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Shale Investment Dashboard in Ohio Q1 AND Q2 2020

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JOB SOHIO

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March 2021

**SHALE INVESTMENT
DASHBOARD IN OHIO
Q1 AND Q2 2020**

**Energy Policy
Center**

1717 Euclid Avenue Cleveland, Ohio 44115
<http://urban.csuohio.edu>

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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 2020. 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 2020 can be summarized as follows:

Total Estimated Upstream Utica Investment: January – June 2020

Lease Renewals and New Leases	\$247,732,000
Drilling	\$767,700,000
Roads	\$3,780,000
Lease Operating Expenses	\$266,220,000
Royalties	\$535,510,000
Total Estimated Upstream Investment	\$1,820,942,000

Total Estimated Midstream Investment: January – June 2020

Transmission Lines	\$700,000,000
Gathering Lines	\$17,790,000
Gathering System Compression and Dehydration	\$67,990,000
Total Estimated Midstream Investment	\$785,780,000

Total Estimated Downstream Investment: January – June 2020

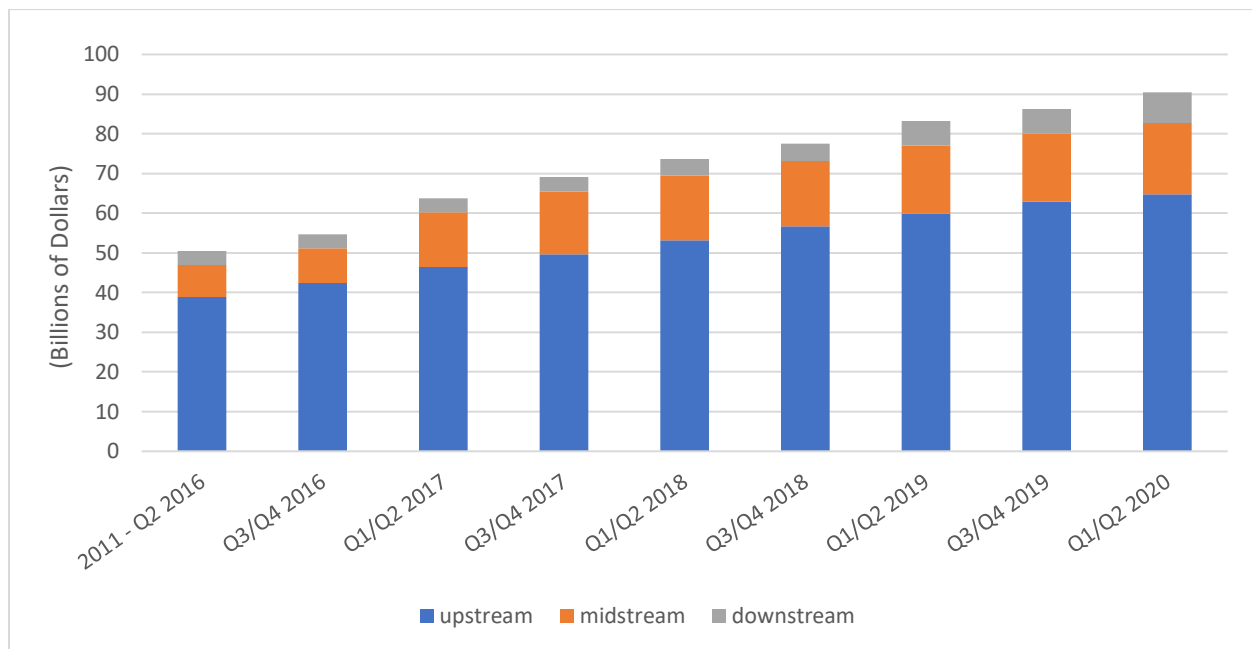
Natural Gas Power Plants	\$1,600,000,000
CHP Plants	\$2,370,000
Total Estimated Downstream Investment	\$1,602,370,000

