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## Shale Investment Dashboard in Ohio Q3 and Q4 2020

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October 2021

**SHALE INVESTMENT  
DASHBOARD IN OHIO  
Q3 AND Q4 2020**

**Energy Policy  
Center**

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<b>1. INTRODUCTION .....</b>	<b>6</b>
<b>2. SHALE INVESTMENT UPDATES.....</b>	<b>6</b>
A. UPSTREAM DEVELOPMENT.....	6
1. Overview. ....	6
2. Production Analysis.....	9
B. UPSTREAM INVESTMENT ESTIMATES .....	14
1. Investments into Drilling. ....	14
2. Lease Operating Expenses.....	15
3. Royalties. ....	17
4. Lease Renewals and New Leases. ....	18
C. ESTIMATED MIDSTREAM INVESTMENTS .....	20
D. DOWNSTREAM DEVELOPMENT .....	23
1. Combined Heat and Natural Gas Power Plants .....	23
2. Petrochemical Plants, Refineries, and Other Downstream Investment .....	26
<b>3. CONCLUSION .....</b>	<b>27</b>
<b>4. APPENDICES .....</b>	<b>29</b>
APPENDIX A. CUMULATIVE OHIO SHALE INVESTMENT .....	29
APPENDIX B. METHODOLOGY .....	36
1. Upstream Methodology.....	36
2. Midstream Methodology.....	38
3. Downstream Methodology.....	40

## LIST OF TABLES

Table 1: Ohio's Shale Production by Reporting Period.....	10
Table 2: Production by County for July – December 2020 .....	11
Table 3: Ohio Utica Well Status as of December 2020 .....	13
Table 4: Well Status by County (December 2020).....	13
Table 5: Estimated Upstream Shale Investment by County, July - December 2020 .....	15
Table 6: Estimated Upstream Shale Investment in Ohio by Company, July - December 2020....	15
Table 7: Estimated Lease Operating Expenses for July - December by County .....	16
Table 8: Estimated Lease Operating Expenses for July - December 2020 by Operator .....	17
Table 9: Total Royalties from Oil.....	18
Table 10: Total Royalties from Residue Gas .....	18
Table 11: Total Royalties from Natural Gas Liquids.....	18
Table 12: Total Estimated Investments into New Leases and Lease Renewals.....	20
Table 13: Midstream Transmission and Gathering Line Investment.....	21
Table 14: Additional Midstream Investment, July - December 2020 .....	22
Table 15: Utica Upstream Companies Drilling in Ohio as of December 2020 .....	33
Table 16: Total Lease Operating Expenses through December 2020.....	34

Table 17: Cumulative Utica-Related Upstream Investments in Ohio through Dec. 2020.....	34
Table 18: Cumulative Utica-Related Midstream Investments in Ohio through Dec. 2020.....	35
Table 19: Cumulative Utica-Related Downstream Investments in Ohio through Dec. 2020 .....	35

## LIST OF FIGURES

Figure 1. Cumulative Shale Investment in Ohio Over Time.....	4
Figure 2: Production by County for Q3 and Q4 of 2020 .....	7
Figure 3: Production by Operator for Q3 and Q4 2020 .....	8
Figure 4. Permits Issued for Shale Wells in Northern and Southern Counties Since 2018 .....	9
Figure 5: Distribution of Gas Equivalent Production for July - December 2020.....	12
Figure 6. Existing and Projected Natural Gas Power Plants .....	25
Figure 7: Total Utica Production in Bcfe (Gas Equivalence) by County through Dec. 2020 .....	29
Figure 8: Total Utica Production in Bcfe by Operator through December 2020.....	29
Figure 9: Cumulative Number of Wells by County .....	30
Figure 10: Distribution of Gas Equivalent Production for 2011 through December 2020 .....	31
Figure 11: Distribution of Utica Wells by Status as of December 2020.....	32
Figure 12. Shale/Natural Gas Value Chain for Petrochemicals.....	41

## Executive Summary

This report presents findings from an investigation into shale-related investment in Ohio. The investment estimates are cumulative from July through December of 2020. Prior investments have been included in previous reports that are available from Cleveland State University.<sup>1</sup> Subsequent reports will estimate additional investment since the date of this report. Investment in Ohio into the Utica during the second half of 2020 can be summarized as follows:

### Total Estimated Upstream Utica Investment: July – December 2020

Lease Renewals and New Leases	\$247,732,000
Drilling	\$951,000,000
Roads	\$4,800,000
Lease Operating Expenses	\$206,121,000
Royalties	\$450,190,000
<b>Total Estimated Upstream Investment</b>	<b>\$1,859,843,000</b>

### Total Estimated Midstream Investment: July – December 2020

Transmission Lines	\$8,900,000
Gathering Lines	\$9,700,000
Gathering System Compression and Dehydration	\$123,416,000
Fractionation Plants	\$283,360,000
<b>Total Estimated Midstream Investment</b>	<b>\$425,376,000</b>

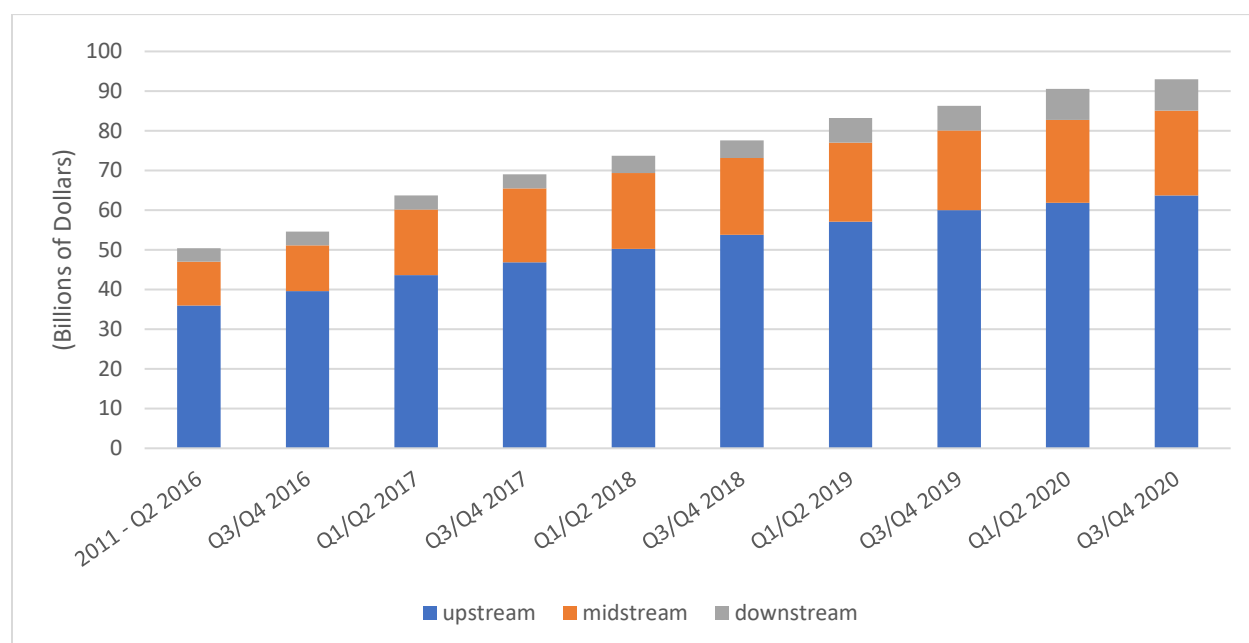
### Total Estimated Downstream Investment: July – December 2020

Natural Gas Refueling Stations	\$1,350,000
Petrochemicals (Including Refineries)	\$66,660,000
Manufacturing/Industrial Plants with Natural Gas as a Critical Feedstock	\$60,000,000
<b>Total Estimated Downstream Investment</b>	<b>\$128,010,000</b>

<sup>1</sup> The nine previous reports on shale investment in Ohio up to June 2020 can be found at [https://engagedscholarship.csuohio.edu/urban\\_enpolc/](https://engagedscholarship.csuohio.edu/urban_enpolc/)

Total investment from July through December 2020 was approximately \$2.4 billion, including upstream, midstream, and downstream. 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 December of 2020 is estimated to be around \$93.0 billion. Of this, \$63.7 billion was in upstream, \$21.3 billion in midstream, and \$8.0 billion in downstream industries.<sup>2</sup> Figure 1 shows the growth in cumulative shale-related investment for Ohio since the release of the first Dashboard.

**Figure 1. Cumulative Shale Investment in Ohio Over Time**



Overall upstream investments were up by about \$40 million in the second half of 2020 compared to the first half of 2020, reflecting slightly higher production volumes as well as a greater number of new wells that were developed. As determined from Ohio Department of Natural Resources Division of Oil and Gas (ODNR) data for shale well drilling, 80 new wells were drilled during the third and fourth quarters of 2020, 17 more than the number drilled in the first half of the year. ODNR production data also indicated that the total volume of gas-equivalent shale production in the second half of 2020 was 1.6% more than overall production in the first half of 2020. Jefferson County had the highest number of new wells with 23, followed by Belmont and Harrison Counties, which each had 14 new wells. This was the first time since the second half of 2018 that a county other than Belmont had the highest number of new wells. Columbiana County had 12 new wells, followed by Monroe County with 11. No other county had more than five new wells drilled for the second half of 2020.

Ascent and Encino were the top producers for Q3 and Q4 of 2020, having produced 411 and 208 billion cubic feet equivalent (Bcfe), respectively. Gulfport was third in production at 187 Bcfe,

<sup>2</sup> Numbers may not add up precisely due to rounding.

followed by Eclipse at 124 Bcfe, Rice Drilling at 119 Bcfe, and Antero at 48 Bcfe. These six companies made up around 89% of the total production for the second half of 2020.

The second half of 2020 saw a reduction in midstream investment compared to the first half of 2020 as no major pipeline projects or natural gas power plants broke ground. However, significant fractionation capacity came online during the Study period, representing an estimated investment of \$283.4 million. Additional midstream spending that occurred in the second half of 2020 included gathering system buildout (\$133.1million) and construction of a nearly two-mile transmission pipeline (\$8.9 million) to provide natural gas to the Long Ridge power plant.

In downstream developments, expansions occurred at Nutrien's ammonia plant in Lima (\$50.0 million), Marathon's oil refinery in Canton (\$10.6 million), and Altivia's petrochemical facility in Haverhill (\$5.0 million) during the Study period. Before a pause due to COVID, \$60 million worth of sitework was done for Petmin's forthcoming iron manufacturing facility in Ashtabula, which will use natural gas as a critical feedstock in the metal production process. There is no definite timeframe for an investment decision on PTT Global's ethane cracker in Belmont County, but the company continues to buy real estate and do preparatory work near the proposed site, including purchases of \$1.1 million in property during the Study period. Additional Q3 and Q4 2020 downstream investment identified by the Study Team included \$1.4 million in liquefied petroleum gas refueling stations.

## 1. INTRODUCTION

This is the tenth CSU study reporting investment resulting from oil and gas development in Ohio related to the Utica and Point Pleasant formations (hereinafter, the “Utica”).<sup>3</sup> This analysis looks at investments made in Ohio between July 1 and December 31, 2020, 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.

