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April 2023

**SHALE INVESTMENT
DASHBOARD IN OHIO
Q1 AND Q2 2022**

**Energy Policy
Center**

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Executive Summary

This report presents findings from an investigation into shale-related investment in Ohio. The investment estimates are cumulative from January through June of 2022. Prior investments have been included in previous reports that are available from Cleveland State University.¹ Subsequent reports will estimate additional investment since the date of this report. Investment in Ohio into the Utica during the first half of 2022 can be summarized as follows:

Total Estimated Upstream Utica Investment: January – June 2022

Lease Renewals and New Leases	\$71,628,000
Drilling	\$922,080,000
Roads	\$13,432,310
Lease Operating Expenses	\$178,628,486
Royalties	\$1,585,438,000
Total Estimated Upstream Investment	\$2,771,206,796

Total Estimated Midstream Investment: January – June 2022

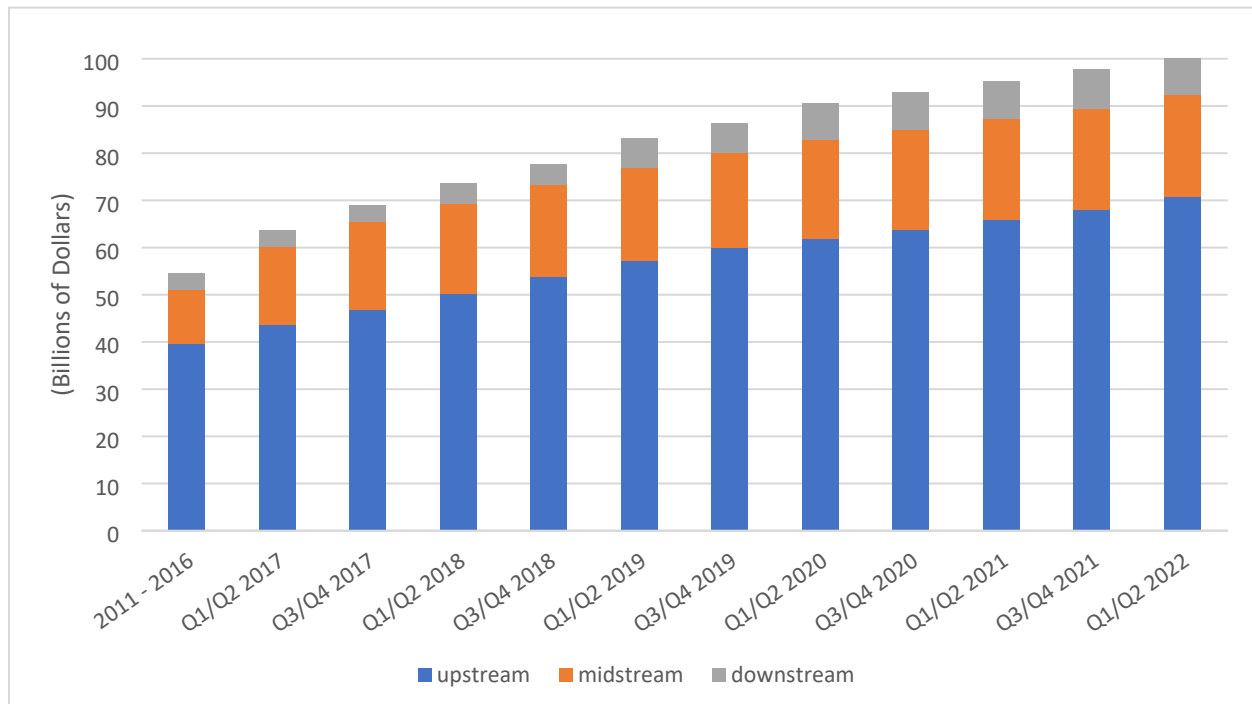
Gathering Lines	\$18,048,000
Gathering System Compression and Dehydration	\$12,783,000
Rail Transloading Facilities	\$5,270,000
Transmission Line Interconnect	\$1,000,000
Total Estimated Midstream Investment	\$37,101,000

Total investment from January through June 2022 was approximately \$2.8 billion, including upstream and midstream. There was no significant Ohio investment in downstream oil and gas industries in the first half of 2022, as we have defined it for this Study. Indirect downstream investment, such as development of new manufacturing as a result of lower energy costs, was not investigated as part of this Study. Together with previous investment to date, cumulative oil and gas investment in Ohio through June of 2022 is estimated to be around \$100.6 billion. Of this, \$70.8 billion has been in upstream, \$21.5 billion in midstream, and \$8.3 billion in downstream industries.² Figure 1 shows the growth in cumulative shale-related investment for Ohio since the release of the first Shale Dashboard.

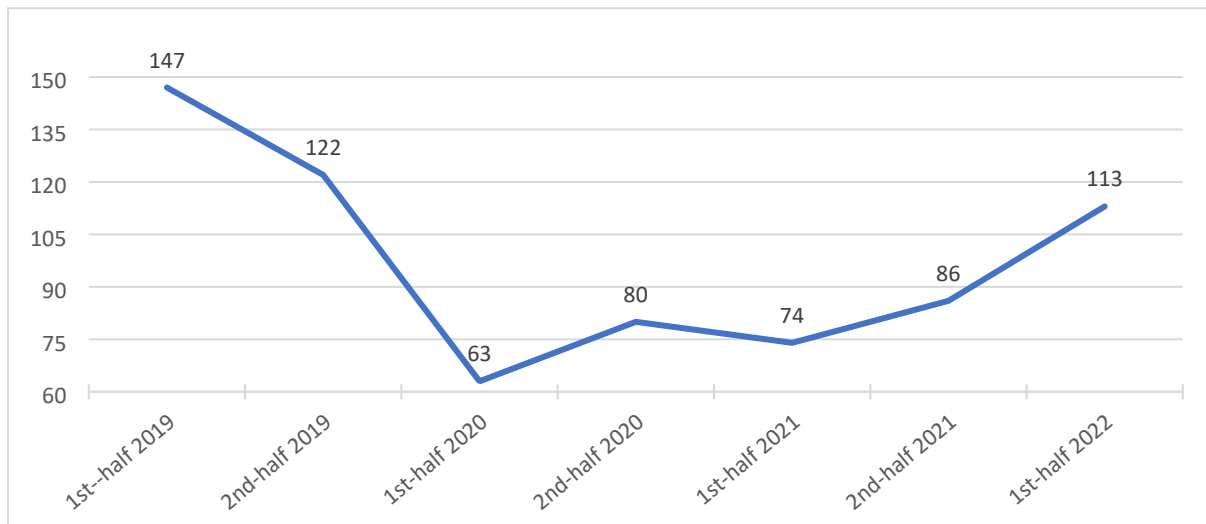
¹ The twelve previous reports on shale investment in Ohio up to December 2021 can be found at https://engagedscholarship.csuohio.edu/urban_enpolc/

² Numbers may not add up precisely due to rounding.

Figure 1: Cumulative Shale Investment in Ohio Over Time



Overall upstream investments were up by about \$628 million in the first half of 2022 compared to the second half of 2021, reflecting both higher royalty earnings and an increase in new wells drilled due to higher oil & gas prices. See Figure 2 for the change in new shale wells drilled in Ohio by 6-month period since 2019. As determined from Ohio Department of Natural Resources Division of Oil and Gas (ODNR) data for shale well drilling, 113 new wells were drilled during the first and second quarters of 2022, 27 more than the number drilled in the second half of 2021. ODNR production data also indicated that the total volume of gas-equivalent shale production in the first half of 2022 was 2.7% less than overall production in the second half of 2021. (Production volumes have consistently been stronger in the second half of the year since the advent of the Shale Investment Dashboard). Jefferson County had the highest number of new wells with 27, followed by Harrison County with 20 new wells, Carroll County with 19 new wells, and Monroe County with 16 new wells. Belmont and Guernsey Counties had 14 and 10 new wells, respectively. No other county had more than 10 new wells drilled for the first half of 2022.

Figure 2: New Shale Wells in Ohio by 6-month Period

Data Source: ODNR (2023).

Ascent and EAP Ohio were the top producers for Q1 and Q2 of 2022, having produced 417 and 197 billion cubic feet equivalent (Bcfe), respectively. Gulfport was third in production at 158 Bcfe. SWN Production (Southwestern) and Rice Drilling produced 121 Bcfe and 82 Bcfe, respectively.³ Antero had the sixth highest production during the Study period at 60 Bcfe. These six companies represented a little over 91% of total production in Ohio for the first half of 2022.

EOG Resources announced the establishment of a 395,000 net-acre position in the Ohio Utica during the second half of 2022, making it one of the largest leaseholders in the play within the state.⁴ The acquisition—totaling around \$500 million—included 135,000 mineral acres in the southern part of the Ohio Utica (e.g., Guernsey and Noble Counties).⁵ The company expects to develop 20 wells throughout its newly acquired Utica acreage footprint in 2023.

The first half of 2022 saw midstream investment of \$37.1 million, around half the spending for this segment compared to the previous 6-month period. The majority of midstream investment during the Study period (\$30.8 million) was for gathering system buildout. However, \$5.3 million was also spent on a propane rail terminal in Sycamore in the northwestern part of the state, supplied primarily by rail cars from regional shale plays.⁶ A further \$1 million was spent on a pipeline interconnection to allow for the delivery of natural gas supplies from the Rover Pipeline

³ SWN Production's Utica assets include wells formerly belonging to Eclipse and Montage Resources.

⁴ See EOG's November 3, 2022 report on quarterly earnings.

https://s24.q4cdn.com/589393778/files/doc_financials/2022/q3/3Q-2022-Earnings-Press-Release-with-Tables.pdf

⁵ *Id.* The acquisition is not included as an upstream investment in this Study because it is assumed that the acreage is not newly leased, and had been accounted for in previous reports estimating bonus payments. EOG's 10-K report does not identify new leases in its acreage, but if this information becomes available, the bonuses will be added to future reports.

⁶ LP Gas Magazine. (2022, February 28). *NGL Supply Co. Ltd. opens Ohio Rail Terminal.*

<https://www.lpgasmagazine.com/ngl-supply-co-ltd-opens-ohio-rail-terminal/>

system to the North Coast Gas Transmission system along NCGT's existing Toledo-to-Marion intrastate pipeline.⁷ Future midstream investment will include Ohio's share of the \$161 million Ohio Valley Connector Expansion project to increase takeaway capacity out of the region, which was actively under development as of March 2023.⁸

There were no significant downstream investments during the first half of 2022. However, sitework has recently begun on the \$1.2 billion natural gas-fired Trumbull Energy Center near Lordstown. Also, construction on a second natural gas-fired power plant in Oregon, OH is planned to commence in the coming year. Natural gas-based hydrogen projects—such as the \$1.6 billion advanced hydrogen clean energy manufacturing facility under development at the site of the DOE's former Portsmouth Gaseous Diffusion Plant near Piketon—will present additional downstream opportunities in the next few years. These and other investments—including the buildout of fueling infrastructure for CNG, LPG, LNG, and hydrogen-powered vehicles—will be included in future Dashboard reports.

1. INTRODUCTION

This is the thirteenth CSU study reporting investment resulting from oil and gas development in Ohio related to the Utica and Point Pleasant formations (hereinafter, the "Utica").⁹ This analysis looks at investments made in Ohio between January 1 and June 30, 2022, separately considering the upstream, midstream, and downstream portions of the industry. For the upstream part, the Study Team estimated spending primarily based upon the likely costs of drilling new and operating existing wells, together with royalties and lease bonuses.

For midstream estimates, the Study Team looked at new infrastructure built during the relevant time period downstream of production, from gathering to the point of hydrocarbon distribution. This included pipelines, processing, natural gas liquid storage, and intermodal transloading facilities.

For the downstream analysis, the Study Team considered those industries that directly consume large amounts of oil, natural gas or natural gas liquids. Since hydrocarbon consumption may or may not be related to shale development, the examination of downstream investment has been limited to those projects that have been deemed by the Study Team to be dependent on, or directly the result of, the large amount of oil and gas being developed in the region as a result of the Marcellus and Utica shale formations.

⁷ See Energy Information Administration. (January 2023). *U.S. Natural Gas Pipeline Projects*. https://www.eia.gov/naturalgas/pipelines/EIA-NaturalGasPipelineProjects_Jan2023.xlsx

⁸ See FERC Docket No. CP22-44. (2023, March 23). *Equitrans, L.P. submits Response to FERC's March 21, 2023, Data Request re the Application for a Certificate of Public Convenience and Necessity for the Ohio Valley Connector Expansion Project under CP22-44*. <https://elibrary.ferc.gov/eLibrary/filedownload?fileid=ECD4D7F4-474C-CF37-9C02-870FD8400000>

⁹ This and other Investment Dashboard reports include drilling into the Marcellus and other shale units, but these comprise a very small portion of shale development in Ohio to date. This will be revisited as necessary in future iterations of the Investment Dashboard reports.

This thirteenth Study includes as Appendix A the cumulative investment made in Ohio resulting from shale development, based upon all previous reports that tracked total investment from early 2011 through June 2022.¹⁰ The methodology for determining the investments is set forth in Appendix B, and has been updated since the last report. Subsequent reports will include incremental spending on a six-month basis.