¹ The eight previous reports on shale investment in Ohio up to June 2019 can be found at:

http://engagedscholarship.csuohio.edu/urban_facpub/1464/
http://engagedscholarship.csuohio.edu/urban_facpub/1500/
https://engagedscholarship.csuohio.edu/urban_facpub/1517/
https://engagedscholarship.csuohio.edu/urban_facpub/1576/
https://engagedscholarship.csuohio.edu/urban_facpub/1597/
https://engagedscholarship.csuohio.edu/urban_facpub/1628/
https://engagedscholarship.csuohio.edu/urban_facpub/1659/
https://engagedscholarship.csuohio.edu/urban_facpub/1690/

Total investment from January through June 2020 was approximately \$4.2 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 June of 2020 is estimated to be around \$90.6 billion. Of this, \$61.9 billion was in upstream, \$20.9 billion in midstream, and \$7.8 billion in downstream industries.² 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 down \$1.1 billion in the first half of 2020 compared to the second half of 2019, reflecting a significant reduction in both new wells drilled and production volume. As determined from Ohio Department of Natural Resources Division of Oil and Gas (ODNR) data for shale well drilling, 63 new wells were drilled during the first and second quarters of 2020, 59 fewer than the number drilled in the second half of the year for 2019. ODNR production data also indicated that the total volume of gas-equivalent shale production in the first half of 2020 was 15% less than overall production in the second half of 2019. Belmont County again had the highest number of new wells with 24, followed by Harrison and Jefferson Counties, which had 17 and 12 new wells, respectively. No other county had more than five new wells drilled for the first half of 2020.

Ascent and Encino were the top producers for Q1 and Q2 of 2020, having produced 422 and 186.7 billion cubic feet equivalent (Bcfe), respectively. Gulfport was third in production at 182.5 Bcfe, followed by Eclipse at 123 Bcfe, Rice Drilling at 119 Bcfe, and Antero at 59 Bcfe. These six companies made up around 90% of the total production for the first half of 2020.

² Numbers may not add up precisely due to rounding.

The first half of 2020 saw an increase in midstream investment compared to the second half of 2019, largely due to the \$700 million invested by TC Energy as part of the Buckeye XPress project to upgrade Columbia Gas’s pipeline transmission network in Ohio. Additional midstream spending that occurred in the first half of 2020 was for gathering system pipeline (\$17.8 million) and gathering system compression and dehydration (\$68.0 million).

Major construction on one natural gas power plant in Guernsey County began in the first half of 2020, representing 1,875 megawatts of output capacity and an investment of \$1.6 billion. Construction on an additional 1,085 MW natural gas power plant in Harrison County is expected to begin in the first half of 2021, the \$1 billion investment for which will be included in a future report.³

One combined heat and power (CHP) plant with a capacity of 0.8 MW was installed during the Study period, representing an estimated investment of \$2.4 million. Further progress was made in late 2020 on permitting for a \$278 million, 105.5 CHP plant on Ohio State University’s main campus; however, as of this writing a construction timeline had yet to be finalized. While COVID-19 and other factors have delayed a final investment decision on the proposed \$10 billion ethane cracker in Belmont County, there is still considerable activity around it according to the project’s developer, PTT Global, including ethane storage and supply deals that were reached in Q3 2020.⁴ The Study Team will continue tracking this and other downstream activities in the state for future reports, including natural gas use for transportation and hydrogen production.

1. INTRODUCTION

This is the ninth CSU study reporting investment resulting from oil and gas development in Ohio related to the Utica and Point Pleasant formations (hereinafter, the “Utica”).⁵ This analysis looks at investment made in Ohio between January 1 and June 30, 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.

³ See <https://emberclear.com/harrison/>

⁴ See <https://www.icis.com/explore/resources/news/2021/02/08/10604419/ptt-global-chemical-remains-bullish-on-us-ohio-cracker-project>. See also: <https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/pttgc-america-secures-storage-services-contract-for-ohio-ethane-cracker-project-59560520>; <https://www.reuters.com/article/usa-ptt-ohio-chemical/ptt-signs-ethane-supply-deal-with-range-for-ohio-petrochemical-plant-idUSL2N2GK19O>

⁵ 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.