This tenth 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 December 2020.<sup>4</sup> 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 80 new wells were listed by the Ohio Department of Natural Resources as “drilled,” “drilling,” or “producing” during the period of July 1 to December 31, 2020.<sup>5</sup> This represents a 27% increase in new well development compared to the first half of 2020. The total number of

<sup>3</sup> 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.

<sup>4</sup> See fn 1, *supra*.

<sup>5</sup> 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.

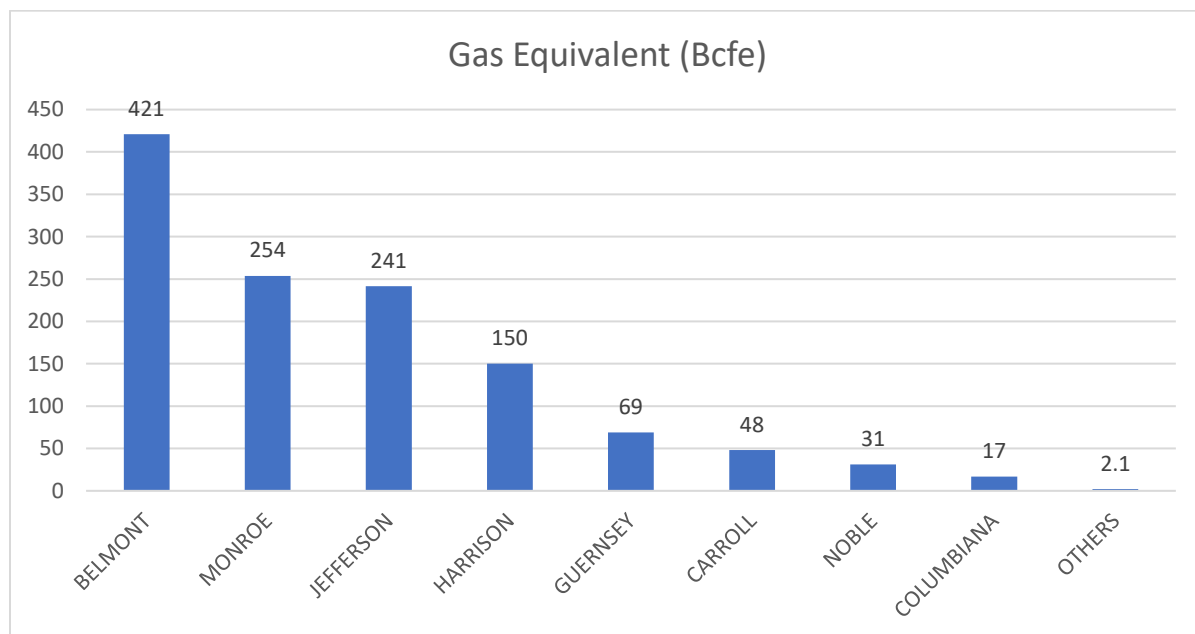


producing wells in the Utica was 2,639 on July 4, 2020, a 4.8% increase from the end of December 2019. Total shale-related oil and gas production in billion cubic feet equivalent (Bcfe) for this period was 1,233 Bcfe, led by Belmont County with 421 Bcfe. Monroe County was second with 254 Bcfe, followed by Jefferson County with 241 Bcfe.<sup>6</sup>

The Ohio Department of Natural Resources (Division of Oil and Gas Resources Management) (ODNR) issues weekly reports on well status and quarterly reports on production. The ODNR production reports for the third and fourth quarters of 2020 provide the foundation for the upstream analyses presented in this Study.

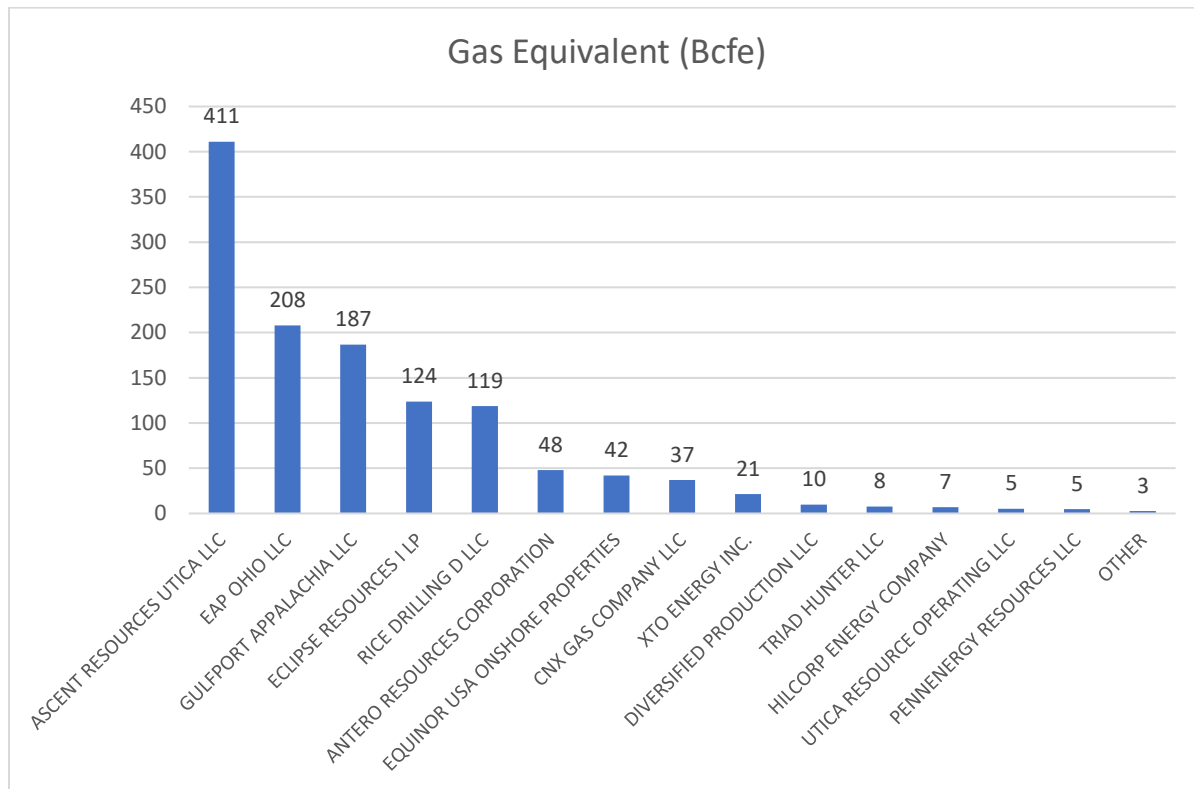
The Utica is currently identified by the ODNR as producing in eighteen eastern Ohio counties with the vast majority (over ninety-eight percent) of producing wells located in eight counties, stretching from Columbiana in the north, to Monroe and Noble at the southern end of the play. Total production in quarters 3 and 4 for 2020 is set forth by county and operator in Figures 2 and 3 below. Total cumulative production in billions of cubic feet equivalent (Bcfe) by county and by operator through December 2020 can be found in Appendix A as Figures 7 and 8.

**Figure 2: Production by County for Q3 and Q4 of 2020**



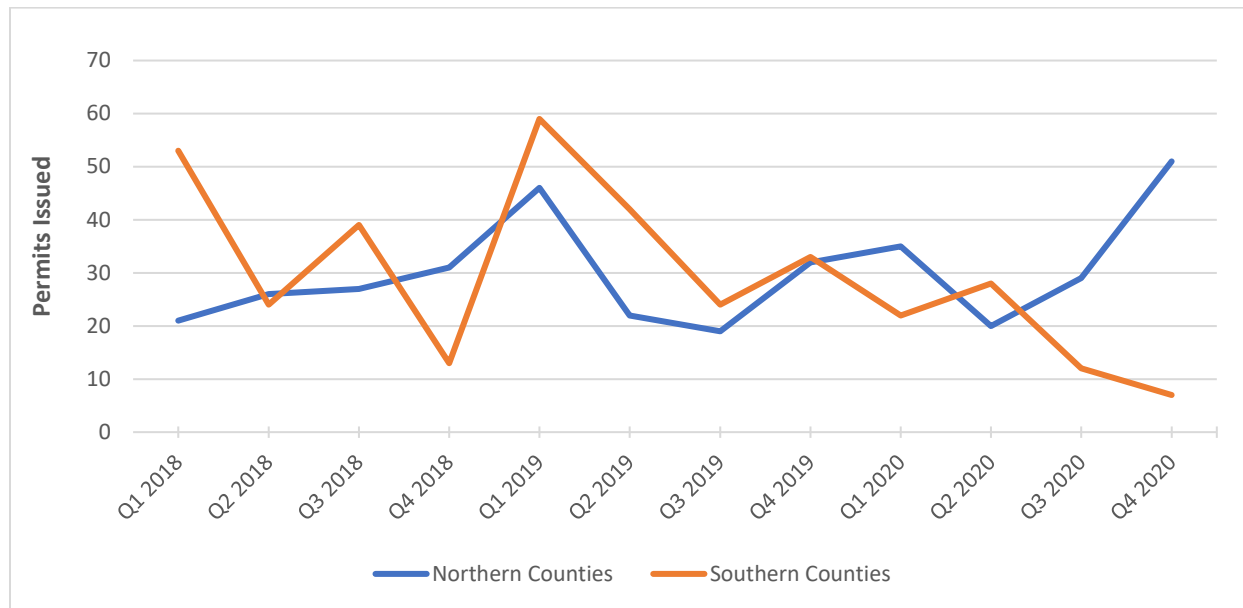
Data Source: ODNR (2021).

<sup>6</sup> 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 (Mcf) 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 (Mcf) = Oil (bbl) x 5.659 Mcf/bbl + Gas (Mcf).

**Figure 3: Production by Operator for Q3 and Q4 2020**

Data Source: ODNR (2021).

Over the last few reports, we have tracked the relatively higher growth in shale well development for more northerly counties than southern ones, as indicated by ODNR permitting activity for Utica wells. A review of these permits suggests that this trend accelerated in the second half of 2020. As shown in Figure 4, by Q4 2020 there were five times as many permits issued for Utica oil and gas wells in the most active northern counties compared to the number of permits issued for the most active southern counties. (The four most active northern counties for drilling and production have been Jefferson, Harrison, Columbiana, and Carroll, while the four most active southern counties have been Belmont, Monroe, Guernsey, and Noble). As a result, we can expect that drilling investment will be moving principally to the northern counties in the next two years.

**Figure 4. Permits Issued for Shale Wells in Northern and Southern Counties Since 2018**

Data Source: ODNR (2021).