2. SHALE INVESTMENT UPDATES

A. UPSTREAM DEVELOPMENT

1. Overview.

A total of 113 new wells were listed by the Ohio Department of Natural Resources as “drilled,” “drilling,” or “producing” during the period of January 1 to June 30, 2022.¹¹ This represents a 31.4% increase in new well development compared to the second half of 2021. The total number of production wells in the Utica was 2,886 on June 30, 2022, a 3.4% increase from the end of December 2021. Total shale-related oil and gas production in billion cubic feet equivalent (Bcfe) for this period was 1,135 Bcfe, led by Belmont County with 306 Bcfe. Jefferson County was second with 284 Bcfe, followed by Monroe County with 229 Bcfe.¹²

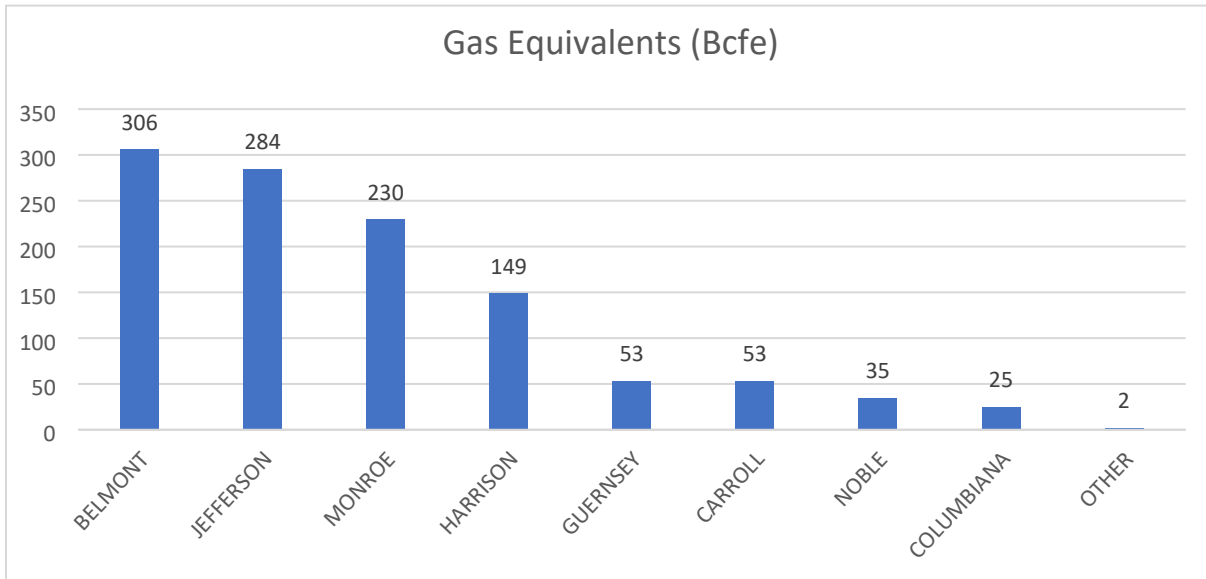
The Ohio Department of Natural Resources (ODNR) Division of Oil and Gas Resources Management issues weekly reports on well status and quarterly reports on production. The ODNR production reports for the first and second quarters of 2022 provide the foundation for the upstream analyses presented in this Study.

The Utica is currently identified by the ODNR as producing in eighteen eastern Ohio counties with the vast majority (over ninety-eight percent) of producing wells located in eight counties, stretching from Columbiana in the north, to Monroe and Noble at the southern end of the play. Total production in quarters 1 and 2 for 2022 is set forth by county and operator in Figures 3 and 4 below. Total cumulative production in billions of cubic feet equivalent (Bcfe) by county and by operator through June 2022 can be found in Appendix A as Figures 10 and 11.

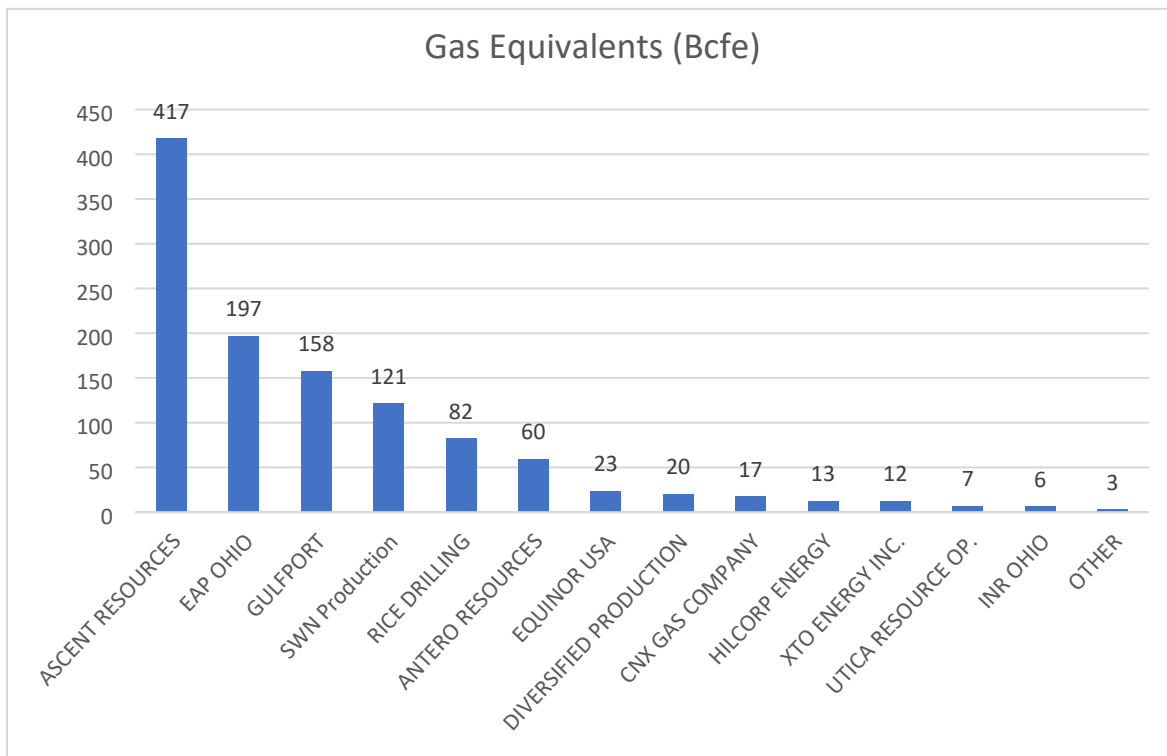
¹⁰ See *fn 1, supra*.

¹¹ The number of new wells was determined using ODNR Cumulative Permitting Activity reports for the beginning and end of the 6-month period (see <http://oilandgas.ohiodnr.gov/shale>). Wells are assigned an American Petroleum Institute API number, which is included in the ODNR reports. Wells were considered new if they had a status of drilled, drilling, or producing at the end of the 6-month period but did not have any one of these status designations at the beginning of it.

¹² Production is reported to the ODNR at the wellhead as gas measured in thousands of cubic feet (Mcf) and as oil measured in barrels (bbl). The Utica also produces significant volumes of natural gas liquids (NGLs) such as ethane, propane, butane and natural gasoline. These NGLs are separated from the natural gas stream at midstream cryogenic and fractionation plants and not included in the ODNR production reports. For the purposes of this Study, oil and gas production is combined as gas equivalents (Mcfe) based on the energy content of oil and gas, measured as British thermal units (Btu). Gas equivalents were calculated using the following formula: Gas Equivalents (Mcfe) = Oil (bbl) x 5.659 Mcf/bbl + Gas (Mcf).

Figure 3: Production by County for Q1 and Q2 of 2022

Data Source: ODNR (2023).

Figure 4: Production by Operator for Q1 and Q2 of 2022

Data Source: ODNR (2023).

2. Production Analysis.

Production can be summarized using tables that show gas equivalent production measured in billions of cubic feet equivalent as a function of time. This summary, for both production in the first and second quarters of 2022, and also for cumulative production since 2011, is set forth in Table 1. Table 2 sets forth production by county for the first half of 2022. Figure 5 sets forth the geographic distribution of production for the same period.

Table 1: Ohio's Shale Production by Reporting Period

Year	Quarter	Production Wells	Gas (Mcf)	Oil (bbl)	Gas Equivalents (Mcf)	Gas Production (% Change from Previous Quarter)
2022	2	2,921	543,019,311	5,018,523	571,419,133	1.3
2022	1	2,850	541,815,020	3,957,294	564,209,347	-5.8
2021	4	2,817	576,496,677	3,912,593	598,638,041	5.2
2021	3	2,764	547,540,443	3,781,319	568,938,927	-0.6
2021	2	2,805	549,211,398	4,154,041	572,332,375	-0.2
2021	1	2,752	548,129,151	4,543,462	573,417,606	-6.4
2020	4	2722	586,878,969	4,625,639	612,624,813	-1.3
2020	3	2688	588,630,465	5,713,477	620,431,107	3.6
2020	2	2643	569,396,136	5,182,481	598,723,796	-2.6
2020	1	2573	581,634,083	5,887,032	614,948,797	-14.1
2019	4	2524	677,685,505	6,818,682	716,272,426	0.2
2019	3	2470	673,962,146	7,200,304	714,708,666	10
2019	2	2365	614,218,362	5,813,755	647,118,402	1.4
2019	1	2277	609,452,391	5,073,536	638,163,531	-8.4
2018	4	2201	663,534,323	5,810,484	696,415,852	9.3
2018	3	2198	605,716,125	5,545,536	637,098,313	9.9
2018	2	2002	554,306,916	4,488,104	579,705,097	4.7
2018	1	1906	531,291,017	3,942,251	553,600,215	5.1
2017	4	1866	503,066,907	4,193,562	526,784,387	8.7
2017	3	1769	460,844,826	4,207,674	484,656,053	18.1
2017	2	1646	387,725,175	4,019,281	410,512,053	4.7
2017	1	1530	369,913,713	3,877,717	391,904,993	2.5
2016	4	1492	362,107,422	3,568,077	382,364,866	-0.2
2016	3	1442	360,681,356	3,954,095	383,057,580	5.9
2016	2	1382	334,257,982	4,839,792	361,646,365	0.3
2016	1	1328	329,537,838	5,485,854	360,582,286	7.0
2015	ANNUAL	1248	923,908,838	20,698,159	1,041,039,721	--
2014	ANNUAL	810	449,966,930	10,893,625	511,613,948	--
2013	ANNUAL	371	99,050,302	3,635,419	119,623,141	--
2012	ANNUAL	82	12,831,292	635,874	16,429,703	--
2011	ANNUAL	9	2,561,524	46,326	2,823,683	--
Total			15,159,372,543	161,523,968	16,071,805,223	--

Source: ODNR (2023).

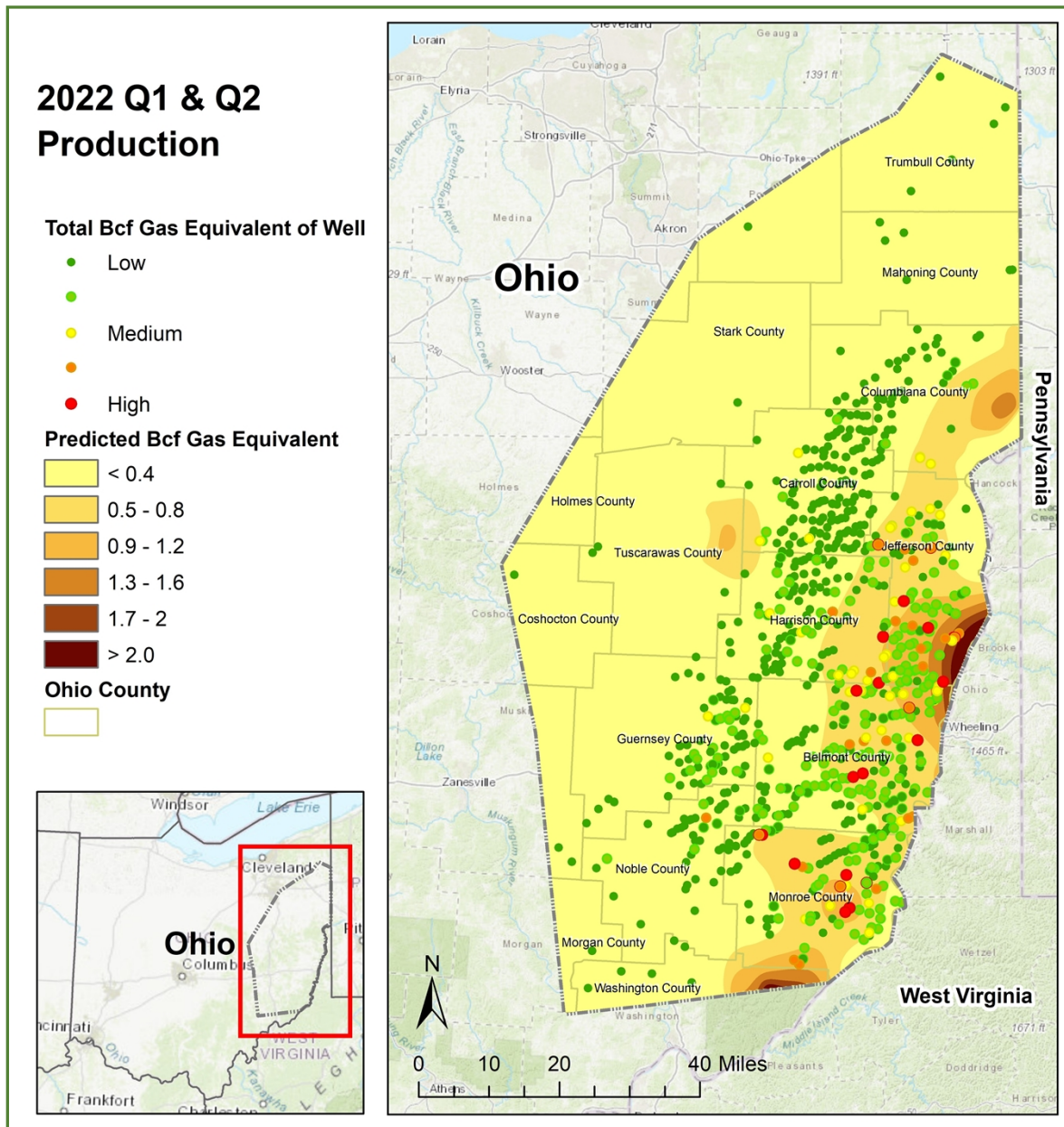
Table 2: Production by County for January – June 2022