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 ninth 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 2020.⁶ 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 63 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, 2020.⁷ This represents a 48% decrease in new well development compared to the second half of 2019. The total number of producing wells in the Utica was 2,518 on June 30, 2020, a 3.9% increase from the end of December 2019. Total shale-related oil and gas production in billion cubic feet equivalent (Bcfe) for this period was 1,214 Bcfe, led by Belmont County with 416 Bcfe. Jefferson County was second with 243 Bcfe, followed by Monroe County with 233 Bcfe.⁸

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 first and second quarters of 2020 provide the foundation for the upstream analyses presented in this Study.

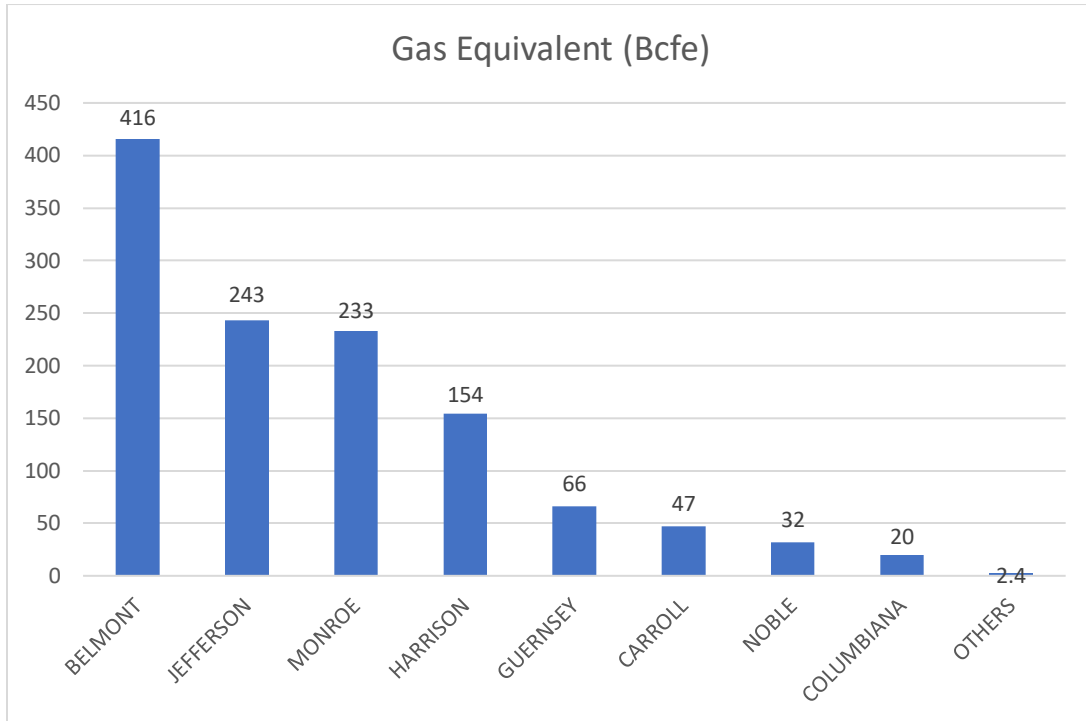
⁶ See fn 1, *supra*.

⁷ 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.

⁸ 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).