## 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 third and fourth quarter of 2020, and also for cumulative production since 2011, is set forth in Table 1. Table 2 sets forth production by county for the second half of 2020. 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)
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	4	1248	301,486,508	6,248,451	336,846,492	39.1
2015	3	989	216,974,492	4,439,258	242,096,253	-4.5
2015	2	992	221,862,582	5,578,255	253,429,927	21.5
2015	1	907	183,585,256	4,432,195	208,667,049	12.8
2014	4	810	164,815,008	3,558,836	184,954,459	25.7
2014	3	688	130,282,395	2,984,534	147,171,872	45.0
2014	2	535	87,773,834	2,422,179	101,480,943	30.1
2014	1	415	67,095,693	1,928,076	78,006,674	53.5
2013	4	371	42,693,774	1,433,731	50,807,259	24.7
2013	3	269	33,255,706	1,323,812	40,747,160	126.2
2013	2	186	14,863,645	556,437	18,012,520	79.1
2013	1	117	8,237,177	321,439	10,056,202	-38.8
2012	ANNUAL	82	12,831,292	635,874	16,429,703	481.9
2011	ANNUAL	9	2,561,524	46,326	2,823,683	--
<b>Total</b>		<b>48,633</b>	<b>11,853,160,543</b>	<b>136,156,736</b>	<b>12,622,849,795</b>	

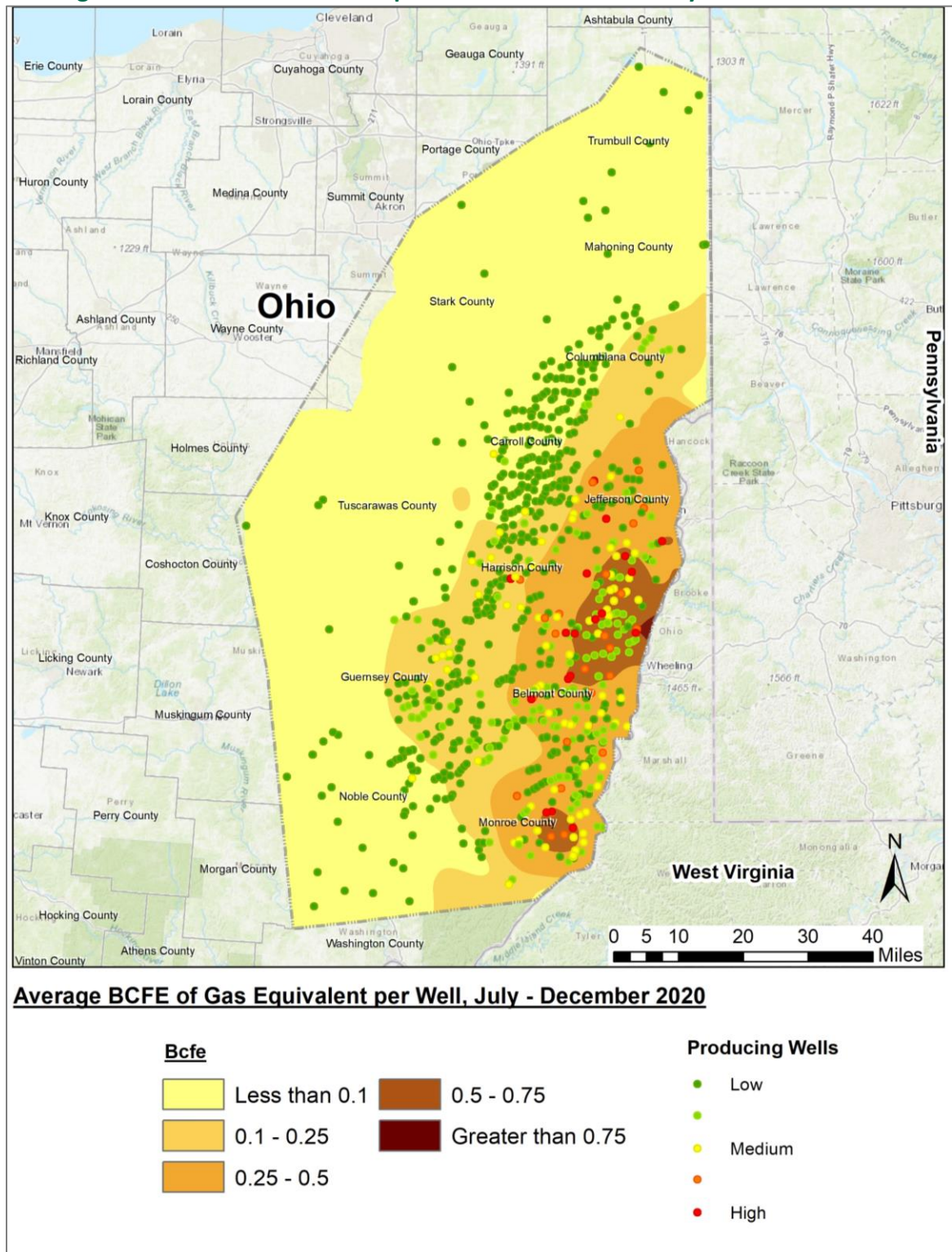
Source: ODNR (2021).

**Table 2: Production by County for July – December 2020**

<b>County</b>	<b>Gas (Mcfe)</b>	<b>Oil (bbl)</b>	<b>Gas Equivalents (Mcfe)</b>	<b>Production Wells</b>
BELMONT	419,828,172	194,180	420,908,958	591
CARROLL	42,312,634	1,039,679	48,099,383	477
COLUMBIANA	16,740,520	13,052	16,813,166	87
COSHOCTON	13,512	0	13,512	1
GUERNSEY	42,553,184	4,727,701	68,867,095	242
HARRISON	130,821,764	3,437,409	149,954,039	428
JEFFERSON	241,445,537	0	241,445,537	255
MAHONING	493,997	2,687	508,953	12
MONROE	250,423,312	590,246	253,708,562	406
MORGAN	76,297	2,837	92,087	2
MUSKINGUM	20,755	576	23,961	1
NOBLE	29,388,947	313,183	31,132,092	175
PORTAGE	32,082	0	32,082	1
STARK	37,947	374	40,029	2
TRUMBULL	153,059	1,017	158,720	7
TUSCARAWAS	162,735	7,667	205,409	7
WASHINGTON	984,135	8,427	1,031,039	11
WAYNE	20,845	81	21,296	1
<b>Total</b>	<b>1,175,509,434</b>	<b>10,339,116</b>	<b>1,233,055,920</b>	<b>2,705</b>

Source: ODNR (2021).

**Figure 5: Distribution of Gas Equivalent Production for July - December 2020**



Of the 2,851 total wells identified from the ODNR records for cumulative drilling activity as of December 2020, 105 were in the process of drilling, 107 wells had been drilled and were awaiting markets, and 2,639 were in the production phase.<sup>7</sup> See Table 3, Ohio Utica Well Status. Belmont County continued to lead in total wells (see Table 4).

**Table 3: Ohio Utica Well Status as of December 2020**

Well Status	No. of Wells
Drilled	107
Drilling	105
Producing	2,639
<b>Total</b>	<b>2,851</b>

Source: ODNR (2021)

**Table 4: Well Status by County (December 2020)**

County	Drilled	Drilling	Producing	Total
ASHLAND	1	0	0	1
BELMONT	22	24	585	631
CARROLL	2	5	474	481
COLUMBIANA	10	12	84	106
COSHOCTON	1	0	1	2
GUERNSEY	3	12	242	257
HARRISON	15	18	420	453
JEFFERSON	11	12	250	273
KNOX	1	0	0	1
MAHONING	1	0	12	13
MEDINA	1	0	0	1
MONROE	22	14	366	402
MORGAN	0	0	2	2
MUSKINGUM	0	0	1	1
NOBLE	1	6	173	180
PORTAGE	7	1	1	9
STARK	4	0	2	6
TRUMBULL	3	1	7	11
TUSCARAWAS	2	0	7	9
WASHINGTON	0	0	11	11
WAYNE	0	0	1	1
<b>Total</b>	<b>107</b>	<b>105</b>	<b>2639</b>	<b>2851</b>

<sup>7</sup> 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.



## 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. We continued to differentiate between northern counties (\$11.4 million per well) and southern counties (\$12.9 million per well). This has been confirmed by recent drilling surveys that indicate an extra 1,700 of lateral length on average for wells drilled in southern counties.

This section covers upstream investments between July and December 2020. Cumulative upstream investments to date in Ohio, including 2011 through the second half of 2020, 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 23 new wells and an investment of around \$263.6 million between July and December 2020. Belmont and Harrison Counties were second and third, with 14 new wells each, to go along with \$181.4 million and 160.4 million invested, respectively. See Table 5. Road-related investments for this version of the Shale Investment Dashboard reflect the average road costs per well determined from a 2017 report by Energy-In-Depth describing Road Use Maintenance Agreements (RUMAs) that companies have entered into with local governments for infrastructure improvements since Utica production began in 2011.<sup>8</sup> The data for that report were obtained directly from the engineer's office for the top eight oil and natural gas producing counties in Ohio.

Ascent Utica Resources LLC, 35% of whose new wells were in the lower cost, more northerly counties, was the leading operator-investor during the six-month period, with 26 new wells and an estimated \$321.4 million invested, followed by EAP Ohio with 24 new wells and an estimated \$275 million invested. Hilcorp Energy Company and Eclipse Resources LP drilled 12 and 10 new wells, respectively, to go along with an estimated investment of \$137.5 million and \$129.6 million. Gulfport and its subsidiaries drilled 6 new wells for an estimated investment of \$76.3 million. See Table 6.

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<sup>8</sup> See "Ohio's Oil & Gas Industry Road Improvement Payments." Prepared by The Ohio Oil & Gas Association and Energy in Depth. <https://www.energyindepth.org/wp-content/uploads/2017/11/2017-Utica-Shale-Local-Support-Series-Ohios-Oil-and-Gas-Industry-Road-Payments.pdf>



**Table 5: Estimated Upstream Shale Investment by County, July - December 2020**

County	No. of New Wells	Drilling (\$)	Roads (\$)	Total Amount (\$)
BELMONT	14	\$180,600,000	\$840,000	\$181,440,000
CARROLL	5	\$57,000,000	\$300,000	\$57,300,000
COLUMBIANA	12	\$136,800,000	\$720,000	\$137,520,000
GUERNSEY	1	\$12,900,000	\$60,000	\$12,960,000
HARRISON	14	\$159,600,000	\$840,000	\$160,440,000
JEFFERSON	23	\$262,200,000	\$1,380,000	\$263,580,000
MONROE	11	\$141,900,000	\$660,000	\$142,560,000
<b>Total</b>	<b>80</b>	<b>\$951,000,000</b>	<b>\$4,800,000</b>	<b>\$955,800,000</b>

Source: The Authors (2021)

**Table 6: Estimated Upstream Shale Investment in Ohio by Company, July - December 2020**

Operators	No. of Wells	Drilling (\$)	Roads (\$)	Total Amount (\$)
ASCENT RESOURCES UTICA LLC	26	\$309,900,000	\$1,560,000	\$311,460,000
EAP OHIO LLC	24	\$273,600,000	\$1,440,000	\$275,040,000
ECLIPSE RESOURCES I LP	10	\$129,000,000	\$600,000	\$129,600,000
GULFPORT APPALACHIA LLC	5	\$63,000,000	\$300,000	\$63,300,000
GULFPORT ENERGY CORPORATION	1	\$12,900,000	\$60,000	\$12,960,000
HILCORP ENERGY COMPANY	12	\$136,800,000	\$720,000	\$137,520,000
RICE DRILLING D LLC	1	\$12,900,000	\$60,000	\$12,960,000
UTICA RESOURCE OPERATING LLC	1	\$12,900,000	\$60,000	\$12,960,000
<b>Total</b>	<b>80</b>	<b>\$951,000,000</b>	<b>\$4,800,000</b>	<b>\$955,800,000</b>

Source: The Authors (2021)

## 2. Lease Operating Expenses.

Post-production investments have been estimated on a half-year basis, assuming an average cost of around \$12,700/month/well. This estimate is based upon recent operator reports.<sup>9</sup> These investments are set forth below. Consistent with total number of production wells, Belmont County and Carroll County led the lease operating expense investment, with an estimated \$45.0 and \$36.3 million invested, respectively.