County	Gas (Mcfe)	Oil (bbl)	Gas Equivalents (Mcfe)	Production Wells ¹³
BELMONT	305,379,996	75,695	305,808,354	622
CARROLL	41,833,417	1,983,197	53,056,329	487
COLUMBIANA	24,449,114	11,373	24,513,474	97
COSHOCTON	10,643	-	10,643	1
GUERNSEY	33,066,391	3,570,244	53,270,402	261
HARRISON	134,022,843	2,573,892	148,588,498	463
JEFFERSON	284,203,720	70	284,204,116	311
MAHONING	453,958	2,875	470,228	11
MONROE	228,717,672	138,381	229,500,770	429
MORGAN	59,218	2,144	71,351	2
MUSKINGUM	257,604	7,386	299,401	2
NOBLE	31,214,208	597,379	34,594,776	176
PORTAGE	28,603	129	29,333	2
STARK	28,059	327	29,909	1
TRUMBULL	168,823	971	174,318	6
TUSCARAWAS	144,343	6,625	181,834	5
WASHINGTON	772,761	5,049	801,333	11
WAYNE	22,958	80	23,411	1
Total	1,084,834,331	8,975,817	1,135,628,479	2,886

Source: ODNR (2023).

¹³ Represents the average number of production wells for the first and second quarters of 2022.

Figure 5: Distribution of Gas Equivalent Production for January – June 2022



Of the 3,118 total wells identified from the ODNr records for cumulative drilling activity as of June 2022, 165 were in the process of drilling, 77 wells had been drilled and were awaiting markets, and 2,876 were in the production phase.¹⁴ (See Table 3, Ohio Utica Well Status.) Belmont County continued to lead in total wells (see Table 4).

¹⁴ The discrepancy between the number of “Producing” wells in Table 3 and “Production” wells in Table 2 is due to how wells are reported in the ODNr’s *Shale Well Drilling & Permitting* and *Well Production* spreadsheets. For a particular point in time, a given well may be classified as non-producing in the spreadsheet for cumulative activity yet have a record of production in the well production spreadsheet.

Table 3: Ohio Utica Well Status as of June 2022

Well Status	No. of Wells
Drilled	77
Drilling	165
Producing	2,876
Total	3,118

Source: ODNR (2022)

Table 4: Well Status by County (June 2022)

County	Drilled	Drilling	Producing	Total
BELMONT	15	26	625	666
CARROLL	2	22	493	517
HARRISON	3	30	460	493
MONROE	19	12	400	431
JEFFERSON	1	35	320	356
GUERNSEY	3	15	260	278
NOBLE	1	6	174	181
COLUMBIANA	13	17	97	127
MAHONING	1	0	12	13
TRUMBULL	3	1	7	11
WASHINGTON	0	0	11	11
PORTAGE	6	1	2	9
TUSCARAWAS	2	0	7	9
STARK	4	0	2	6
COSHOCTON	1	0	1	2
MORGAN	0	0	2	2
MUSKINGUM	0	0	2	2
ASHLAND	1	0	0	1
KNOX	1	0	0	1
MEDINA	1	0	0	1
WAYNE	0	0	1	1
Total	77	165	2,876	3,118

B. UPSTREAM INVESTMENT ESTIMATES

Upstream investments have been broken down into four areas: investments into drilling, including road construction associated with well development; lease operating (post-production) expenses; new lease and lease renewal bonuses; and royalties on hydrocarbon production. The methodology used for each calculation is set forth in Appendix B. Average drilling costs were updated for this study, based upon reports from publicly traded operating companies. Previous shale reports differentiated between northern and southern counties with respect to drilling costs based on the greater vertical depths and horizontal lengths of wells developed in southern counties, on average. However, a recent review of ODNr drilling surveys indicated that there is no longer a significant difference in average well depth and horizontal length between northern and southern counties. Based on an average lateral length of 13,600 ft. for the eight most active shale-producing counties in Ohio over the last two years, and average drilling and completion costs of \$600 per lateral foot for operators in the Utica during 2022, we assumed an average drilling cost of \$8.2 million per well for *all* horizontal wells.¹⁵

This section covers upstream investments between January and June 2022. Cumulative upstream investments to date in Ohio, including 2011 through the first half of 2022, are set forth in Table 17 of Appendix A.

1. Investments into Drilling.

The following tables set forth estimated investments for the Study period made into drilling shale wells in Ohio. Jefferson County was the leader in new upstream investment, with 27 new wells and an investment of around \$223.5 million between January and June 2022. Harrison and Carroll counties were second and third, with 20 and 19 new wells, and approximately \$165.6 million and \$157.3 million invested, respectively. (See Table 5). Road-related investments for this version of the Shale Investment Dashboard reflect average road costs per well determined from three sources: The Ohio Oil and Gas Association's (OOGA) 2017 report *Ohio's Oil & Gas Industry Road Improvement Payments*; OOGA's 2022 *Community Impact/Sustainability Report*; and spending in 2021 on Road Use Maintenance Agreements (RUMAs) by companies in Monroe, Noble, and Carroll Counties as reported to the Study Team by the engineer's office for those counties.¹⁶ Based on information from these sources, road costs related to drilling were assumed to be \$118,870 per well.

¹⁵ See Upstream Methodology in Appendix B.

¹⁶ OOGA's 2017 report indicated that oil and gas companies in Ohio had spent approximately \$300 million on roads from 2011 through 2017. OOGA's 2022 report indicated that cumulative spending by the industry on roads had reached approximately \$400 million by the end of 2021. This suggests that \$100 million was spent on roads from 2018 through 2021. The Study Team has tracked 846 new wells over that period for the bi-annual shale dashboards. This suggests an average expenditure per well on roads of around \$118,200. Independent of this estimate, the 2021 RUMA-based improvement totals as gathered by the engineer's office in Monroe, Noble, and Carroll counties and shared with the Study Team tallied about \$3.825 million. Based on the 32 new wells the Study Team tracked for those three counties last year, this comes out to \$119,500 per well. The two estimates were averaged and rounded to the nearest \$1,000 to yield the rule of thumb for spending on roads.

Ascent was the leading operator-investor during the six-month period, with 51 new wells and an estimated \$422.2 million. EAP Ohio recorded the second highest investment, with 32 new wells and an estimated \$264.9 million investment. Gulfport Appalachia and SWN Production invested \$91.1 million and \$82.8 million in 11 and 10 wells, respectively. (See Table 6.)

Table 5: Estimated Upstream Shale Investment by County, January – June 2022

County	No. of New Wells	Drilling (\$)	Roads (\$)	Total Amount (\$)
JEFFERSON	27	\$220,320,000	\$3,209,490	\$223,529,490
HARRISON	20	\$163,200,000	\$2,377,400	\$165,577,400
CARROLL	19	\$155,040,000	\$2,258,530	\$157,298,530
MONROE	16	\$130,560,000	\$1,901,920	\$132,461,920
BELMONT	14	\$114,240,000	\$1,664,180	\$115,904,180
GUERNSEY	10	\$81,600,000	\$1,188,700	\$82,788,700
COLUMBIANA	7	\$57,120,000	\$832,090	\$57,952,090
Total	113	\$922,080,000	\$13,432,310	\$935,512,310

Source: The Authors (2023)

Table 6: Estimated Upstream Shale Investment in Ohio by Company, January – June 2022

Operators	No. of Wells	Drilling (\$)	Roads (\$)	Total Amount (\$)
ASCENT RESOURCES UTICA LLC	51	\$416,160,000	\$6,062,370	\$422,222,370
EAP OHIO LLC	32	\$261,120,000	\$3,803,840	\$264,923,840
GULFPORT APPALACHIA LLC	11	\$89,760,000	\$1,307,570	\$91,067,570
SWN Production (Ohio) LLC	10	\$81,600,000	\$1,188,700	\$82,788,700
ANTERO RESOURCES CORPORATION	3	\$24,480,000	\$356,610	\$24,836,610
INR OHIO LLC	2	\$16,320,000	\$237,740	\$16,557,740
DIVERSIFIED PRODUCTION LLC	2	\$16,320,000	\$237,740	\$16,557,740
EOG RESOURCES INC.	1	\$8,160,000	\$118,870	\$8,278,870
ECLIPSE RESOURCES I LP	1	\$8,160,000	\$118,870	\$8,278,870
Total	113	\$922,080,000	\$13,432,310	\$935,512,310

Source: The Authors (2023)

2. Lease Operating Expenses.

Post-production investments have been estimated on a half-year basis, assuming an average cost of \$0.16/Mcf-equivalent.¹⁷ This estimate is based upon recent operator reports.¹⁸ These investments are set forth below. Belmont County and Jefferson County led the lease operating expense investment, with an estimated \$48.2 million and \$44.8 million invested, respectively.

Table 7: Estimated Lease Operating Expenses for January – June 2022 by County

County	Gas Equivalents (Mcf)	Lease Operating Expense for Period
BELMONT	305,808,354	\$48,164,816
JEFFERSON	284,204,116	\$44,762,148
MONROE	229,500,770	\$36,146,371
HARRISON	148,588,498	\$23,402,688
GUERNSEY	53,270,402	\$8,390,088
CARROLL	53,056,329	\$8,356,372
NOBLE	34,594,776	\$5,448,677
COLUMBIANA	24,513,474	\$3,860,872
OTHER	2,091,761	\$329,452
TOTAL	1,135,628,479	\$178,861,486

Table 8: Estimated Lease Operating Expenses for January – June 2022 by Operator

Operator	Gas Equivalents (Mcf)	Lease Operating Expense for Period
ASCENT RESOURCES UTICA LLC	417,368,330	\$65,735,512
EAP OHIO LLC	196,715,703	\$30,982,723
GULFPORT APPALACHIA LLC	157,766,273	\$24,848,188
SWN Production (Ohio) LLC	121,156,362	\$19,082,127
RICE DRILLING D LLC	82,116,624	\$12,933,368
ANTERO RESOURCES CORPORATION	59,599,195	\$9,386,873
EQUINOR USA ONSHORE PROP.	23,149,858	\$3,646,103
DIVERSIFIED PRODUCTION LLC	19,980,685	\$3,146,958
CNX GAS COMPANY LLC	17,239,710	\$2,715,254
HILCORP ENERGY COMPANY	12,617,967	\$1,987,330
XTO ENERGY INC.	12,231,081	\$1,926,395
UTICA RESOURCE OPERATING LLC	6,545,532	\$1,030,921
INR OHIO LLC	6,161,178	\$970,386
OTHER	2,979,982	\$469,347
TOTAL	1,135,628,479	\$178,861,486

¹⁷ Previous reports relied on a per-well rule-of-thumb to calculate lease operating expenses, which attributed an equal amount to both low- and high-producing wells. A production-based rule of thumb more accurately captures the expenses that companies are likely to incur while operating wells.

¹⁸ The per-Mcf rule-of-thumb for lease operating expenses is based on average production costs for Ascent's and Gulfport's Utica operations in the first half of 2022 as reported in quarterly financial statements for both companies. See Appendix B.

3. Royalties.

Royalty investments have been estimated on a per quarter basis, assuming the formulas set forth in Appendix B. Total estimated royalties spent on Ohio properties between January and June 2022 were nearly \$1.6 billion, or about 36% higher than the amount dispersed in the second half of 2021. The breakdown by quarter for oil, residue gas (gas left after extracting liquids) and natural gas liquids is set forth in Tables 9, 10, and 11 below. The average price for natural gas was \$5.51/MMBtu during the first half of 2022, up from \$4.02 in the second half of 2021.¹⁹ Regional oil prices increased from an average of \$84.54/bbl during the first quarter of 2022 to \$98.71/bbl for the second quarter.²⁰ For comparison, regional oil prices averaged \$60.02 and \$67.11 per barrel in the third and fourth quarters of 2021, respectively.

Table 9: Total Royalties from Oil, January – June 2022 (in millions)

Year	Quarter	Oil Price \$/bbl	Oil Royalty (20%) \$/bbl	Royalty (\$mm)
2022	2	\$98.71	\$19.74	\$99.08
2022	1	\$84.54	\$16.91	\$66.91
			Subtotal	\$165.99

Table 10: Total Royalties from Residue Gas, January – June 2022 (in millions)

Year	Quarter	Residue Gas Price \$/Mcf	Residue Gas Royalty (20%) \$/Mcf	Royalty (\$mm)
2022	2	7.53	\$1.51	\$719.82
2022	1	4.58	\$0.92	\$437.20
			Subtotal	\$1,157.02

Table 11: Total Royalties from Natural Gas Liquids, January – June 2022 (in millions)

Year	Quarter	NGL Price \$/bbl	NGL Royalty (20%) \$/bbl	Royalty (\$mm)
2022	2	29.61	5.92	\$141.51
2022	1	25.36	5.07	\$120.93
			Subtotal	\$262.43

¹⁹ Reflects average natural gas prices over the respective periods across the Columbia Gas, Eastern Gas South, and Texas Eastern M-2 trading hubs as derived from Intercontinental Exchange (ICE) trade data published in regular weekly market reports by Snyder Brothers Gas Marketing. See <https://www.snyderbrothersinc.com>.