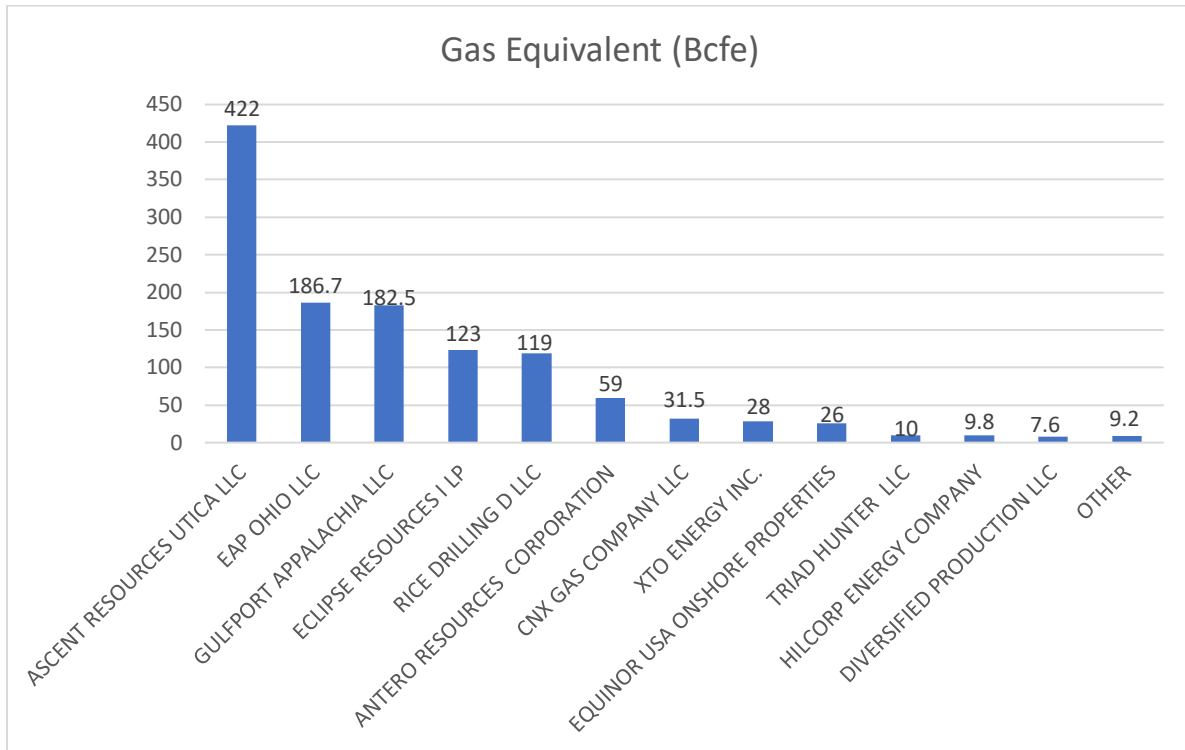
The Utica is currently identified by the ODNR as producing in eighteen eastern Ohio counties with the vast majority (over ninety-eight percent) of producing wells located in eight counties, stretching from Columbiana in the north, to Monroe and Noble at the southern end of the play. Total production in quarters 1 and 2 for 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 June 2020 can be found in Appendix A as Figures 7 and 8.

Figure 2: Production by County for Q1 and Q2 of 2020



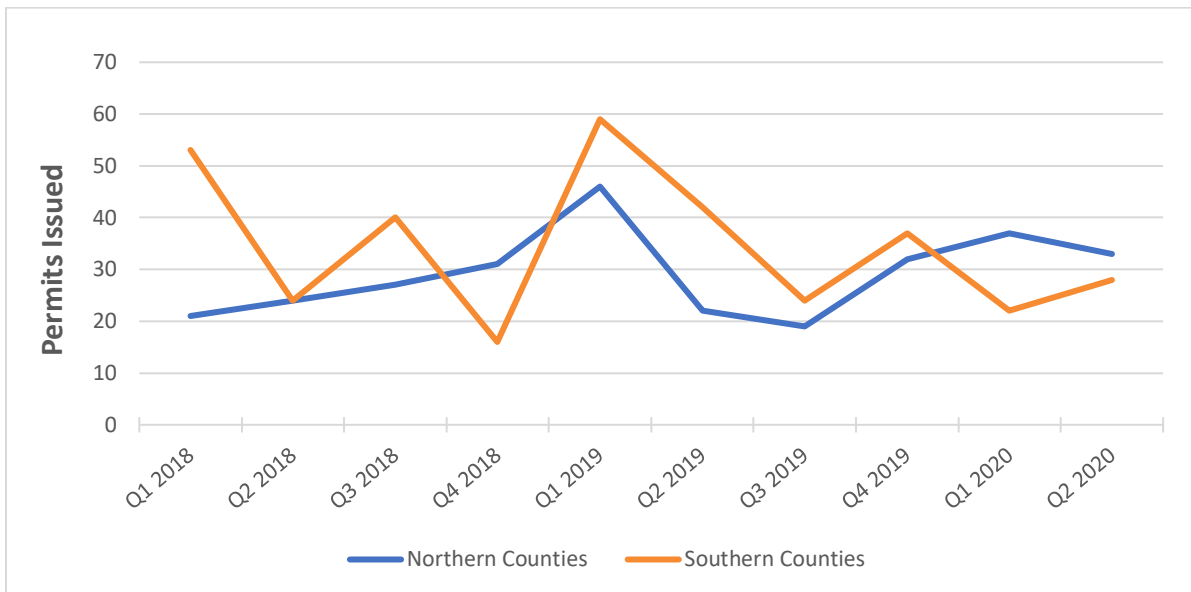
Data Source: ODNR (2020).