<sup>9</sup> The per-month rule-of-thumb for lease operating expenses per producing well for this report is based on Ascent's unit lease operating expenses for 2020 as reported in company financial statements.

**Table 7: Estimated Lease Operating Expenses for July - December by County**

County	Production Wells	Lease Operating Expense for Period
BELMONT	591	\$45,034,000
CARROLL	477	\$36,347,000
COLUMBIANA	87	\$6,629,000
COSHOCTON	1	\$76,000
GUERNSEY	242	\$18,440,000
HARRISON	428	\$32,614,000
JEFFERSON	254.5	\$19,393,000
MAHONING	12	\$914,000
MONROE	406	\$30,937,000
MORGAN	2	\$152,000
MUSKINGUM	1	\$76,000
NOBLE	174.5	\$13,297,000
PORTAGE	1	\$76,000
STARK	2	\$152,000
TRUMBULL	7	\$533,000
TUSCARAWAS	7	\$533,000
WASHINGTON	11	\$838,000
WAYNE	1	\$76,000
<b>Total</b>	<b>2,705</b>	<b>\$206,121,000</b>

**Table 8: Estimated Lease Operating Expenses for July - December 2020 by Operator**

Operator	Production Wells	Lease Operating Expense for Period
ANTERO RESOURCES CORPORATION	223	\$16,993,000
ARTEX ENERGY GROUP LLC	7	\$533,000
ASCENT RESOURCES UTICA LLC	599	\$45,644,000
CNX GAS COMPANY LLC	47	\$3,581,000
DIVERSIFIED PRODUCTION LLC	17	\$1,295,000
EAP OHIO LLC	826	\$62,941,000
ECLIPSE RESOURCES I LP	185	\$14,097,000
EQUINOR USA ONSHORE PROPERTIES	50	\$3,810,000
GEOPETRO LLC	16	\$1,219,000
GULFPORT APPALACHIA LLC	393	\$29,947,000
HILCORP ENERGY COMPANY	23	\$1,753,000
NORTHWOOD ENERGY CORP	6	\$457,000
PENNENERGY RESOURCES LLC	40	\$3,048,000
PIN OAK ENERGY PARTNERS LLC	23	\$1,753,000
RICE DRILLING D LLC	137	\$10,439,000
TRIAD HUNTER LLC	22	\$1,676,000
UTICA RESOURCE OPERATING LLC	33	\$2,515,000
XTO ENERGY INC.	59	\$4,496,000
<b>Total</b>	<b>2,705</b>	<b>\$206,121,000</b>

### 3. Royalties.

Royalty investments have been estimated on a per quarter basis, assuming the formula set forth in Appendix B. Total estimated royalties spent on Ohio properties between July and December 2020 were around \$450.2 million. 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 \$1.27/MMBtu during the second half of 2020, down from \$1.58 in the second half of 2020.<sup>10</sup> Regional oil prices increased from an average of \$31.15/bbl during the third quarter of 2020 to \$33.03/bbl for the fourth quarter.<sup>11</sup> For comparison, regional oil prices averaged \$41.07 and \$19.65 per barrel in the first and second quarters of 2020, respectively.

<sup>10</sup> Reflects average Appalachia regional natural gas prices over the respective periods. See <https://www.naturalgasintel.com/appalachian-consolidation-continues-as-west-virginia-natural-gas-trade-groups-merge/>.

<sup>11</sup> See <https://ergon.com>

**Table 9: Total Royalties from Oil**  
**July - December 2020 (in millions of dollars)**

Year	Quarter	Oil Price \$/bbl	Oil Royalty (20%) \$/bbl	Royalty (\$mm)
2020	4	\$33.03	\$6.61	\$30.58
2020	3	\$31.15	\$6.23	\$35.60
			<b>Subtotal</b>	<b>\$66.18</b>

**Table 10: Total Royalties from Residue Gas**  
**July - December 2020 (in millions of dollars)**

Year	Quarter	Residue Gas Price \$/Mcf	Residue Gas Royalty (20%) \$/Mcf	Royalty (\$mm)
2020	4	1.46	\$0.29	\$149.77
2020	3	1.32	\$0.26	\$134.68
			<b>Subtotal</b>	<b>\$284.45</b>

**Table 11: Total Royalties from Natural Gas Liquids**  
**July - December 2020 (in millions of dollars)**

Year	Quarter	NGL Price \$/bbl	NGL Royalty (20%) \$/bbl	Royalty (\$mm)
2020	4	9.91	\$1.98	\$51.13
2020	3	9.35	\$1.87	\$48.43
			<b>Subtotal</b>	<b>\$99.56</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 85% of the Utica wells to date, and it is assumed that they likewise control over 85% 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.<sup>12</sup> 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 25% 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, and 10% over the half-year study period (i.e., 5% of total acreage each year).

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 conservative number in the Utica, and therefore likely to still be conservative for renewals of older leases. But there is evidence that in 2020 new lease bonus rates were depressed due to sustained low natural gas prices. Nevertheless, the most recent publicly reported information on lease bonuses suggests, however, that \$5000/acre continues to be a reasonable estimate. In late 2019, for example, Belmont County leased county-owned mineral rights for \$5750/acre for a 5-year primary term.<sup>13</sup>

<sup>12</sup> *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. See e.g., Chesapeake Energy Corporation. (2018). 2017 annual report. [https://www.sec.gov/Archives/edgar/data/0000895126/000089512618000060/chk-20171231\\_10k.htm](https://www.sec.gov/Archives/edgar/data/0000895126/000089512618000060/chk-20171231_10k.htm). 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.

<sup>13</sup> See Belmont County Board of County Commissioner meeting minutes for December 18, 2019. <https://belmontcountycommissioners.com/wp-content/uploads/bsk-pdf-manager/2020/01/December-18-2019-2.pdf>

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 will be under reported.

**Table 12: Total Estimated Investments into New Leases and Lease Renewals  
July and December 2020 (in millions of dollars)**

Operator	Acreage not held for production	Estimated Bonus Investment (\$mm)
ANTERO RESOURCES CORPORATION <sup>14</sup>	21,590	10.8
ASCENT RESOURCES UTICA HOLDINGS, LLC	84,232	42.1
EAP OHIO LLC <sup>15</sup>	246,831	123.4
Southwest Energy Company (Montage Resources) <sup>16</sup>	58,840	29.4
GULFPORT ENERGY CORPORATION	48,216	24.1
Rice Drilling D LLC (EQT)	35,755	17.9
<b>Total</b>	<b>495,464</b>	<b>247.7</b>

### 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

<sup>14</sup> While Antero’s FY2020 10-K did not distinguish Ohio Utica Shale from Marcellus Shale for the company’s holdings in the Appalachian basin, its FY2019 10-K did. For FY2019, 90,814 of the company’s 541,447 total net acres were in Ohio, or 16.8%. Applying this percentage to Antero’s Appalachian basin holdings for FY2020 of 514,884 total net acres yields an estimated 86,359 total net acres in Ohio for 2020.

<sup>15</sup> Total net acreage for EAP Ohio, a privately held company, was determined by revising the 900,000 total net Ohio Utica acres that Encino Energy Partners purchased from Chesapeake Energy in 2018 based upon the growth rate in net Ohio acreage from FY2018 to FY2020 for the other operators listed in Table 12, as gleaned from their publicly available annual financial reports.

<sup>16</sup> Montage Resources merged with Southwestern in FY2020. Southwestern had no Ohio holdings prior to this. For FY2019, Montage and Southwestern together held 233,760 total net acres in Ohio out of their combined 783,849 total net acres in the Appalachian basin, or 29.8%. Applying this percentage to the merged company’s 789,218 total net acres in the Appalachian basin for FY2020 yields an estimated 235,361 total net acres in Ohio for 2020.

power output for the region as obtained from the INGAA. A full description of the methodology can be found in Appendix B.

Additional investment information was collected from midstream company investor presentations, news reports, and other sources including Ohio EPA permits. The following two tables summarize midstream investments identified by the Study Team for the second half of 2020. Table 13 sets forth gathering and transmission line investments while Table 14 sets forth all other midstream investments, including that for compression.

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 Transmission and Gathering Line Investment  
July - December 2020**

Company	Additions to Infrastructure	Total Amount (\$mm)
Equitrans Midstream Corp.	<ul style="list-style-type: none"> <li>Long Ridge Lateral<sup>17</sup></li> <li>1.89 miles of 12" pipeline</li> </ul>	8.9
Summit Midstream Partners, LLC	<ul style="list-style-type: none"> <li>2.7 miles of 12.75" pipeline</li> </ul>	6.7
Blue Racer Midstream LLC	<ul style="list-style-type: none"> <li>0.3 miles of 8.63" pipeline</li> </ul>	0.5
Cardinal Gas Services (Williams)	<ul style="list-style-type: none"> <li>26 feet of 6.63" pipeline</li> <li>1.5 miles of 8.63" pipeline</li> </ul>	2.5
	<b>Total</b>	<b>18.6</b>

Source for Gathering Line Mileage and Diameter Data: PUCO Gathering Construction Reports (2021)

<sup>17</sup> The application for pipeline construction submitted to the PUCO indicates that this pipeline project is distinct from the Long Ridge Energy Generating Project, a natural gas-fired electric generation plant that was previously approved by the PUCO. See <https://dis.puc.state.oh.us/TiffToPdf/A1001001A19K19B51445H03163.pdf>