²⁰ Reflects average prices reported by Ergon for Marcellus-Utica light crude (<https://ergon.com>). See Appendix B.

4. Lease Renewals and New Leases.

New leases and lease renewal investments have been estimated for the Utica region based upon the drilling activity of the top six drilling companies in the region. These six companies have together drilled over 88% of the Utica wells to date, and it is assumed that they likewise control over 88% of the leases. The estimated investments into new leases and lease renewals are set forth below in Table 12.

There are several potential sources of error in these estimates. Because operators do not report lease bonus information, the Study Team was required to estimate investments into lease bonuses based upon some industry rules of thumb, together with information found in public leases. One important rule of thumb we deployed in estimating lease bonus investment is that “primary” lease terms average about 5 years. The primary term is that period of time during which the operator may conduct drilling operations but hold the lease without producing. Once a lease is drilled and production begins, the lease moves into its “secondary term,” and may be thereafter “held by production” (HBP) for the life of that production. Using this rule of thumb, we determined that each operator will, on average, every year replace about 20% of its undeveloped acreage that is not HBP.

However, it is possible to hold undeveloped acreage without producing it. This can be done through the process of unitization. An operator may, for instance, have a 750-acre unit that is designed to drain a reservoir by 3 wells draining 250 acres each. The operator may drill the first well and begin to pay royalties therefrom to all the unit leases, thereby moving all the unit leases into HBP status, even though only one third of the reservoir is actually producing. Under this scenario, 500 acres would be classified as “undeveloped acreage,” while 250 acres would be “developed acreage.”

Most operators report undeveloped acreage.²¹ However, they generally do not distinguish what portions of their undeveloped acreage are HBP or under primary term. Some do, however, report what percentage of their overall acreage is HBP, and this number can be used to estimate the likely acreage of leases that required bonuses. Based on the most recent annual financial reports for Antero, Ascent, and Gulfport, the Study Team found that on average 14% of a Utica operator’s net Utica acreage was not classified as “Held-By-Production.” Accordingly, for purposes of this Study, and using the 5-year primary term assumption, we assumed that operators, on average, paid lease bonuses on 20% of such non-HBP acreage for the year (i.e. ~3% of the total net acreage), and 10% over the half-year Study period.

Another important assumption is the lease bonus rate. For this Study, we have assumed bonuses to average \$5000/acre lease for renewals and new leases. From 2013-2019, this was a pretty

²¹ *Undeveloped acreage* is defined by operators as that acreage on which wells have not been drilled or completed to a point that would permit the production of economic quantities of oil and natural gas regardless of whether the acreage contains proved reserves. Accordingly, undeveloped acreage can have a wide range of meaning, ranging from highly speculative to proven. Operators use a different, more rigorous classification system to account for proven or potential reserves.

conservative number in the Utica, and therefore likely to still be conservative for renewals of older leases. There is evidence that in 2020 new lease bonus rates were depressed due to sustained low natural gas prices. More recent publicly reported information on lease bonuses suggests, however, that \$5000/acre continues to be a reasonable estimate. In May 2022, for example, the Muskingum Watershed Conservancy District leased mineral rights for \$5,500/acre for a 5-year primary term on acreage in Harrison County.²² A more recent bid to drill on state-owned land confirmed this per-acreage bonus estimate, although the primary term was shorter.²³

One additional factor that may make the lease bonus estimate inaccurate is the use of only “net” non-HBP lease acreage data to avoid possible double counting of leases. Operating companies often collaborate on development with non-operators but report only their own portion of the lease. However, bonuses must be paid on the “gross” lease acreage. So long as the non-operators are among the top six operators (which is commonly the case), their own net acreage reports will capture all the acreage. But if they are not, the acreage will not be captured, and the bonuses estimated herein will be under reported.

²² See Muskingum Watershed Conservancy District. (2022, May 20). *MWCD Negotiates Oil and Gas Lease with Encino Energy*. <https://www.mwcd.org/news/2022/05/20/mwcd-negotiates-oil-and-gas-lease-with-encino-energy>

²³ See Cleveland.com. (2023, April 10). *Texas Driller Offers Ohio ‘Potential’ of Nearly \$2 Billion to Frack Salt Fork State Park*. <https://www.cleveland.com/open/2023/04/texas-driller-offers-ohio-potential-of-nearly-2-billion-to-frack-salt-fork-state-park.html>

**Table 12: Total Estimated Investments into New Leases and Lease Renewals
January – June 2022 (in millions)**

Operator	Acreage not held for production ²⁴	Estimated Bonus Investment (\$mm)
ANTERO RESOURCES ²⁵	17,302	\$8.7
ASCENT RESOURCES ²⁶	42,087	\$21.0
EAP OHIO ²⁷	21,802	\$10.9
GULFPORT ENERGY ²⁸	30,077	\$15.0
RICE DRILLING (EQT) ²⁹	17,129	\$8.6
SOUTHWESTERN ENERGY (SWN) ³⁰	14,861	\$7.4
Total	143,257	\$71.6

C. ESTIMATED MIDSTREAM INVESTMENTS

Midstream investment includes natural gas processing and fractionation facilities, including rail and transloading facilities for storing and handling natural gas liquids. Midstream also includes transmission and gathering pipelines, storage facilities, compressor stations (including compressor engines), dehydration units, and generators installed as part of these stations.

Pipeline investments were estimated using mileage and size information from the Public Utilities Commission of Ohio, and cost information from the Interstate Natural Gas Association of America (INGAA). Similarly, compressor station investments were based on estimated cost per unit of power output for the region as obtained from the INGAA. A full description of the methodology can be found in Appendix B.

²⁴ Antero and Southwestern did not distinguish between Ohio, Pennsylvania, and West Virginia acreage for their Appalachia operations in their FY2022 10-K reports. EAP Ohio is privately held and does not release this sort of annual financial report. Gross developed acreage in Ohio for these companies was assumed to be equivalent to the total acreage for their horizontal drilling units in the state, data for which is available through the ODNR's Oil & Gas Well Viewer at <https://gis.ohiodnr.gov/mapviewer/?config=oilgaswells>. For operators who *do* file 10-K reports in which Appalachian acreage is differentiated by state (Ascent, Gulfport, and Rice Drilling), this estimate for gross developed acreage has been within $\pm 10\%$ of the actual amount. Total net acreage for Antero, Southwestern Energy, and EAP Ohio were estimated based on the average ratio of total-net-acres-to-gross-developed-acres in Ohio for Ascent, Gulfport, and Rice Drilling.

²⁵ Fifteen percent of Antero's total net Ohio acreage was assumed to not be held by production as this was the percentage of the company's overall net Appalachian acreage not held by production in FY2022 based on its most recently filed 10-K.

²⁶ Twelve percent of Ascent's total net Ohio acreage was not held by production based on the company's FY2022 Consolidated Financial Statements.

²⁷ See *fn 24, supra*. Approximately 5% of EAP's acreage in Ohio is not held by production (see <https://www.encinoenergy.com/operations>).

²⁸ Sixteen percent of Gulfport's net Ohio acreage was not held by production based on the company's FY2022 10-K.

²⁹ Acreage not held by production was not identified in the FY2022 10-K for Rice Drilling or Southwestern Energy. This percentage was assumed to be 12%, which was the average for Antero, Ascent, EAP Ohio, and Gulfport.

³⁰ *Id.*

Additional investment information was collected from midstream company investor presentations, news reports, and other sources including Ohio EPA permits. Table 13 summarizes midstream investments identified by the Study Team for the first half of 2022. Some costs related to these projects may have occurred outside the six-month window for this study. However, because the investments cannot easily be separated and tracked while construction is ongoing, the investments are treated as though made entirely during the Study period if construction on the project was begun then.

Table 13: Midstream Investments, January – June 2022

Category	Company	Additions to Infrastructure	Total Amount (\$mm)
Gathering System	Cardinal Gas Services (Williams)	<ul style="list-style-type: none"> 0.04 miles of 8.63" pipeline 1.41 miles of 16" pipeline 	\$5.8
	Dominion Energy	<ul style="list-style-type: none"> 2,760 hp of compression at New Cambridge Compressor Station in Guernsey County 	\$12.8
	EOG Resources	<ul style="list-style-type: none"> 3.89 miles of 6.63" pipeline 	\$6.1
	Summit Midstream Partners	<ul style="list-style-type: none"> 1.12 miles of 12.75" pipeline 	\$3.4
	Utica Gas Services (Williams)	<ul style="list-style-type: none"> 1.34 miles of 8.63" pipeline 	\$2.8
Transportation	NGL Supply Co. Ltd. propane rail terminal ³¹	<ul style="list-style-type: none"> 180,000-gallon rail terminal in Sycamore, OH for propane from Utica/Marcellus 	\$5.3
	Rover Pipeline ³²	<ul style="list-style-type: none"> North Coast Interconnect Project for delivery of natural gas supplies to the North Coast Gas Transmission system. 	\$1.0
Total			\$37.1

Source for Gathering Line Mileage and Diameter Data: PUCO Gathering Construction Reports (2023). Numbers may not add up precisely due to rounding.

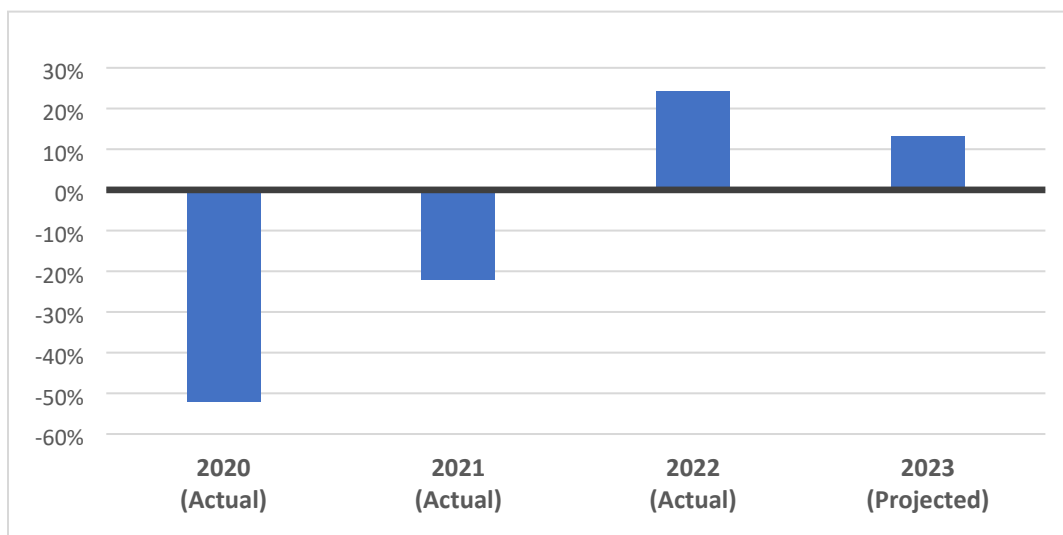
Midstream investments were down 50% during the first half of 2022 compared to the second half of 2021, totaling around \$37 million. Spending for this segment has likely rebounded moderately since the first half of 2022. Figure 6 shows the average annual growth in capital expenditures for midstream companies operating in the Utica based on actual spending since 2019, and projected spending for 2023.³³ (This change in Capex growth reflects operations both inside and outside the Utica for these companies).

³¹ See fn 6, *supra*.

³² See fn 7, *supra*.

³³ Midstream companies whose expenditures were factored into estimating average Capex growth based on available Capex guidance were Antero Midstream, Summit Midstream, Williams, MPLX, Energy Transfer, and Kinder Morgan.

