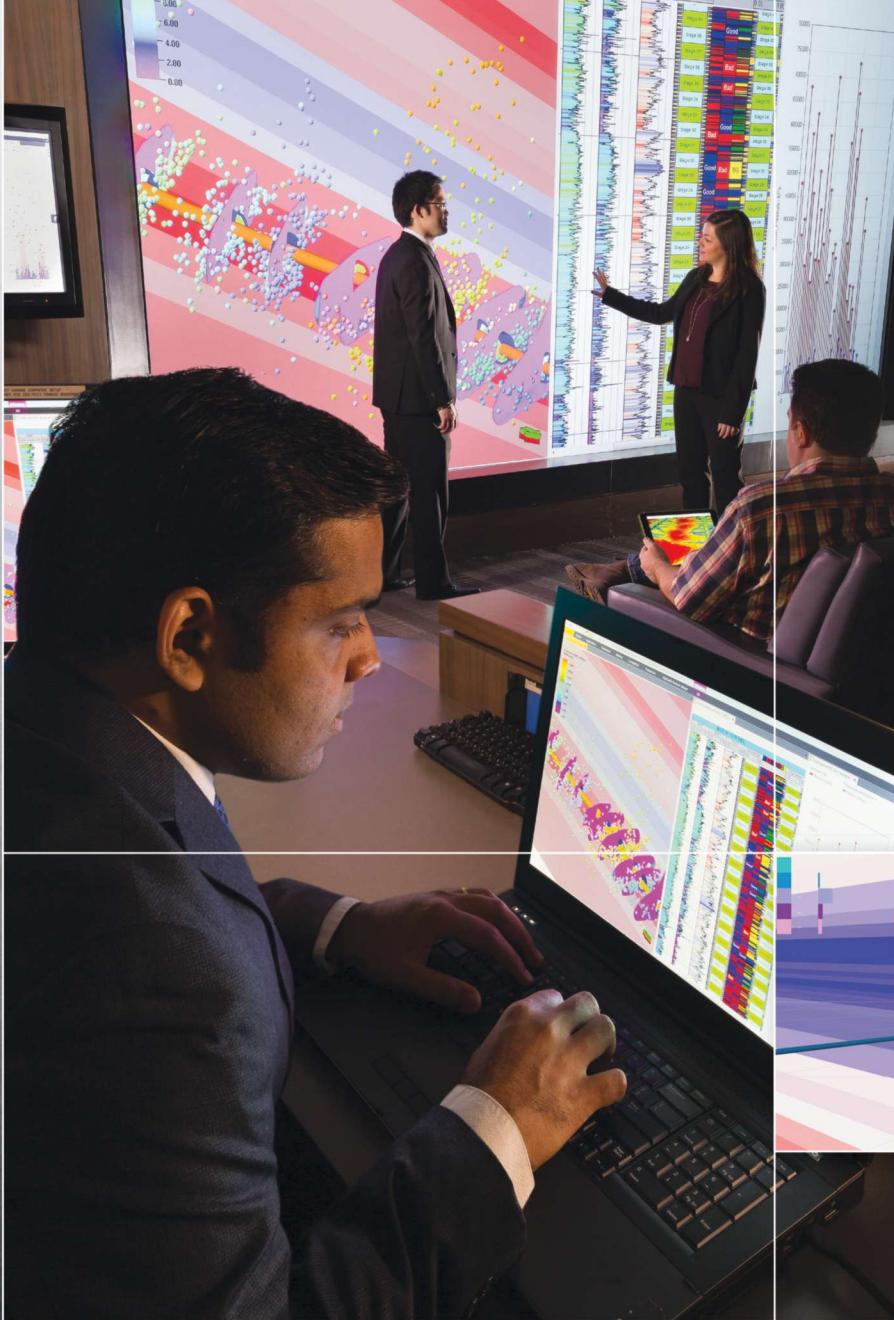
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