**Table 14: Additional Midstream Investment, July - December 2020**

<b>Company</b>	<b>Additions to Infrastructure</b>	<b>Estimated Investment (\$mm)</b>
Antero Resources - Capstone Pad	<ul style="list-style-type: none"> <li>525 hp of compression at Capstone Pad, Guernsey county</li> </ul>	1.97
Ascent Resources - Utica LLC	<ul style="list-style-type: none"> <li>250 hp of compression in Harrison County</li> <li>50 MMscfd of dehydration in Harrison County</li> </ul>	2.32
Augusta Compressor Facility - Utica Gas Services, L.L.C.	<ul style="list-style-type: none"> <li>16,880 hp of compression in Carroll County</li> <li>240 MMscfd of dehydration in Carroll County</li> </ul>	67.61
Blue Racer Midstream LLC	<ul style="list-style-type: none"> <li>8,050 hp of compression in Noble County</li> </ul>	30.14
Diversified Gas & Oil PLC	<ul style="list-style-type: none"> <li>60 hp of compression in Geauga County</li> <li>40 hp of compression in Lake County</li> </ul>	0.37
Eclipse Resources 1 LP	<ul style="list-style-type: none"> <li>4,160 hp of compression at Riggerbach Pad, in Monroe County</li> </ul>	15.58
EQT Production	<ul style="list-style-type: none"> <li>250 hp of compression in Belmont County</li> </ul>	0.94
Humphreys Compressor Station	<ul style="list-style-type: none"> <li>31 hp of compression in Belmont County</li> </ul>	0.12
MarkWest (MPLX)	<ul style="list-style-type: none"> <li>31 hp of compression each at Arrowhead, Lake and Yoder stations in Harrison County</li> <li>31 hp of compression each at Barnesville West and Morristown stations in Belmont County</li> <li>Hopedale V fractionation (80,000 bbl/day), Harrison County<sup>18</sup></li> </ul>	283.60
Rice Olympus Midstream	<ul style="list-style-type: none"> <li>95 MMscfd of dehydration at Conway Dehydration Facility, Belmont County</li> </ul>	2.39
Strike Force South	<ul style="list-style-type: none"> <li>62 MMscfd of dehydration at Roberts Dehydration Facility, Monroe County</li> </ul>	1.64
Tri-County Compressor Station	<ul style="list-style-type: none"> <li>31 hp of compression in Belmont County</li> </ul>	0.12
	<b>Total</b>	<b>406.78</b>

<sup>18</sup> [https://www.mplx.com/content/documents/mplx/investor\\_center/2020/MPLX\\_3Q20\\_Conf\\_Call\\_Slides.pdf](https://www.mplx.com/content/documents/mplx/investor_center/2020/MPLX_3Q20_Conf_Call_Slides.pdf)



Most of the midstream investment for the study period came from the installation of a fifth fractionator at MPLX's Hopedale complex in Harrison County. This 80,000 bbl/day addition to C3+ fractionation capacity, which went into service during the second half of 2020, was estimated to represent a nearly \$300 million investment based on a review of published reports for recently completed fractionator projects in other parts of the country (see Appendix B). Additional midstream processing investment included an estimated \$10 million worth of dehydration for dry gas.

The balance of midstream investment during the study period was for moderate gathering system buildout and additions to compression for moving processed dry gas and natural gas liquids (NGLs) downstream. Altogether, an estimated \$132.2 million was spent on gathering lines and compression during the third and fourth quarters of 2020. No major interstate or interstate pipeline projects commenced during the latter half of 2020.

There were no developments with respect to NGL storage during the study period. However, in August 2021 Mountaineer obtained a fresh set of permits from the ODNR to operate a storage complex across three salt caverns in Monroe County.<sup>19</sup> This facility could supply ethane to nearby crackers. Mountaineer is also considering making a portion of the facility's storage capacity available for hydrogen that would be supplied to power plants in the region.<sup>20</sup>

Adding together the amounts in Tables 13 and 14 yields a total midstream investment for the second half of 2020 of \$425.4 million. This was \$360.4 million less than the amount of midstream investment we previously identified for the first half of 2020, but \$309.3 million more than was estimated for the second half of 2019 in a prior shale investment report.

Cumulative midstream investments through the end of 2020 are set forth in Table 18 in Appendix A.

## **D. DOWNSTREAM DEVELOPMENT**

### **1. Combined Heat and Natural Gas Power Plants**

Over the past nine 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. There was no new investment into these plants during the second half of 2020. We noted in the last shale report that Harrison Power LLC and its parent company EmberClear had initiated an engineering, procurement, and construction (EPC) services contract in early 2020 for a 1,085 MW power plant in Harrison County. Construction for this \$1 billion plant had not started as of October 2021. However, Gemma Power Systems, the construction engineering company contracted to build the plant, stated recently via its parent company Argan, Inc. that it is "cautiously optimistic" that

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<sup>19</sup> <https://marcellusdrilling.com/2021/10/oh-issues-permits-to-build-salt-caverns-for-mountaineer-ngl-h2-storage/>

<sup>20</sup> *Id.*

construction for this project will begin by the end of January 2022.<sup>21</sup> This investment will be included in a future shale report.

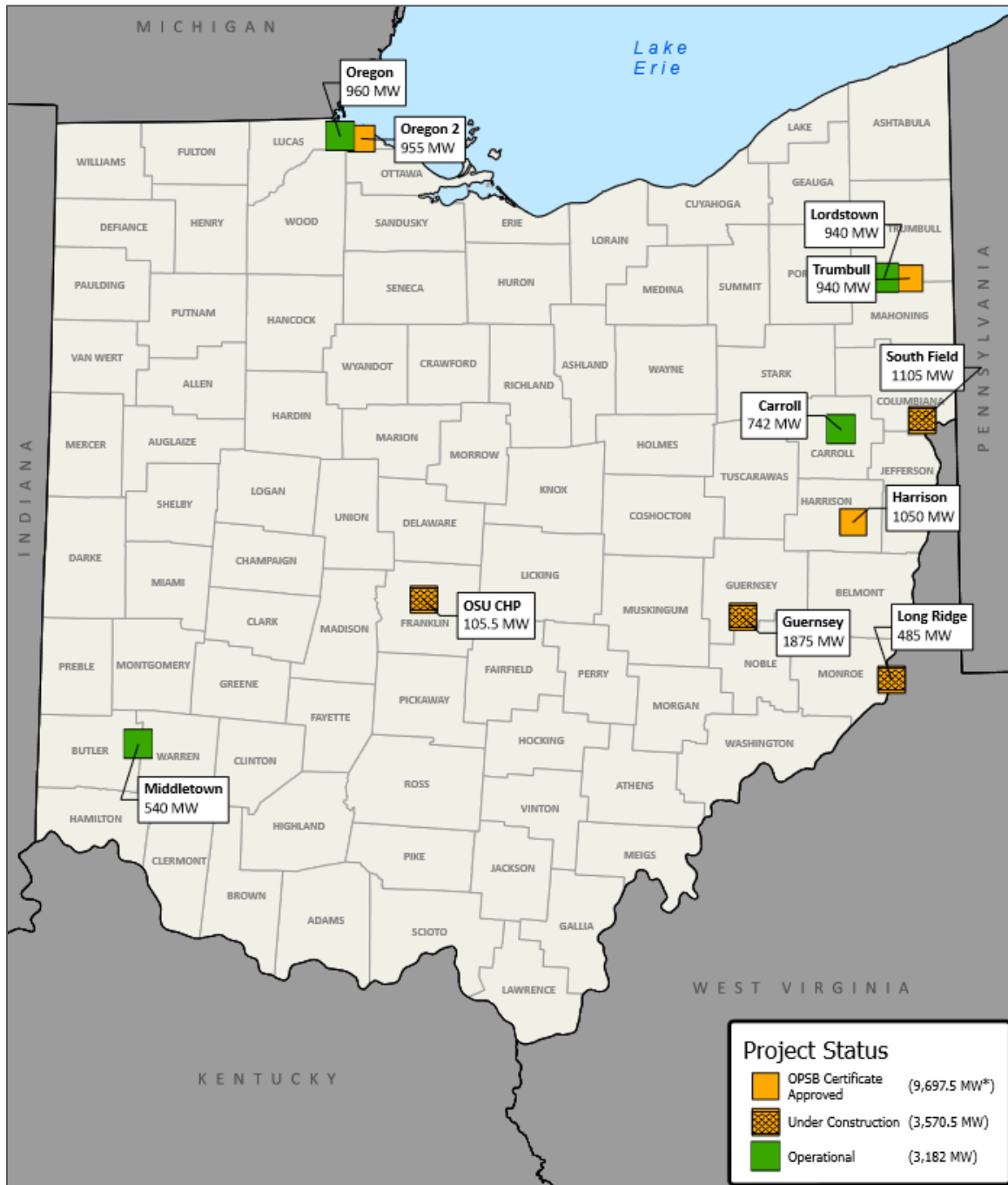
As previously reported, a \$278 million, 105.5 MW CHP plant at Ohio State University's main campus received construction approval from the Ohio Power Siting Board in September 2020.<sup>22</sup> Major construction for this project began in 2021.<sup>23</sup> This investment will be included in a future shale investment report. The 10 current and projected natural gas-powered facilities across 8 locations, along with the CHP project at Ohio State, including their current status, are set forth in Figure 6 below.

<sup>21</sup> <https://dd7pmep5szm19.cloudfront.net/2476/0001558370-21-012256.htm>

<sup>22</sup> See <https://buildingthefuture.osu.edu/news/2020/09/18/news-ohio-state-gains-approval-chp>.

<sup>23</sup> See <https://trustees.osu.edu/meeting/2021/8/master-planning-aug-2021>. See also [https://trustees.osu.edu/sites/default/files/documents/2021/05/PUBLIC\\_MATERIALS\\_MPF\\_May\\_2021.pdf](https://trustees.osu.edu/sites/default/files/documents/2021/05/PUBLIC_MATERIALS_MPF_May_2021.pdf)

Figure 6. Existing and Projected Natural Gas Power Plants



Source: Ohio Power Siting Board (2021)

## 2. Petrochemical Plants, Refineries, and Other Downstream Investment

Average construction costs for new liquefied petroleum gas (LPG) stations are around \$225,000 per station.<sup>24</sup> Six new LPG refueling stations (in Cleveland, Mentor, North Olmsted, Solon, Walnut Hills, and Zanesville) opened during the study period.<sup>25</sup> Altogether, this represents an estimated investment into natural gas-based transportation of \$1.4 million.

No new compressed natural gas (CNG) refueling stations opened in the second half of 2020. However, in the last shale report we identified a CNG refueling station under development by the Greater Cleveland Regional Transit Authority (RTA) in conjunction with Trillium. This \$6.3 million project received final approval from RTA's board of trustees in January 2021 and will be included in the next shale investment report.<sup>26</sup>

A number of somewhat moderate investments into refineries and petrochemical plants occurred during the second half of 2020. Among these were the \$50 million in upgrades and expansions at Nutrien's Lima ammonia plant.<sup>27</sup> Marathon's Canton oil refinery also saw upgrades during the study period that expanded its processing capacity by 2,000 barrels per day.<sup>28</sup> This facility processes oil production from Utica shale into products such as gasoline and asphalt.<sup>29</sup> According to the EIA, the unit capital investment for expanding capacity at a facility such as the Canton refinery that produces both distillates and higher-values products such as gasoline is \$5,280/bbl/day.<sup>30</sup> The Canton refinery's overall processing capacity expansion in the second half of 2020 was therefore estimated at \$10.56 million.