Figure 6: Average Capex Growth for Midstream Operators



The region likely has sufficient near-term gas processing capacity. For example, in 2022 MPLX had about 1.6 Bcf/d of gas processing capacity and 115,000 bpd of fractionation capacity that was underutilized across its Utica and Marcellus operations, representing approximately 25% of the company's design capacity in the region.³⁴

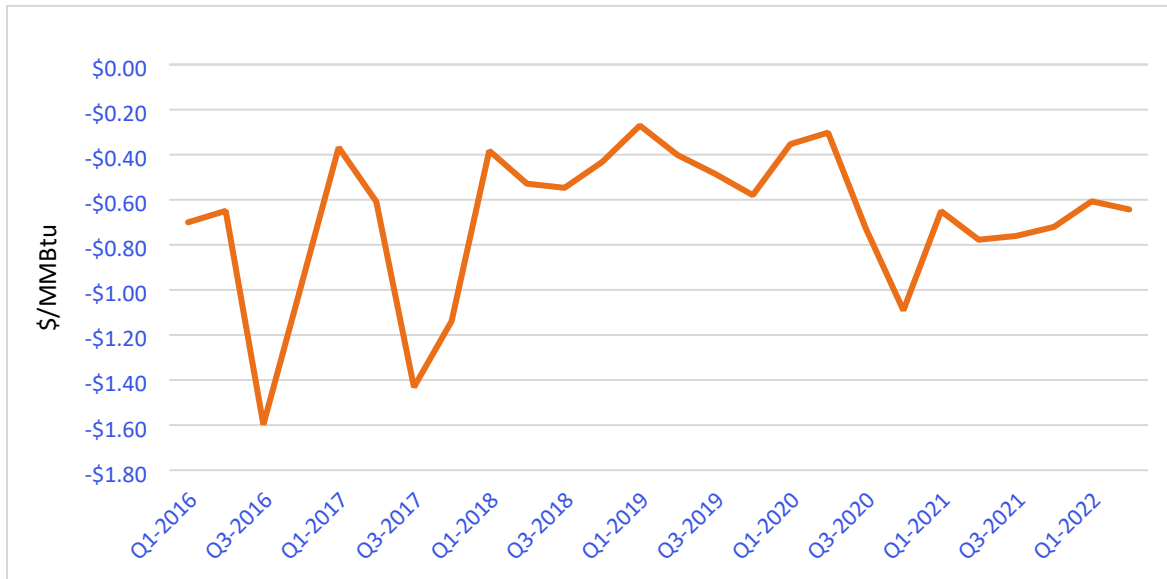
Future midstream investment in Ohio will likely be directed toward pipeline projects to bolster takeaway capacity out of the region. The sustained discount at which regional gas has traded relative to the Henry Hub indicates that a pipeline constraint persists. (See Figure 7). One such project is the \$161 million Ohio Valley Connector Expansion, the purpose of which is to increase the capability (by 350 MMcf/d) to deliver natural gas volumes to mid-continent and Gulf Coast markets along the Rockies Express and Rover pipeline systems.³⁵ The Ohio Valley Connector Expansion project will likely have all required rights of way secured by April 2023, with construction beginning soon thereafter.³⁶ This and other midstream projects to be tracked for future shale reports are listed in Table 14. Cumulative midstream investments through the end of June 2022 are set forth in Table 18 in Appendix A.

³⁴ See MPLX's FY2022 Form 10-K submission to the U.S. Securities and Exchanges Commission. <https://d18rn0p25nwr6d.cloudfront.net/CIK-0001552000/e02cfb18-f2d1-4d28-b38b-1f7dae662c38.pdf>

³⁵ See FERC Docket No. CP22-44. (2022, September 30). *Draft Environmental Impact Statement for Equitrans, LP's Ohio Valley Connector Expansion Project under CP22 44*.

<https://elibrary.ferc.gov/eLibrary/filedownload?fileid=B15F441D-A174-C0E5-8B1C-838EC4300000>

³⁶ See *fn 8, supra*. See also Equitrans Midstream. (n.d.). *Ohio Valley Connector Expansion: Project Schedule*. <https://www.ovcx.info/project-schedule/>

Figure 7. Average Eastern Gas South Trading Margin Compared to Henry Hub³⁷**Table 14: Future Ohio Midstream Projects**

Project	Description	Est. Investment (\$mm)
Ohio Valley Connector Expansion ³⁸	Takeaway capacity out of Appalachia (Ohio portion)	\$19.0
Gathering system buildout ³⁹	2.5 miles of pipeline with avg. diameter of 12.75"; 4,565 hp of compression	\$28.1

D. DOWNSTREAM DEVELOPMENT

1. Combined Heat and Natural Gas Power Plants

Over the past twelve reports, we have noted 10 new natural gas-powered power plants in Ohio that were in the planning, construction, or newly operational stages since 2015. Based on a recent review of EIA data for the six of these plants that are operational, the Study Team estimates that these facilities require around 42,400 mcf annually per MW of installed power

³⁷ See Energy Information Administration. (2023, March 15). *Henry Hub Natural Gas Spot Price*. <https://www.eia.gov/dnav/ng/hist/rngwhhdm.htm>. See also Snyder Brothers Gas Marketing. (2016-2023). *Market Reports* [weekly report that includes ICE settlement prices for natural gas trading hubs in the Appalachian basin]. <https://www.snyderbrothersinc.com>.

³⁸ See fn 35, *supra*.

³⁹ Pipeline estimate reflects construction starts through the end of December 2022 as gathered from the PUCO's Gathering Construction Reports. Compression estimate reflects projects receiving Final Issuance of Permit-to-Install and Operate from Ohio EPA as of December 31, 2022. See Appendix B for methodology used to calculate total dollar amount.

generation capacity on average.⁴⁰ This translates to an estimated 40 Bcf of natural gas consumed annually for a 940 MW power plant.

No new construction starts occurred for plants under development during the first half of 2022. However, in January 2023 tree clearing and site preparation began for the \$1.2 billion, 940 MW Trumbull Energy Center.⁴¹ Investment related to this natural gas-fired power plant will be included in a future shale report.

In September 2022, Clean Energy Future-Oregon, LLC applied for, and was granted by the Ohio Power Siting Board the following month, a one-year extension of its certificate to construct a 955 MW natural gas-fired power plant in Lucas County that would be in addition to the 960 MW one already operational nearby.⁴² This application amendment indicates that construction on the second Oregon, OH plant is planned to commence by October 2023. Construction on the \$1 billion, 1085 MW Harrison Power Plant had not started as of April 2023.⁴³ Meanwhile, construction for the \$1.6 billion, 1875MW Guernsey Power Station—investment for which was included in a previous report—is nearing completion and is planned to conclude in the first half of 2023.⁴⁴

The 10 current and projected natural gas-powered facilities across 8 locations, along with the 106 MW CHP project at Ohio State (investment for which was included in the last Shale Dashboard), are set forth in Figure 8 below.

⁴⁰ See Energy Information Administration. (2023, March 27). *Form EIA-923 Detailed Data with Previous Form Data (EIA-906/920)*. <https://www.eia.gov/electricity/data/eia923>. Form EIA-923 data include monthly and annual fuel consumption and electricity generation at the power plant level. Based on EIA's data for net generation and the PUCO's data for nominal net capacity per facility, Ohio's six operational natural gas-fired power plants developed since 2015 have an average capacity factor of nearly 77%.

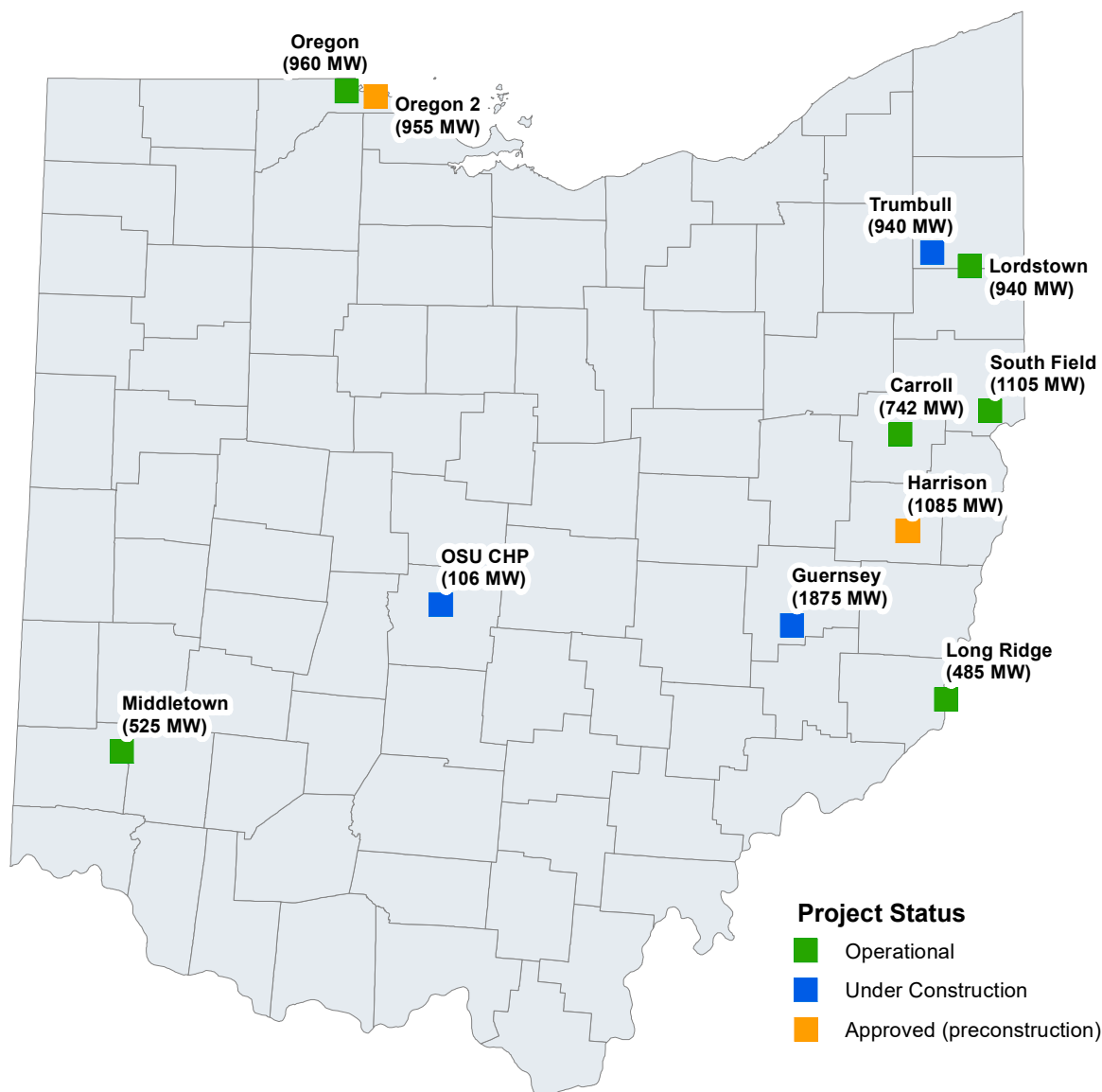
⁴¹ Business Journal Daily. (2023, January 11). *Site Work Begins for Second Power Plant in Lordstown*. <https://businessjournaldaily.com/site-work-begins-for-second-power-plant-in-lordstown>

⁴² PUCO Case Record 22-0826-EL-BGA. (2022). *Application of Oregon Clean Energy Future-Oregon, LLC for a Second Amendment to its Certificate*. <https://dis.puc.state.oh.us/CaseRecord.aspx?CaseNo=22-0826-EL-BGA&x=22&y=20>.

⁴³ No construction notice had been filed with the Ohio Power Siting Board as of this writing.

⁴⁴ PUCO Case Record 16-2443-EL-BGN. (2022). *Compliance Report electronically filed by Mr. Matt Butler on behalf of Staff of OPSB*. <https://dis.puc.state.oh.us/CaseRecord.aspx?CaseNo=16-2443>.

Figure 8: Existing and Projected Natural Gas Power Plants



Source: Ohio Power Siting Board (2023)

2. Other Future Downstream Investment

No significant direct downstream expenditures were identified during the Study Period for other uses of natural gas and NGLs. However, some downstream investments have either occurred since the first half of 2022, or are likely to occur based on recent announcements. These downstream investments to be tracked and included in future shale reports are described herein.

a. Petrochemical

As previously reported, Nutrien plans to expand production capacity of Urea Ammonium Nitrate (a natural gas derivative) beginning in 2023 at its Lima complex as part of \$260 million in spending toward organic growth projects across five North American sites.⁴⁵ Also, Tessengerlo Kerly broke ground in August 2022 on a \$44 million facility in Defiance that will use natural gas as a feedstock to produce the company's range of liquid fertilizers.⁴⁶

b. Transportation

Five public liquefied petroleum gas (LPG) fueling stations opened across the state in January 2023.⁴⁷ Most of these recently opened stations are located at U-Haul self-storage and vehicle rental locations as part of the company's efforts to convert medium and heavy-duty fleets from gasoline and diesel to LPG, also known as Autogas.⁴⁸ Equipment costs for LPG refueling stations range from \$150,000 for medium stations with an 18,000-gallon storage tank, to \$300,000 for large stations with a 30,000-gallon storage tank.⁴⁹

Federal funding opportunities under the Infrastructure Investment and Jobs Act could foster further investment toward refueling infrastructure for vehicles powered by natural gas derivatives. The recently announced Charging and Fueling Infrastructure (CFI) Discretionary Grant Program will provide \$2.5 billion toward alternative fueling infrastructure in publicly accessible locations in urban and rural communities, as well as along designated Alternative Fuel Corridors (see Figure 9 for Alternative Fuel Corridors in Ohio).⁵⁰

Qualifying projects under the CFI program can include natural gas, propane, or hydrogen fueling infrastructures.⁵¹ For projects that place neighborhood-level alternative fueling infrastructure within communities, award amounts will range from a minimum of \$500,000 to a maximum of \$15 million. For projects that place alternative refueling infrastructure along or within close

⁴⁵ Nutrien. (January 2023). *Investor Presentation*. <https://nutrien-prod-asset.s3.us-east-2.amazonaws.com/s3fs-public/uploads/2023-01/Investor%20Presentation%202023-01%20FINAL.pdf>.

⁴⁶ See Tessengerlo Kerley, Inc. (2022, August 31). *Tessengerlo Kerley, Inc. Celebrates Groundbreaking in Ohio for Fertilizer Facility*. <https://www.tkinet.com/en/defiance-ohio-groundbreaking>.