Figure 3: Production by Operator for Q1 and Q2 2020



Data Source: ODNR (2020).

We noted in the last report how new upstream activities appear to be trending toward northern counties in the Utica, and away from the southern counties where drilling and production had previously been concentrated. A review of permits issued by the ODNR for Utica shale wells suggests that this trend may continue. Figure 4 shows the number of permits issued for oil and gas wells in the Utica by quarter for the most active northern and southern counties since the beginning of 2018. (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 shown in Figure 4, northern counties had surpassed southern counties for number of permits issued by Q1 2020, a position that was sustained into the following quarter.

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

Data source: ODNR (2020).

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 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 first 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	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	--
Total		43223	10,677,651,109	125,817,620	11,389,793,875	

Source: ODNR (2020).

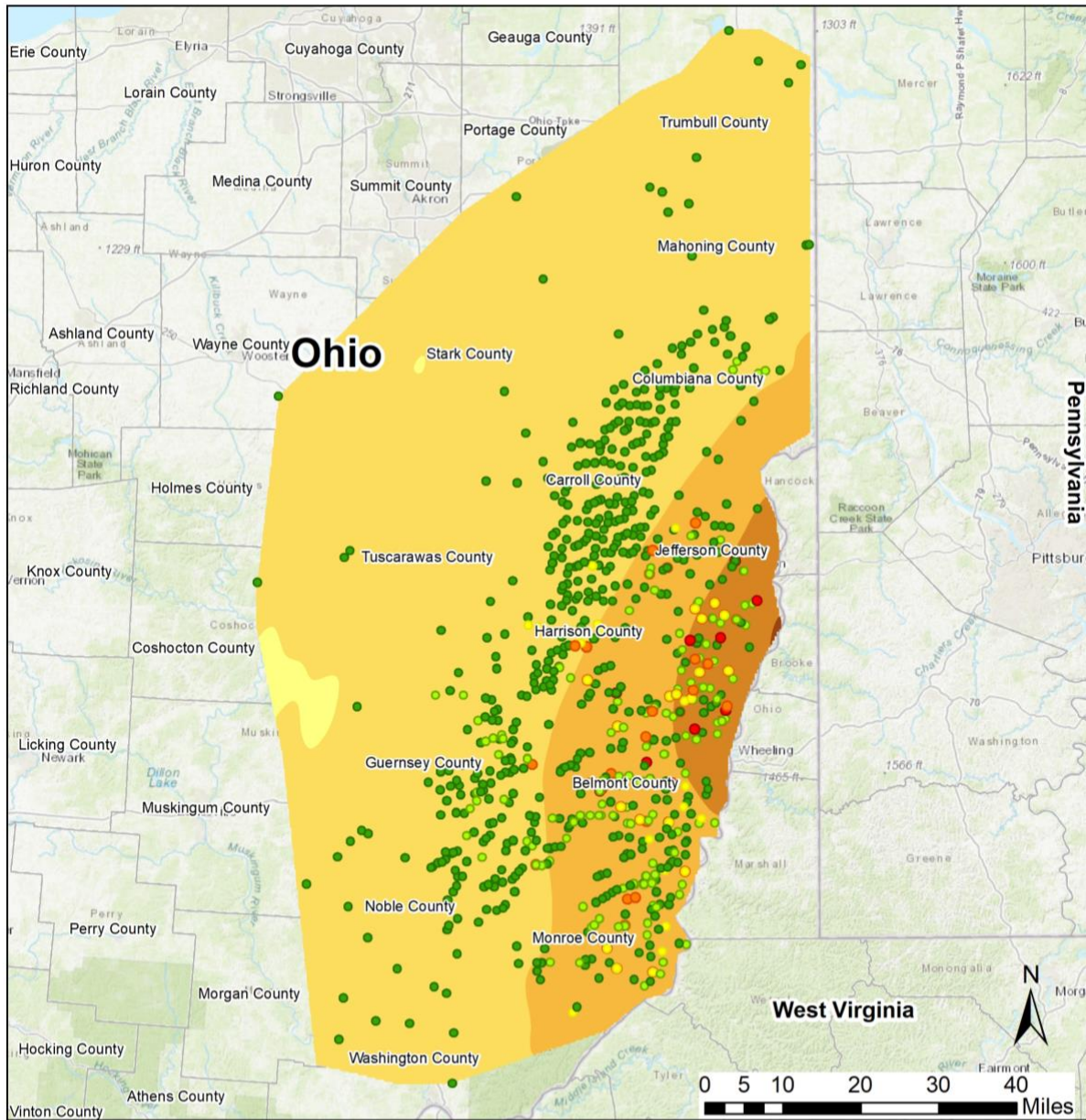
Table 2: Production by County for January – June 2020