We noted in the last shale report that Petmin USA began construction for its pig iron manufacturing facility in Ashtabula in the second half of 2020.<sup>31</sup> Once completed, the plant will use natural gas as a critical feedstock in reducing iron from its ore.<sup>32</sup> While construction on the \$474 million facility was halted in 2021 due to logistics challenges related to COVID-19, it was not before \$60 million had been spent on sitework for the project, which we include in

<sup>24</sup> See [https://afdc.energy.gov/files/u/publication/propane\\_costs.pdf](https://afdc.energy.gov/files/u/publication/propane_costs.pdf)

<sup>25</sup> See <https://afdc.energy.gov/>

<sup>26</sup> See <http://www.riderta.com/sites/default/files/events/2021-01-19BoardPackage.pdf>

<sup>27</sup> <https://www.limaohio.com/news/423082/nutrien-plans-100-million-investment>

<sup>28</sup> See Marathon Petroleum's FY2020 and FY2019 Form 10-K submissions to the U.S. Securities and Exchange Commission: <https://d18rn0p25nwr6d.cloudfront.net/CIK-0001510295/2e568e5d-2387-443e-860e-557a13fa2b27.pdf>; <https://d18rn0p25nwr6d.cloudfront.net/CIK-0001510295/7e0628b1-62ac-4832-bae9-3512dc5a7ffb.pdf>

<sup>29</sup> *Id.*

<sup>30</sup> <https://www.eia.gov/analysis/studies/petroleum/lto/pdf/lighttightoil.pdf>

<sup>31</sup> [https://www.starbeacon.com/news/local\\_news/construction-on-petmins-ashtabula-facility-begins/article\\_99313771-8396-52f7-916f-3bc179521a50.html](https://www.starbeacon.com/news/local_news/construction-on-petmins-ashtabula-facility-begins/article_99313771-8396-52f7-916f-3bc179521a50.html)

<sup>32</sup> The plant design includes Tenova's HYL Energiron ZR technology. For more on this process of directly reducing iron using natural gas, see [https://www.tenova.com/fileadmin/user\\_upload/tenova\\_products/steel\\_making\\_direct\\_and\\_pre\\_reduction\\_technologies/energiron\\_book\\_2014.pdf](https://www.tenova.com/fileadmin/user_upload/tenova_products/steel_making_direct_and_pre_reduction_technologies/energiron_book_2014.pdf)

downstream investment for this report.<sup>33</sup> The company plans to resume construction on the project in late 2021.<sup>34</sup>

While construction of the ethane cracker in Belmont County has been on hold as PTT Global seeks a partner to finance the project, the company has continued buying real estate around Dilles Bottom, OH as part of the site preparation process.<sup>35</sup> A review of records from the Belmont County Auditor shows that PTT Global was buying properties around the proposed site as recently as July 2021.<sup>36</sup> Altogether, the company spent \$1.1 million on real estate in Belmont County during the second half of 2020, which we include in downstream investment for this report.

Other downstream investments for the second half of 2020 include a \$5 million expansion of Altivia Petrochemicals' plant in Haverhill, OH where NGL derivatives such as phenol and acetone are produced.<sup>37</sup> Total downstream investment across the projects described herein was \$128.0 million during the second half of 2020.

Cumulative downstream investments reported to date in Ohio, including 2011 through the second half of 2020, 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 slightly in the second half of 2020 compared to the first half of the year, driven by 1.6% increase in total gas-equivalent production and a 27% increase in new well development. While southerly Belmont County again led all counties in production, more northerly Jefferson County had the highest number of new wells developed during the Study period. This suggests that drilling activities continue to be focused more northward. Indeed, there were twice as many new wells drilled in northern counties than southern ones during the second half of 2020. Altogether, upstream shale investment totaled nearly \$1.9 billion for the second half of 2020.

While midstream investments were down in the second half of 2020 compared to the first half, these expenditures represent more than twice what was spent for this segment during the second half of 2019. Among these investments were an estimated \$283.4 million in fractionation capacity and \$133.1 million in gathering system buildout. Combined with modest transmission

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<sup>33</sup> <https://www.petminusa.com/blog/petmin-announces-plans-to-restart-474-million-manufacturing-facility-in-the-fall>

<sup>34</sup> *Id.*

<sup>35</sup> See <https://www.theintelligencer.net/news/community/2021/08/demolition-continues-at-proposed-belmont-county-ethane-cracker-site/>

<sup>36</sup> See <http://oh-belmont-auditor.publicaccessnow.com/OwnerSearch.aspx>

<sup>37</sup> See <https://www.areadevelopment.com/newsitems/6-9-2020/altivia-petrochemicals-production-facility-haverhill-ohio.shtml>

pipeline additions (\$8.9 million), a total of \$425.4 million was spent on midstream infrastructure for the Study period.

Without any new major pipeline projects or natural gas power plants breaking ground, downstream investments for the second half of 2020 were down substantially, consisting primarily of capacity expansions at existing petrochemical plants (\$66.7 million) and sitework at prospective petrochemical manufacturing facilities (\$60 million) such as the PTT Global cracker in Belmont County. The opening of natural gas-based refueling stations added another \$1.4 million in downstream investment during the third and further quarters of 2020.

Altogether, shale-related investment in Ohio for the first second half of 2020, including upstream, midstream, and downstream, was around \$2.4 Billion. Cumulative total shale related investment since 2012 is around \$93.0 billion.

## **About the Study Team**

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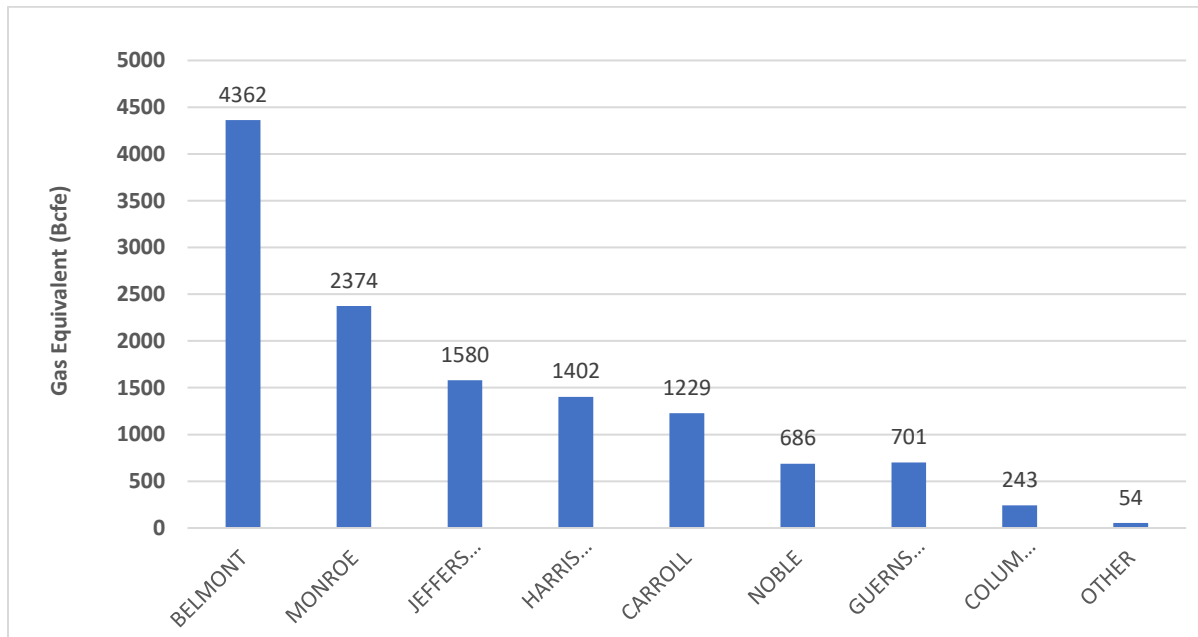
## **About the Energy Policy Center**

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 7: Total Utica Production in Bcfe (Gas Equivalence) by County through December 2020**



**Figure 8: Total Utica Production in Bcfe by Operator through December 2020**

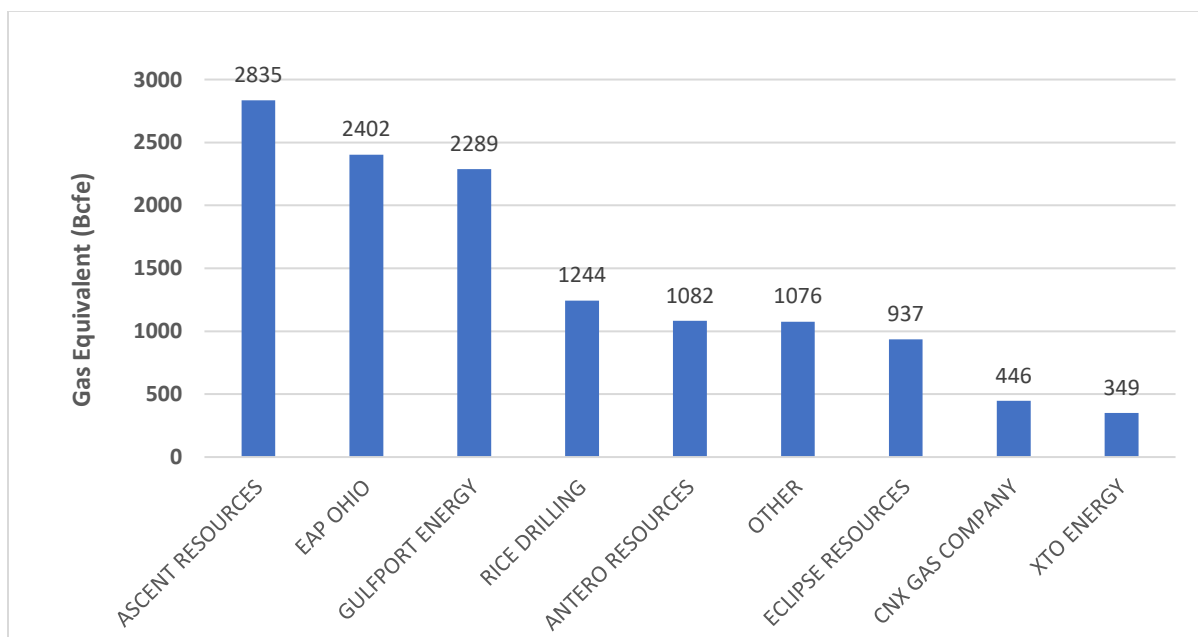
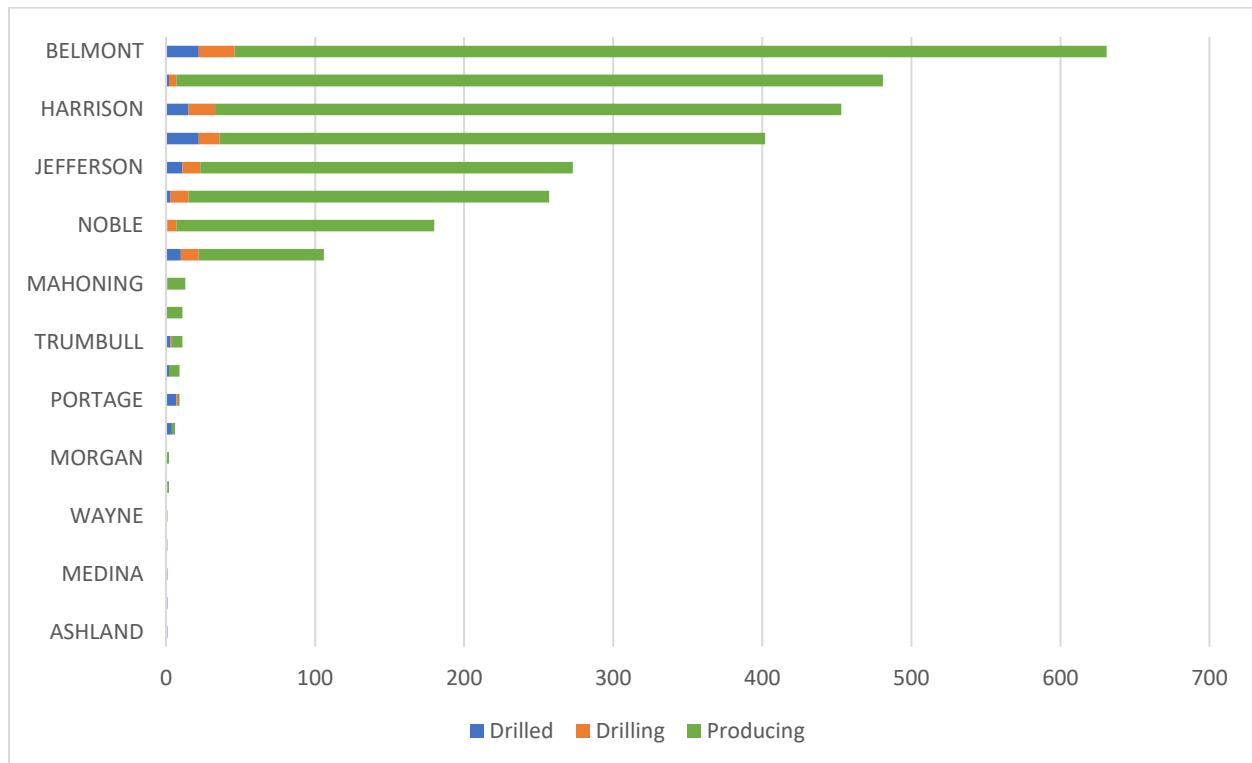