See also JobsOhio. (2022, January 31). *New Multi-Million Dollar Fertilizer Plant Coming to Northwest Ohio*. <https://www.jobsohio.com/news-press/new-multi-million-dollar-fertilizer-plant-coming-to-northwest-ohio>

⁴⁷ Alternative Fuels Data Center. (2023). *Locate Stations* [Station Data by State]. https://afdc.energy.gov/data_download.

⁴⁸ See U-Haul. (n.d.). *Propane AutoGas Trip Planner* [What is Propane AutoGas Fleet?]. <https://www.uhaul.com/Propane/AutoGas>. See also U-Haul. (n.d.). *Beginner's Guide to Autogas Vs. Gasoline*. <https://www.uhaul.com/Tips/Propane/Beginners-Guide-To-Autogas-Vs-Gasoline-18268/>

⁴⁹ Alternative Fuels Data Center. (August 2014). *Costs Associated with Propane Vehicle Fueling Infrastructure*. https://afdc.energy.gov/files/u/publication/propane_costs.pdf.

⁵⁰ Joint Office of Energy and Transportation. (2023). *Technical Assistance and Resources for States and Communities* [Charging and Fueling Infrastructure (CFI) Discretionary Grant Program]. <https://driveelectric.gov/states-communities>.

⁵¹ U.S. Department of Transportation. (2023, March 21). *Charging and Fueling Infrastructure Discretionary Grant Program*. <https://www.grants.gov/web/grants/view-opportunity.html?oppId=346798>.

proximity to an Alternative Fuel Corridor, award amounts will start at a minimum of \$1 million with no cap on the maximum award amount. For both project types, the awarded amount can cover up to 80% of total project cost.

Figure 9: Alternative Fuel Corridors in Ohio⁵²



Data Source: U.S. Department of Transportation (2022)

⁵² See U.S. Department of Transportation. (2022, November 1). *Alternative Fuel Corridors*. <https://hub.arcgis.com/datasets/usdot::alternative-fuel-corridors/about>

c. Hydrogen

A team of companies have coalesced around a plan to develop a \$1.6 billion closed-loop manufacturing facility powered by clean hydrogen at the former site of the DOE's Portsmouth Gaseous Diffusion Plant near Piketon.⁵³ Newpoint Gas, the lead on the project, will procure hydrogen from natural gas, capturing the associated CO₂ and storing it in nearby geologic formations.⁵⁴ In March 2023, Newpoint signed a teaming agreement with CDM Smith for the latter to serve as the engineering, procurement, and construction (EPC) partner on the Piketon clean hydrogen project.⁵⁵ This adds to an already established list of partners that includes Babcock & Wilcox, which will provide foundational technology for hydrogen generation and decarbonization, and J.W. Didado as the primary electrical contractor.⁵⁶

Cumulative downstream investments reported to date in Ohio, including 2011 through the first half of 2022, are set forth in Table 19 in Appendix A. An outline of the key products and processes for this sector within the shale gas value chain is set forth in Appendix B.

3. CONCLUSION

Total upstream shale investment in Ohio was up considerably (+29.3%) for the first half of 2022 compared to the second half of 2021. This increase accompanied surging natural gas prices that in the first half of 2022 more than doubled average prices for 2016 through 2021. This upward trend in upstream investment likely continued into the second half of 2022, during which the region saw some of its highest natural gas prices (>\$8/MMBtu at local hubs) since the advent of shale development. While southerly Belmont County again led all counties in production, more northerly Jefferson County for the fourth six-month period in a row had the highest number of new wells developed. Indeed, 65% of new well development during the Study period occurred in more northerly counties (Carroll, Columbiana, Harrison, and Jefferson), suggesting that investment for this segment continues to be tilted toward the northern part of the Utica. Altogether, upstream shale investment totaled nearly \$2.8 billion for the first half of 2022. It remains to be seen how the geographical distribution of drilling will change as a result of EOG's recent investment into the condensate heavy parts of the Utica.

⁵³ Business Wire. (2022, September 8). *J.W. Didado Electric to Partner with Newpoint Gas on Advanced Hydrogen Generation and Carbon Sequestration Project in Ohio*. <https://www.businesswire.com/news/home/20220908005657/en/J.W.-Didado-Electric-to-Partner-with-Newpoint-Gas-on-Advanced-Hydrogen-Generation-and-Carbon-Sequestration-Project-in-Ohio>

⁵⁴ See Columbus Dispatch. (2022, May 17). *Hydrogen Power Plant Proposed for Former Uranium Enrichment Facility in Southern Ohio*. <https://www.dispatch.com/story/business/2022/05/17/hydrogen-power-facility-planned-site-former-piketon-plant/9798251002/>. See also Newpoint Gas. (2022). *h2Trillium Energy and Manufacturing (h2TEAM) Complex*. <https://www.newpointgas.com/wp-content/uploads/2022/06/Final-h2TEAM-%E2%80%93-Revitalizing-Central-Appalachia-2022.6.15.pdf>

⁵⁵ Newpoint Gas. (2023, March 21). *CDM Smith and Newpoint Gas Sign Clean Hydrogen Project Teaming Agreement to Reindustrialize Former DOE Site in Pike County Ohio*. <https://www.newpointgas.com/news/cdm-smith-and-newpoint-gas-sign-clean-hydrogen-project-teaming-agreement-to-reindustrialize-former-doe-site-in-pike-county-ohio/>

⁵⁶ *Id.*

Midstream investments for the first half of 2022 were constrained as the region appears to have sufficient processing capacity for the time being. Pipeline projects to enhance takeaway capacity out of the region, particularly the \$161 million Ohio Valley Connector Expansion project, continued to progress and could commence with construction in the first half of 2023. Gathering system buildout continued during the Study period, with an estimated investment of \$18 million for pipelines and \$12.8 million for compression. Additional midstream spending included \$5.3 million towards a propane rail terminal.

The first half of 2022 saw a pause in downstream investment. However, this will soon change. Construction starts representing at least \$2 billion in natural gas power generation are planned for 2023. Also, construction for a 500-metric ton/day hydrogen production plant that uses natural gas with carbon capture—part of a \$1.6 billion clean energy manufacturing facility—is planned to commence sometime in 2023.⁵⁷ Spurred by federal support for alternative fueling stations, additional millions may flow into the state to build out refueling infrastructure for CNG, LNG, LPG, and hydrogen-powered vehicles.

Altogether, shale-related investment in Ohio for the first half of 2022, including upstream, midstream, and downstream, was around \$2.8 Billion. Cumulative total shale related investment since 2012 is around \$100.6 billion.

⁵⁷ See Newpoint Gas. (2022). *h2Trillium Energy and Manufacturing (h2TEAM) Complex*. <https://www.newpointgas.com/wp-content/uploads/2022/06/Final-h2TEAM-%E2%80%93Revitalizing-Central-Appalachia-2022.6.15.pdf>

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About the Energy Policy Center

The Energy Policy Center is housed within the Maxine Goodman Levin College of Urban Affairs at Cleveland State University. The mission of the EPC is to help overcome social and institutional barriers to the implementation of solutions to energy challenges by providing an objective channel for the free exchange of ideas, the dissemination of knowledge, and the support of energy related research in the areas of public policy, economics, law, business and social science. For more information, go to <http://urban.csuohio.edu/epc/>.

4. APPENDICES

APPENDIX A. CUMULATIVE OHIO SHALE INVESTMENT

Figure 10: Total Utica Production in Bcfe (Gas Equivalence) by County through June 2022

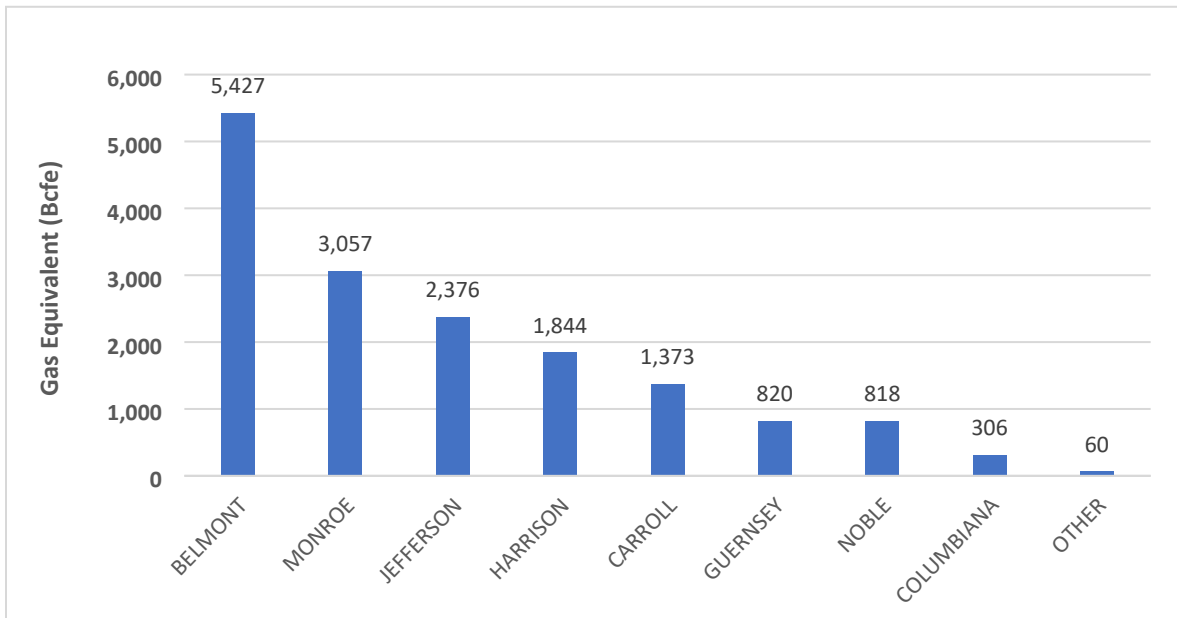


Figure 11: Total Utica Production in Bcfe by Operator through June 2022

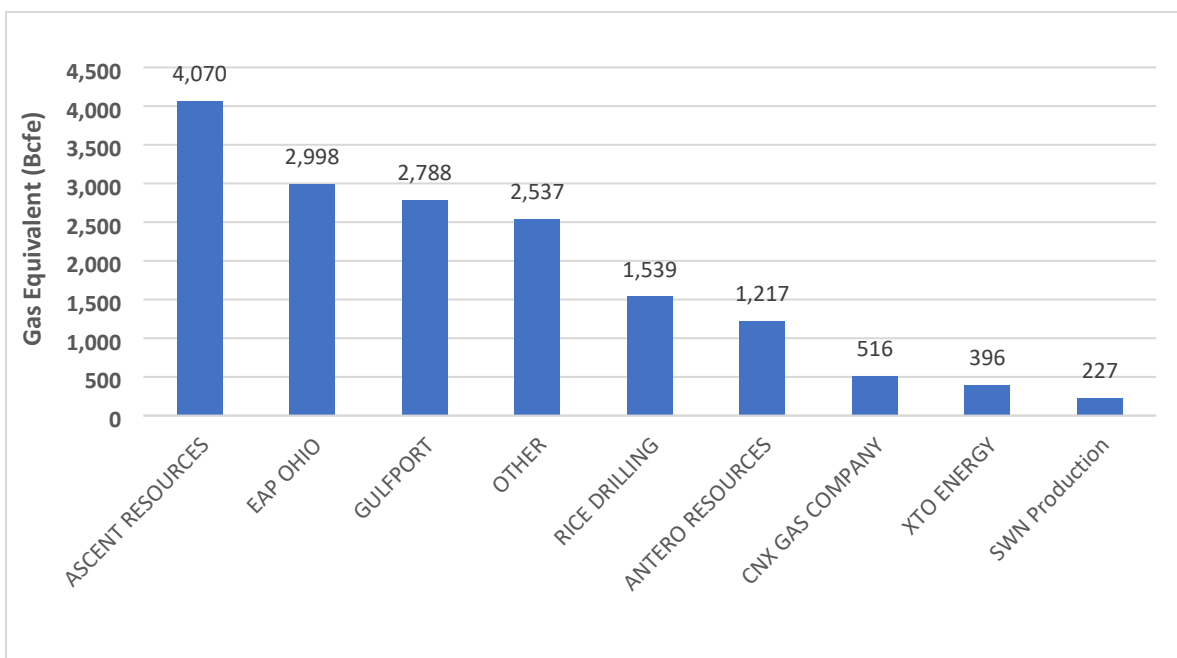
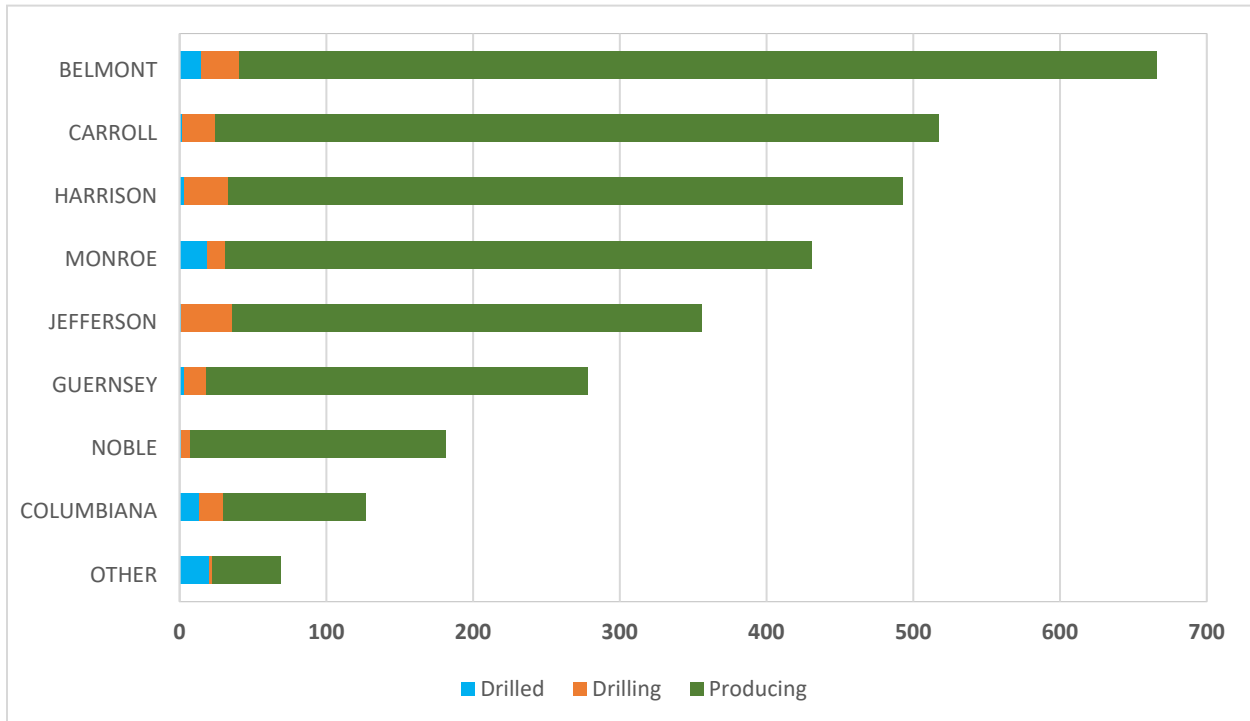