County	Gas (Mcf)	Oil (bbl)	Gas Equivalents (Mcf)	Production Wells ⁹
BELMONT	413,782,526	411,224	416,109,643	561
CARROLL	41,508,152	969,977	46,997,252	476
COLUMBIANA	19,513,234	16,105	19,604,372	87
COSHOCTON	14,449	0	14,449	1
GUERNSEY	38,257,912	4,973,656	66,403,831	237
HARRISON	131,904,295	3,897,464	153,960,044	415
JEFFERSON	243,104,814	0	243,104,814	233
MAHONING	542,875	1,843	553,305	13
MONROE	230,099,893	589,870	233,437,967	384
MORGAN	70,292	2,577	84,875	2
MUSKINGUM	18,575	259	20,041	1
NOBLE	30,577,911	186,091	31,631,000	171
PORTAGE	30,006	0	30,006	1
STARK	29,865	468	32,513	2
TRUMBULL	212,927	1,248	219,989	7
TUSCARAWAS	177,577	8,755	227,122	7
WASHINGTON	1,150,400	9,882	1,206,322	11
WAYNE	34,516	94	35,048	1
Total	1,151,030,219	11,069,513	1,213,672,593	2,610

Source: ODNR (2020).

⁹ Represents the average number of production wells for the first and second quarters of 2020.

Figure 5: Distribution of Gas Equivalent Production for January – June 2020



Avg BCF OF GAS EQUIVALENT Second Half 2020

Total BCF of Gas Equivalent

0 - 0.4	1.2 - 1.6
0.4 - 0.8	1.6 - 2.0
0.8 - 1.2	2.0 & Greater

Producing Wells

- Low
- Medium
- High

Of the 2,772 total wells identified from the ODNR records for cumulative drilling activity as of June 2020, 111 were in the process of drilling, 143 wells had been drilled and were awaiting markets, and 2,518 were in the production phase.¹⁰ 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 June 2020

Well Status	No. of Wells
Drilled	143
Drilling	111
Producing	2,518
Total	2,772

Source: ODNR (2020)