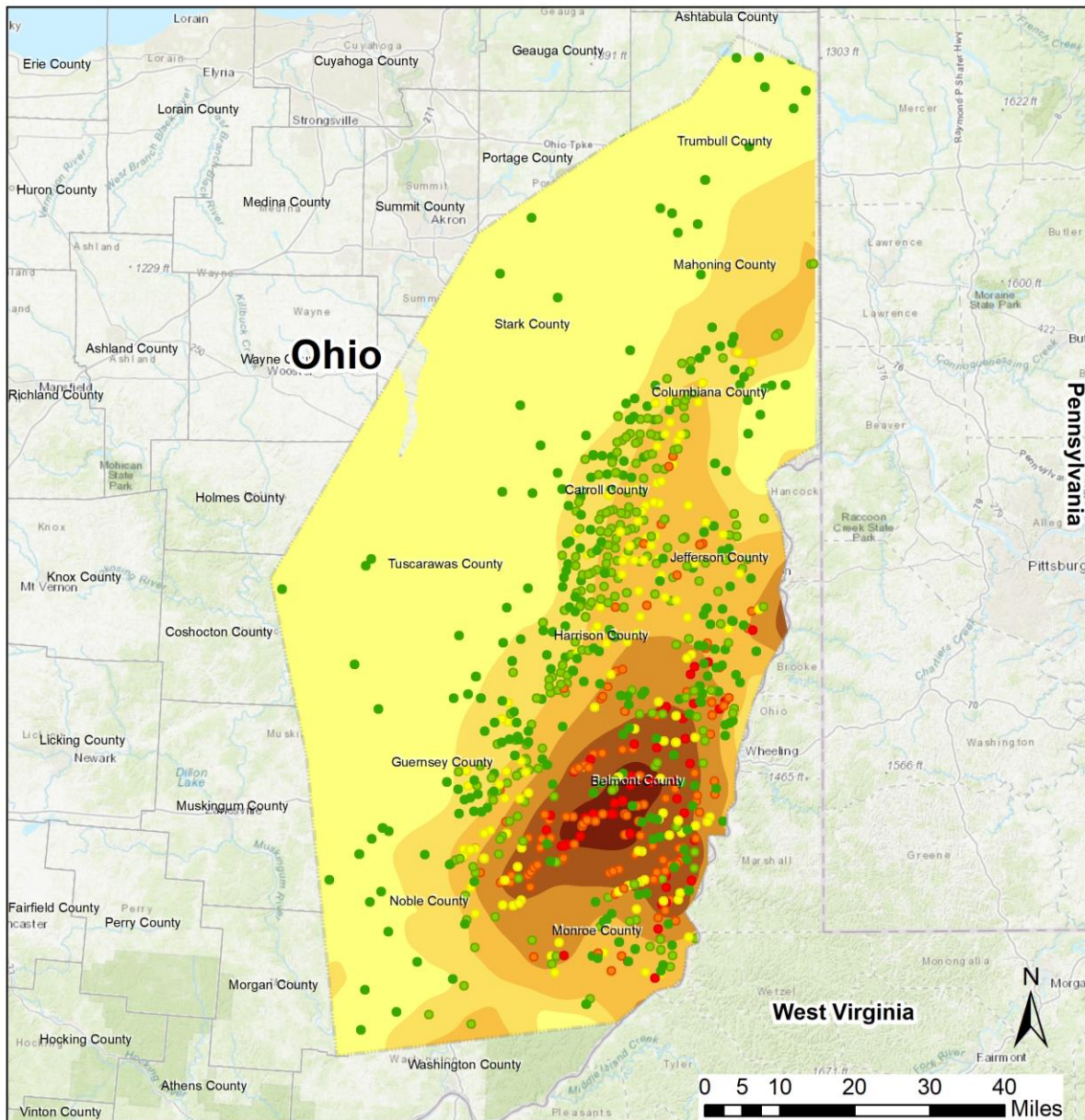
Figure 9: Cumulative Number of Wells by County



Source: Ohio Department of Natural Resources (December 2020)



**Figure 10: Distribution of Gas Equivalent Production for 2011 through December 2020**



**Total BCfe of Gas Equivalent per Well, 2011 - December 2020**

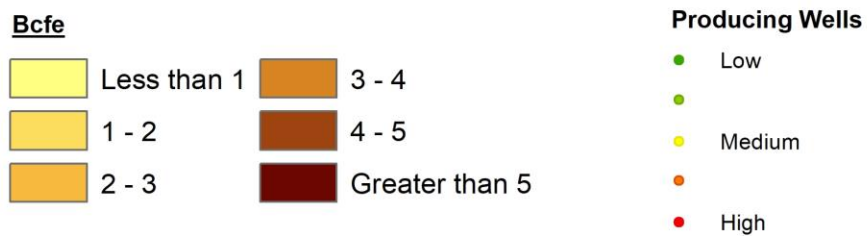
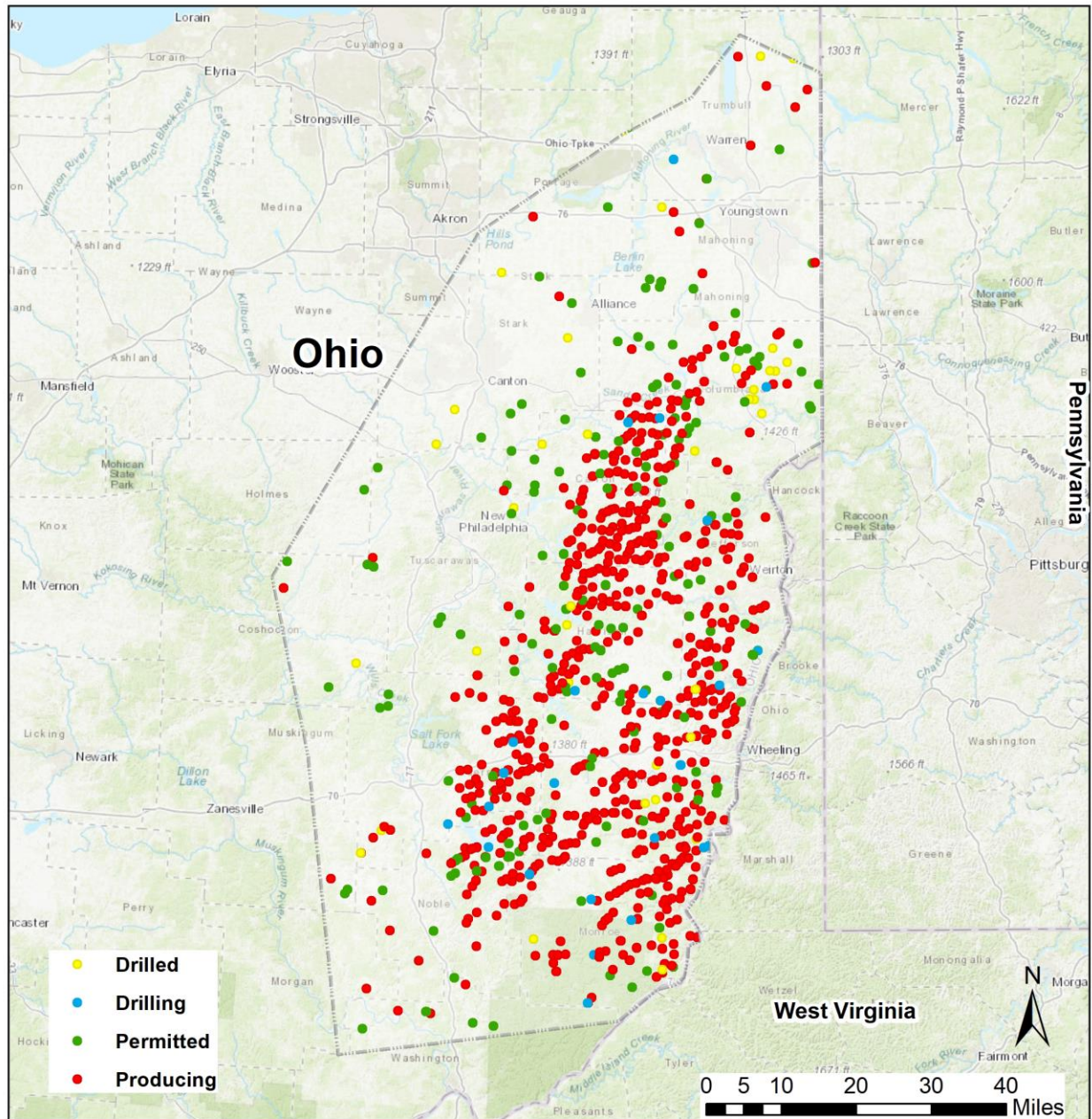