Figure 12: Cumulative Number of Wells by County through June 2022

Source: Ohio Department of Natural Resources (June 2022)

Figure 13: Distribution of Gas Equivalent Production for 2011 through June 2022

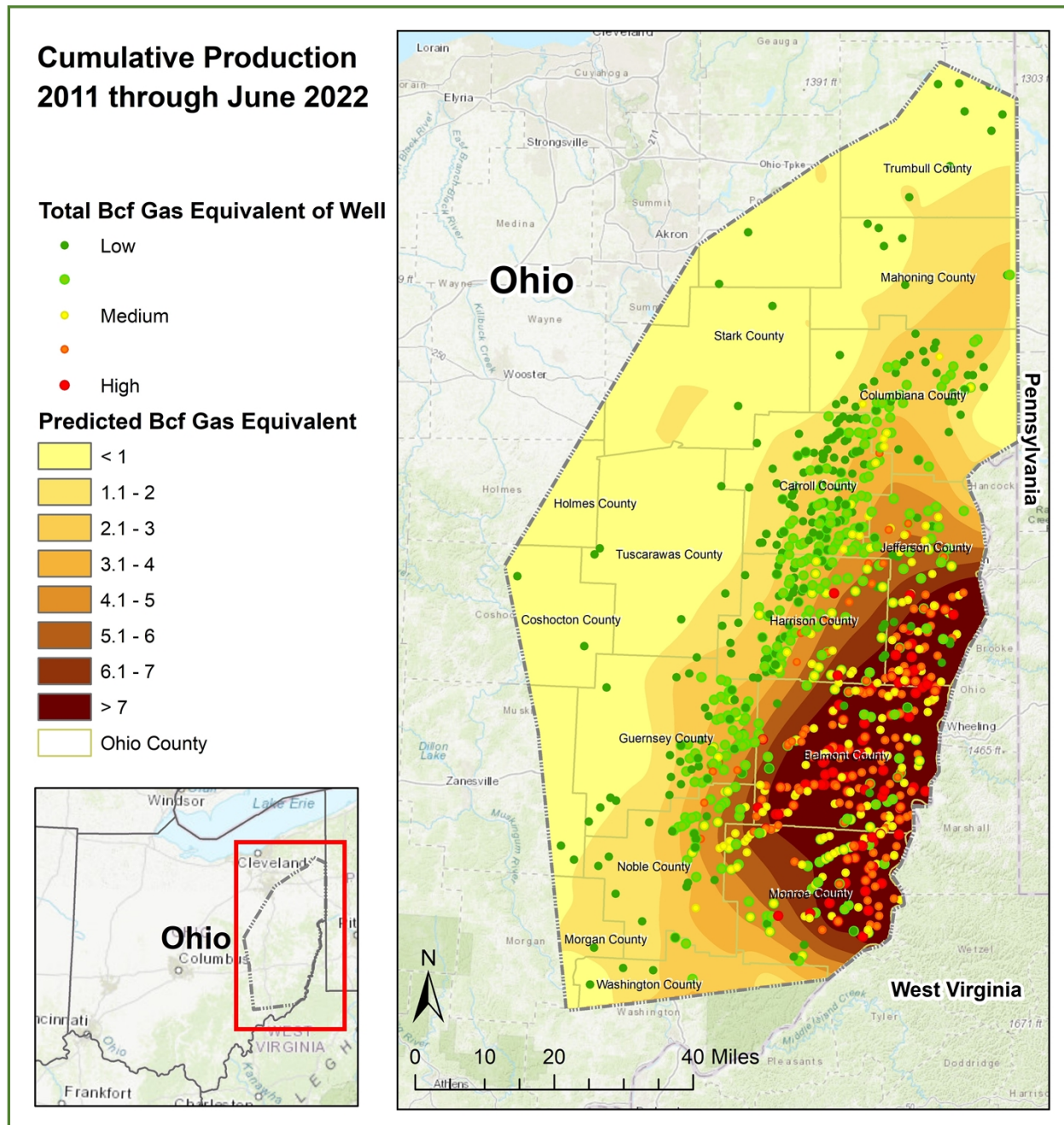


Figure 14: Distribution of Utica Wells by Status as of July 1, 2022

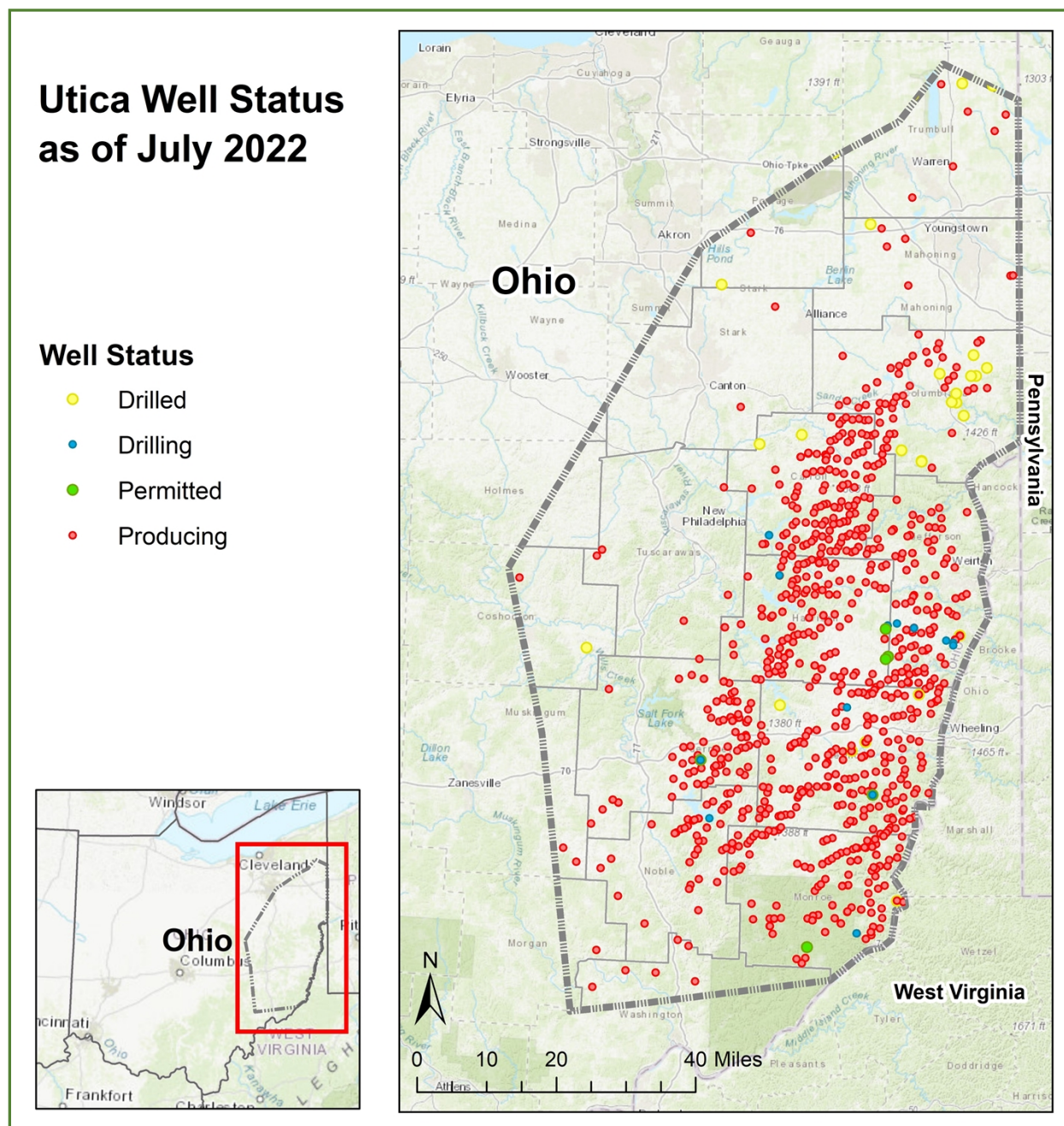


Table 15: Utica Upstream Companies Drilling in Ohio as of July 1, 2022

Operator	Cumulative no. of Wells
EAP OHIO LLC	929
ASCENT RESOURCES UTICA LLC	750
GULFPORT APPALACHIA LLC	437
ANTERO RESOURCES CORPORATION	242
SWN Production (Ohio) LLC	208
RICE DRILLING D LLC	149
XTO ENERGY INC.	58
HILCORP ENERGY COMPANY	47
CNX GAS COMPANY LLC	46
INR OHIO LLC	45
EQUINOR USA ONSHORE PROPERTIES INC.	42
UTICA RESOURCE OPERATING LLC	37
PIN OAK ENERGY PARTNERS LLC	33
DIVERSIFIED PRODUCTION LLC	27
GEOPETRO LLC	17
GULFPORT ENERGY CORPORATION	12
ARTEX ENERGY GROUP LLC	9
NORTHWOOD ENERGY CORP	6
SUMMIT PETROLEUM INC	6
EOG RESOURCES INC.	5
CHESAPEAKE EXPLORATION LLC	3
DEVON ENERGY PRODUCTION CO LP	3
BRAMMER ENGINEERING INC	2
EQT PRODUCTION COMPANY	2
AMERICAN ENERGY UTICA LLC	1
BP AMERICA PRODUCTION COMPANY	1
ECLIPSE RESOURCES I LP	1
Grand Total	3,118

Note: Cumulative Number of Wells are calculated based upon the total number Drilled, Drilling, and Producing. Source: ODNR (July 1, 2022).

Table 16: Total Lease Operating Expenses through June 2022 (in millions)

Year	Period	Production Wells	Lease Operating Expenses for Period (\$mm)
2022	Q1 and Q2	2,886	178.6
2021	Q3 and Q4	2,791	151.8
2021	Q1 and Q2	2,806	205.7
2020	Q3 and Q4	2,705	206.1
2020	Q1 and Q2	2,610	266.2
2019	Q3 and Q4	2,497	262.2
2019	Q1 and Q2	2,273	228.0
2018	Q3 and Q4	2,200	231.0
2018	Q1 and Q2	1,874	191.2
2017	Q3 and Q4	1,818	121.8
2017	Q1 and Q2	1,588	141.3
2016	Q3 and Q4	1,467	101.2
2016	Q1 and Q2	1,355	97.6
2015	Annual	1,034	148.9
2014	Annual	612	88.1
2013	Annual	237	34.1
2012	Annual	82	3.0
2011	Annual	9	0.3
		Total	2,657.1

Table 17: Cumulative Utica-Related Upstream Investments in Ohio through June 2022

Estimated Investments	Total Amount
Mineral Rights	\$25,724,763,000
Drilling	\$29,974,440,000
Roads	\$1,116,115,310
Lease Operating Expenses	\$2,657,165,486
Royalties	\$11,385,688,000
Total	\$70,858,171,796

Table 18: Cumulative Utica-Related Midstream Investments in Ohio through June 2022

Estimated Investments	Total Amount
Midstream Gathering	\$7,807,279,000
Processing Plants	\$1,259,300,000
Fractionation Plants	\$1,697,360,000
NGL Storage	\$261,000,000
Rail Loading Terminals	\$150,270,000
Transmission Pipelines	\$10,304,128,000
Total	\$21,479,337,000

Table 19: Cumulative Utica-Related Downstream Investments in Ohio through June 2022

Estimated Investments	Total Amount
Petrochemical Plants and Refineries	\$635,443,000
Other Industrial Plants	\$760,000,000
Natural Gas Refueling Stations	\$78,675,000
Natural Gas Power Plants	\$6,442,500,000
Combined Heat and Power (CHP) Plants	\$377,370,000
Total	\$8,293,988,000