Figure 11: Distribution of Utica Wells by Status as of December 2020





**Table 15: Utica Upstream Companies Drilling in Ohio as of December 2020**

Operator	Cumulative no. of Wells
AMERICAN ENERGY UTICA LLC	3
AMERICAN PETROLEUM PRTR OH LLC	2
ANADARKO E & P ONSHORE LLC	4
ANTERO RESOURCES CORPORATION	258
ARSENAL RESOURCES LLC	2
ARTEX ENERGY GROUP LLC	9
ASCENT RESOURCES UTICA LLC	671
BEUSA ENERGY LLC	1
BP AMERICA PRODUCTION COMPANY	1
BRAMMER ENGINEERING INC	2
CARRIZO (UTICA) LLC	3
CHESAPEAKE EXPLORATION LLC	111
CHEVRON APPALACHIA LLC	2
CNX GAS COMPANY LLC	58
DEVON ENERGY PRODUCTION CO LP	9
DIVERSIFIED PRODUCTION LLC	17
EAP OHIO LLC	901
ECLIPSE RESOURCES I LP	221
EM ENERGY OHIO LLC	7
ENERVEST OPERATING LLC	20
EQT PRODUCTION COMPANY	2
EQUINOR USA ONSHORE PROPERTIES INC.	45
GEOPETRO LLC	17
GULFPORT APPALACHIA LLC	422
GULFPORT ENERGY CORPORATION	51
HALCON OPERATING COMPANY INC	4
HESS OHIO DEVELOPMENTS LLC	24
HESS OHIO RESOURCES LLC	1
HG ENERGY LLC	2
HILCORP ENERGY COMPANY	74
NORTHWOOD ENERGY CORP	6
PDC ENERGY INC	8
PENNENERGY RESOURCES LLC	40
PIN OAK ENERGY PARTNERS LLC	24
PROTEGE ENERGY III LLC	1
R E GAS DEVELOPMENT LLC	9
RICE DRILLING D LLC	149
SIERRA RESOURCES LLC	3
STATOIL USA ONSHORE PROPERTIES INC	5
SUMMIT PETROLEUM INC	6
SWEPI LP	1
TRIAD HUNTER LLC	32
UTICA RESOURCE OPERATING LLC	37
XTO ENERGY INC.	80
<b>Grand Total</b>	<b>3,345</b>

Note: Cumulative Number of Wells are calculated based upon the total number Drilled, Drilling, and Producing. Source: ODNR (December 31, 2020).

**Table 16: Total Lease Operating Expenses through December 2020**  
(in millions of dollars)

Year	Period	Production Wells	Lease Operating Expenses for Period (\$mm)
2020	Q3 and Q4	2,705	206.1
2020	Q1 and Q2	2772	266.2
2019	Q3 and Q4	2497	262.2
2019	Q1 and Q2	2173	228.0
2018	Q3 and Q4	2200	231.0
2018	Q1 and Q2	1874	191.2
2017	Q3 and Q4	1818	121.8
2017	Q1 and Q2	1588	141.3
2016	Q3 and Q4	1467	101.2
2016	Q1 and Q2	1355	97.6
2015	Annual	1034	148.9
2014	Annual	612	88.1
2013	Annual	237	34.1
2012	Annual	82	3.0
2011	Annual	9	0.3
		<b>Total</b>	<b>2,121.0</b>

**Table 17: Cumulative Utica-Related Upstream Investments in Ohio through December 2020**

Estimated Investments	Total Amount
Mineral Rights	\$25,420,005,000
Drilling	\$27,474,000,000
Roads	\$1,088,020,000
Lease Operating Expenses	\$2,121,012,000
Royalties	\$7,619,278,000
<b>Total</b>	<b>\$63,722,315,000</b>

**Table 18: Cumulative Utica-Related Midstream Investments in Ohio through December 2020**

<b>Estimated Investments</b>	<b>Total Amount</b>
Midstream Gathering	\$7,659,287,000
Processing Plants	\$1,259,300,000
Fractionation Plants	\$1,697,360,000
NGL Storage	\$261,000,000
Rail Loading Terminals	\$145,000,000
Transmission Pipelines	\$10,303,128,000
<b>Total</b>	<b>\$21,325,075,000</b>

**Table 19. Cumulative Utica-Related Downstream Investments in Ohio through Dec. 2020**

<b>Estimated Investments</b>	<b>Total Amount</b>
Petrochemical Plants and Refineries	\$618,885,000
Other Industrial Plants	\$760,000,000
Natural Gas Refueling Stations	\$47,375,000
Natural Gas Power Plants	\$6,442,500,000
Combined Heat and Power (CHP) Plants	\$87,470,000
<b>Total</b>	<b>\$7,956,230,000</b>

## 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: Northern Counties - \$11.4 mm/well; Southern Counties - \$12.9 mm/well.<sup>38</sup>
  - Equivalent true vertical depth (TVD) for wells in all counties.
  - Average drilling and completion costs of \$900 per lateral foot.<sup>39</sup>
  - Average lateral length of 12,660 ft. for northern counties and 14,360 ft. for southern counties.<sup>40</sup>
- Roads: average investments - approximately \$60,000 per well based on 2013 data from Carroll County Engineer's Office.<sup>41</sup>

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 July 1, 2020, from the number existent as of December 31, 2020. This information was downloaded from the ODNR Oil and Gas Well database.<sup>42</sup>

**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, processing and disposal of produced water, among other expenses. Lease operating expenses for Utica wells were estimated to be around \$12,700/month, throughout the life of the well. This average expense was developed by the study team based on analysis of Ascent's lease operating

<sup>38</sup> 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 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. However, the same review of drilling surveys indicated that laterals for new wells in southern counties were 1,700 feet longer on average than for those in the north. This difference in average lateral length is the basis for the difference in drilling cost between northern and southern counties.

<sup>39</sup> Based on Ascent Resources' estimated drilling costs per lateral foot in the Utica according to the company's chairman and CEO. Ascent is active in both northern and southern counties. See <https://oklahoman.com/article/5626621/ascent-resources-reports-growth-in-utica-shale-field-during-2018>

<sup>40</sup> Calculated using well completion reports obtained from the ODNR's *Ohio Oil & Gas Well Database*.

<sup>41</sup> See fn 12, *supra*.

<sup>42</sup> <http://oilandgas.ohiodnr.gov/well-information/oil-gas-well-database>

expenses for the second half of 2020, divided by the number of wells operated, as reported in their financial statements.<sup>43</sup>

For purposes of estimating the lease operating expenses for Q3 and Q4 2020, the Study Team assumed that all wells listed as “producing” by the Ohio Department of Natural Resources on July 1, 2020 were incurring this cost and continued to do so through December 31, 2020.

**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.<sup>44</sup>
- The residue energy content was around 1.1 MMBtu/Mcf.<sup>45</sup>
- Residue gas in the Utica was selling at an average price of \$1.20 /MMBtu for Q3 and \$1.32/MMBtu for Q4.<sup>46</sup> This price for the Columbia-Appalachia hub was used to estimate royalties.
- Around 44 barrels of liquids were recovered per million cubic feet of gas produced.<sup>47</sup>
- Natural gas liquids were selling for around 30% of the listed price for Marcellus-Utica light crude oil.<sup>48</sup>

<sup>43</sup> See

[https://ascentresources.com/documents/18/2019\\_Consolidated\\_Financial\\_Statements\\_\\_Ascent\\_Resources\\_Utica\\_Holdings\\_LLC.pdf](https://ascentresources.com/documents/18/2019_Consolidated_Financial_Statements__Ascent_Resources_Utica_Holdings_LLC.pdf). See also <https://ir.gulfportenergy.com/all-sec-filings/content/0001628280-20-002453/0001628280-20-002453.pdf>

<sup>44</sup> Based on industry interviews, experts citing API 12.3, Manual of Petroleum Measurements and Standards

<sup>45</sup> The EIA estimates that the average conversion should be 1.037 MMBtu/Mcf (see: [www.eia.gov/tools/faqs/faq.php?id=45](http://www.eia.gov/tools/faqs/faq.php?id=45)). However, industry interviews suggest 1.1 is closer to the average conversion for the Utica Shale.

<sup>46</sup> <https://www.naturalgasintel.com/appalachian-consolidation-continues-as-west-virginia-natural-gas-trade-groups-merge/> 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>

<sup>47</sup> Based on industry data.

<sup>48</sup> Based on industry interviews.

- Oil in the Utica region was selling for \$31.15 and \$33.03 per barrel, on average, during the third and the fourth quarter of 2020, respectively.<sup>49</sup>
- Royalty rates are 20% of gross production.

**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 lease, we assumed that approximately 20% of the undeveloped acreage identified will need to be renewed each year or is otherwise new.<sup>50</sup> 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 every 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.

<sup>49</sup> 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>

<sup>50</sup> 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.



Compressor station investments were calculated based on the horsepower rating listed in Ohio EPA air permit data and estimated construction costs per horsepower of \$3,744 for the Midwest Region as obtained from the INGAA, as projected for 2020.<sup>51</sup>

The approximate capital cost for TEG dehydration units based on throughput was obtained from Carroll's *Natural Gas Hydrates: A Guide for Engineers* (2014, 3<sup>rd</sup> 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/d<sup>52</sup>
- 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.<sup>53</sup>

For this report, up-to-date cost projections for natural gas transmission and gathering line pipelines, per inch-mile, was obtained from the Interstate Natural Gas Association of America (INGAA).<sup>54</sup> The estimated cost for natural gas pipelines for the Midwest Region as used in this

<sup>51</sup> *Id.*

<sup>52</sup> 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](https://s22.q4cdn.com/128149789/files/doc_presentations/2019/11/Investor-Day-Slides-for-Website-11.06.2019-vF.pdf)).

<sup>53</sup> that the data currently used supersedes data used in previous reports for study periods through June 30, 2017. Newer data suggests that the previously used assumption of 4 miles of gathering line per well pad was about twice as high as what midstream companies actually deploy in the field on average. Additionally, oil and gas companies can accommodate more than three times the 3-wells-per-pad that the Study Team assumed in prior studies. Earlier iterations of this dashboard assumed companies would drill three wells per pad on average, move on to other locations, and then come back later to infill. As the Utica play becomes more mature, we can expect that there will be a greater number of wells per pad, and therefore fewer gathering pipeline miles per well.

<sup>54</sup> The INGAA Foundation, Inc. (2018). *North America Midstream Infrastructure through 2035*. <https://www.ingaa.org/File.aspx?id=34703>.

analysis was \$194,429 per inch-mile, which included labor, raw materials, and permitting costs, as projected by the INGAA for 2020.

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 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 12 shows the primary intermediates and products that can be manufactured from the main hydrocarbon components in shale gas as part of downstream production.<sup>55</sup>

<sup>55</sup> See

[https://www.energy.gov/sites/prod/files/2020/06/f76/Appalachian%20Energy%20and%20Petrochemical%20Report\\_063020\\_v3.pdf](https://www.energy.gov/sites/prod/files/2020/06/f76/Appalachian%20Energy%20and%20Petrochemical%20Report_063020_v3.pdf)

Figure 12. Shale/Natural Gas Value Chain for Petrochemicals