APPENDIX B. METHODOLOGY

1. Upstream Methodology.

Investment into the upstream for this fourth report has been broken down into four categories.

a. Wells and Related Roads. The first category is investment into wells and includes one-time investments into drilling and road construction related to well development. They were estimated as:

- Drilling:
 - Drilling and completion costs of \$8.2 mm/well.⁵⁸
 - Equivalent true vertical depth (TVD) for wells in all counties.
 - Average drilling and completion costs of \$600 per lateral foot.⁵⁹
 - Average lateral length of 13,600 ft.⁶⁰
- Roads: average investments - approximately \$119,000 per well based on recent OOGA reports and data for 2021 from engineer's office in Carroll, Noble, and Monroe counties.⁶¹

The number of new wells developed in the Study period, used as a basis for these calculations, were accounted for by subtracting the number of wells in the drilled, drilling and producing categories as of December 31, 2021, from the number existent as of June 30, 2022. This information was downloaded from the ODNR's weekly *Combined Utica/Point Pleasant Shale Permitting Report*.⁶²

b. Lease Operating Expense. The second estimated upstream cost identified by operators is the "lease operating expense." This includes post-production costs such as the storage,

⁵⁸ Previous shale reports distinguished between drilling costs for northern counties (Carroll, Harrison, Jefferson, Columbiana, Trumbull, Mahoning and Tuscarawas) and southern counties (Noble, Guernsey, Belmont, Monroe and Washington) based on the assumption that the Utica is deeper in the south, requiring more expensive drilling in over-pressured formations. The Study Team conducted a review of drilling surveys associated with ODNR completion reports for new wells drilled since January 2020 and found a difference in mean true vertical depth between northern and southern counties of less than 500 ft., which would likely not lead to significant cost differences. Also, the same review of drilling surveys indicated that laterals for new wells in southern counties were not longer on average than for those in the north, contrary to prior analyses of lateral lengths by county. Indeed, laterals for wells in northern counties were found to be about 600 feet longer on average than those in the south, although this difference would likely not lead to significant cost differences.

⁵⁹ Based on Ascent Resources' and Antero Resources' recent estimated drilling costs per lateral foot in the Appalachian Basin. See PR Newswire. (2022, March 10). *Ascent Resources Utica Holdings, LLC Reports Fourth Quarter and Year-End 2021 Operating and Financial Results and Issues Initial 2022 Guidance*. <https://www.prnewswire.com/news-releases/ascent-resources-utica-holdings-llc-reports-fourth-quarter-and-year-end-2021-operating-and-financial-results-and-issues-initial-2022-guidance-301500382.html>. See also PR Newswire. (2021, February 17). *Antero Resources Reports Fourth Quarter Results, Announces 2021 Guidance, Proved Reserves and Drilling Partnership*. <https://www.prnewswire.com/news-releases/antero-resources-reports-fourth-quarter-results-announces-2021-guidance-proved-reserves-and-drilling-partnership-301230367.html>.

⁶⁰ Calculated using well completion reports obtained from the ODNR's *Ohio Oil & Gas Well Database*.

⁶¹ See fn 16, *supra*.

⁶² Ohio Department of Natural Resources. (2023). *Horizontal Wells*. <https://ohiodnr.gov/business-and-industry/energy-resources/oil-and-gas-wells/horizontal-wells>

processing and disposal of produced water, among other expenses. Lease operating expenses for Utica wells were estimated to be a production-based \$0.16/Mcf-equivalent. This average expense was developed by the Study Team based on analysis of Ascent's and Gulfport's lease operating expenses in the Utica for the first half of 2022 as reported in their quarterly financial statements.⁶³

c. Oil and Gas Production Royalties. A third area of upstream investment, royalty calculation, is more complicated. The estimate is based upon the total production over the six-month period and the likely price received for sales of the hydrocarbon during that same period. However, because much of the natural gas has been processed, Ohio Department of Natural Resources production records cannot be readily converted to royalty payments. Accordingly, a number of assumptions are required to estimate the royalties paid. These include estimating the local market conditions at the time hydrocarbons were sold. Royalties were estimated on a per quarter basis for Utica production based upon the hydrocarbon content for a typical Utica well.

To estimate the royalties, the following assumptions were made based upon industry interviews, industry investor presentations, and Energy Information Agency reports:

- Production for each well was similar to that found in the wet gas region, and not the dry gas or condensate regions. This represents the average situation.
- The average production shrinkage after processing was 12%, thereby making the residue gas volume 88% of the total natural gas production.⁶⁴
- The residue energy content was around 1.1 MMBtu/Mcf.⁶⁵
- Residue gas in the Utica was selling at an average price of \$4.17/MMBtu for Q1 and \$6.85/MMBtu for Q2.⁶⁶ These prices were used to estimate royalties.
- Around 44 barrels of liquids were recovered per million cubic feet of gas produced.⁶⁷
- Natural gas liquids were selling for around 30% of the listed price for Marcellus-Utica light crude oil.⁶⁸
- Oil in the Utica region was selling for \$84.54 and \$98.71 per barrel, on average, during the first and second quarters of 2022, respectively.⁶⁹
- Royalty rates are 20% of gross production.

⁶³ See Ascent Resources' financial reports at <https://ascentresources.com/financials>. See also Gulfport Energy's financial reports at <https://www.gulfportenergy.com/investors/sec-filings/quarterly-reports>.

⁶⁴ Based on industry interviews, experts citing API 12.3, Manual of Petroleum Measurements and Standards.

⁶⁵ EIA estimates a conversion rate of 1.037 MMBtu/Mcf (see <https://www.eia.gov/tools/faqs/faq.php?id=45&t=8>). However, industry interviews suggest 1.1 is closer to the average conversion for the Utica Shale.

⁶⁶ Reflects average price across the Columbia Gas, Eastern Gas South, and Texas Eastern M-2 trading hubs as derived from ICE trade data published by Snyder Brothers Gas Marketing at <https://www.snyderbrothersinc.com>. Hub prices reflect the delivered price of natural gas and so do not require further deductions for transportation costs. See <https://www.eia.gov/todayinenergy/detail.php?id=18391>

⁶⁷ Based on industry data.

⁶⁸ Based on industry interviews.

⁶⁹ See Marcellus/Utica prices for light crude at <http://ergon.com/prices>. More than 95% of Ohio oil production is light crude by API gravity. See <https://www.eia.gov/petroleum/production/xls/api-history.xlsx>

d. New and Renewal Lease Bonuses. Finally, a fourth form of upstream investment was estimated: new and renewal lease bonuses. For this purpose, we assumed that the average new lease or renewal bonus paid was \$5000/acre, and that the typical lease has a five-year primary term. In prior studies, based upon the assumption that most undeveloped acreage was in the primary term of the least, we assumed that approximately 20% of the undeveloped acreage identified will need to be renewed each year or is otherwise new.⁷⁰ Since this Study covered six months, we assumed that half of this 20% was renewed or new during the Study period. However, as units have developed in the Utica, we have changed this estimate going forward to assume that 25% of the operator's total acreage is in its primary term, and that 20% of this acreage must be renewed or replaced very year (10% for a six-month period). This estimate may be high insofar as companies are not renewing or replacing all their primary term acreage. However, it may also be low insofar as the studies have only identified net acreage for the top six to nine operators in Ohio and may not be capturing all of the non-operator net acreage. (Acreage status is typically reported in company 10-K and other financial statements).

2. Midstream Methodology.

Midstream investments include pipeline construction (intrastate, gathering lines and inter-state), processing plants (compression, dehydration, fractionation, and others), natural gas liquid storage facilities, and railroad terminals and transloading facilities. Midstream expenditures were estimated based upon a combination of midstream company investor reports, media reports, and industry "rules of thumb" obtained from industry interviews, government reports, and industry trade journals. Estimated investments were then compared against investor presentations and other information gleaned from public sources to confirm their accuracy. Interviews were also used to confirm ranges of expenditures.

a. Processing plants. Processing plant information was obtained by searching a wide range of resources including EPA permit databases, news agencies, and company web sites and presentations. For purposes of estimating the investments for midstream processing plants, rules of thumb were developed based upon facility throughput capacities. These rules of thumb were applied to the processing plants that have been built in Ohio, using the throughput capacity estimates cited in permit documents, or made available from public literature. Likewise, rules of thumb based upon throughput capacity were used to estimate investments downstream of the processing plants, such as storage facilities and loading terminals. Dehydration processing plants were estimated using average cost per Mcf capacity for similarly designed and recently built plants in the Appalachian region.

Compressor station investments were calculated based on the horsepower rating listed in Ohio EPA air permit data and estimated construction costs per horsepower of \$4,631 for the Midwest

⁷⁰ This estimate was confirmed through industry interviews. New operator undeveloped acreage reports are likely to be made available over time that may suggest these estimates could be either too high or too low.

Region as projected by the Interstate Natural Gas Association of America (INGAA) for 2022 after adjusting for inflation.⁷¹

The approximate capital cost for TEG dehydration units based on throughput was obtained from Carroll's *Natural Gas Hydrates: A Guide for Engineers* (2014, 3rd ed.). Facilities receiving a final permit-to-install or permit-to-install-and operate were assumed to be constructed during the same 6-month period in which the permit was issued by the Ohio EPA.

The following assumptions were used to estimate midstream-related investments:

- Processing Plants.
 - \$400,000 per MMcf/d throughput
 - \$80 MM per 200 MMcf/d plant (typical skid size)
- Fractionation Plants: \$3,542 per bbl/d⁷²
- Storage Tankage: \$80 MM for 1 Bcf/d throughput
- Rail Loading Terminals: \$40 MM for 1 Bcf/d throughput

b. Pipelines. Pipeline investments were estimated by applying “inch-mile” cost estimates to known pipeline diameter and length for both inter- and intrastate projects. Interstate pipeline diameters and mileage can be determined from Federal Energy Regulatory Commission data. These estimates were confirmed from investor presentations, when available. Intrastate mileage and diameter were determined using data for gathering system construction that was obtained from the Public Utilities Commission of Ohio.

For this report, up-to-date cost projections for natural gas transmission and gathering line pipelines, per inch-mile, was obtained from the INGAA. The estimated cost for natural gas pipelines for the Midwest Region as used in this analysis was \$237,353 per inch-mile, which included labor, raw materials, and permitting costs, as projected by the INGAA for 2022 after adjusting for inflation.⁷³

No investments into distribution lines were included in the Study since it is assumed that these have not grown as a direct result of shale development. For pipelines carrying liquids, the

⁷¹ See The INGAA Foundation, Inc. (2018). *North America Midstream Infrastructure through 2035*. <https://ingaa.org/wp-content/uploads/2018/06/34703.pdf>. INGAA's projections for midstream infrastructure costs are in 2016 dollars. These projections were converted to 2022 dollars using the Bureau of Labor Statistics' Producer Price Index for *Other Pipeline Transportation* (available at <https://fred.stlouisfed.org/series/PCU48694869>).

⁷² The Study Team reviewed the published investment costs and throughput capacities of eight different fractionation facilities that have been developed since 2018, all of which are in Texas. The assumed unit cost for fractionation reflects the median investment per barrel of processing capacity per day for these eight facilities. See the following examples: Targa Resources Inc.'s Mont Belvieu fractionation facilities (<https://www.naturalgasintel.com/targa-building-two-new-fractionation-trains-at-mont-belvieu/>); Phillip 66's Sweeny fractionation facilities (https://s22.q4cdn.com/128149789/files/doc_presentations/2019/11/Investor-Day-Slides-for-Website-11.06.2019-vF.pdf).

⁷³ See fn 71, *supra*.

investment assumption is that expenditures will be comparable to those seen for gas pipelines. These were also corroborated by industry investor reports.

3. Downstream Methodology.

For estimating downstream expenditures, the Study Team relied upon publicly available reports gathered from news media, trade association publications, company websites and investor presentations. The Study Team also used interviews, and Ohio EPA permits and public notices to identify projects and support investment estimates. Search terms included identified company names, and key words associated with specific facility types and industries.

As of this report, downstream investment is categorized into eight categories:

- Natural Gas Power Plants
- Combined Heat and Power Plants
- Ethane Cracker Plants
- Methanol Plants
- Refineries
- Natural Gas refueling stations
- Petrochemical Plants
- Other industrial plants with natural gas inputs

NAICS codes used to generate keywords for searches included the following:

3251 – Basic Chemical Manufacturing

3252 – Resin, Synthetic Rubber, and Artificial and Synthetic Fibers and Filaments Manufacturing

3253 – Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing

3255 – Paint, Coating, and Adhesive Manufacturing

3259 – Other Chemical Product and Preparation Manufacturing

3261 – Plastics Product Manufacturing

Downstream activities include the deployment of processes that turn hydrocarbons— natural gas (methane) and natural gas liquids (ethane, propane, butanes)—into higher-valued fuels and petrochemicals. Shale gas may be monetized into numerous resulting value-added products. Figure 15 shows the primary intermediates and products that can be manufactured from the main hydrocarbon components in shale gas as part of downstream production.⁷⁴

⁷⁴ See U.S. Department of Energy. (June 2020). *The Appalachian Energy and Petrochemical Renaissance: An Examination of Economic Progress and Opportunities*. https://www.energy.gov/sites/prod/files/2020/06/f76/Appalachian%20Energy%20and%20Petrochemical%20Report_063020_v3.pdf

Figure 15: Shale/Natural Gas Value Chain for Petrochemicals