Table 4: Well Status by County (June 2020)

County	Drilled	Drilling	Producing	Total
ASHLAND	1	0	0	1
BELMONT	30	43	545	618
CARROLL	2	2	472	476
COLUMBIANA	10	0	84	94
COSHOCTON	1	0	1	2
GUERNSEY	6	14	236	256
HARRISON	13	22	404	439
JEFFERSON	17	10	223	250
KNOX	1	0	0	1
MAHONING	0	0	13	13
MEDINA	1	0	0	1
MONROE	40	12	339	391
MORGAN	0	0	2	2
MUSKINGUM	0	0	1	1
NOBLE	5	6	169	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
Total	143	111	2,518	2,772

¹⁰ 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 January and June 2020. Cumulative upstream investments to date in Ohio, including 2011 through the first half of 2020, are set forth in Table 18 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. Belmont County was the leader in new upstream investment, with 24 new wells and an investment of around \$311.0 million between January and June 2020. Harrison and Jefferson Counties were second and third, with 17 and 12 new wells, respectively, to go along with \$194.8 and \$137.5 million invested. 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 2011.¹¹ 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, 40% of whose new wells were in the lower cost, more northerly counties, was the leading operator-investor during the six-month period, with 25 new wells and an estimated \$309.0 million invested, followed by EAP Ohio with 16 new wells and an estimated \$183.4 million. Gulfport Appalachia LLC drilled 9 new wells for an estimated investment of \$116.6 million. Rice Drilling and Chesapeake Exploration LLC (see footnote 12 re: Encino) both drilled 4 wells for an estimated investment of \$51.8 and \$45.8 million, respectively. See Table 6.

¹¹ 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, January – June 2020

County	No. of New Wells	Drilling (\$)	Roads (\$)	Total Amount (\$)
BELMONT	24	\$309,600,000	\$1,440,000	\$311,040,000
CARROLL	1	\$11,400,000	\$60,000	\$11,460,000
GUERNSEY	4	\$51,600,000	\$240,000	\$51,840,000
HARRISON	17	\$193,800,000	\$1,020,000	\$194,820,000
JEFFERSON	12	\$136,800,000	\$720,000	\$137,520,000
MONROE	5	\$64,500,000	\$300,000	\$64,800,000
Total	63	\$767,700,000	\$3,780,000	\$771,480,000

Source: The Authors (2020)

Table 6: Estimated Upstream Shale Investment in Ohio by Company, January – June 2020

Operators	No. of Wells	Drilling (\$)	Roads (\$)	Total Amount (\$)
ASCENT RESOURCES UTICA LLC	25	\$307,500,000	\$1,500,000	\$309,000,000
CHESAPEAKE EXPLORATION LLC ¹²	4	\$45,600,000	\$240,000	\$45,840,000
CNX GAS COMPANY LLC	1	\$12,900,000	\$60,000	\$12,960,000
EAP OHIO LLC	16	\$182,400,000	\$960,000	\$183,360,000
ECLIPSE RESOURCES I LP	2	\$25,800,000	\$120,000	\$25,920,000
EQUINOR USA ONSHORE PROPERTIES INC.	2	\$25,800,000	\$120,000	\$25,920,000
GULFPORT APPALACHIA LLC	9	\$116,100,000	\$540,000	\$116,640,000
RICE DRILLING D LLC	4	\$51,600,000	\$240,000	\$51,840,000
Total	63	\$767,700,000	\$3,780,000	\$771,480,000

Source: The Authors (2020)

2. Lease Operating Expenses.

Post-production investments have been estimated on a half-year basis, assuming an average cost of around \$17,500/month/well. This estimate is based upon recent operator reports.¹³ 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 \$57.2 and \$48.5 million invested, respectively.

¹² While Encino's deal to purchase Chesapeake's Ohio Utica assets was completed in 2018, the legal and operational transition of a handful of assets was not complete as of early 2020.

¹³ The per-month rule-of-thumb for lease operating expenses per producing well for this report is based on Ascent's and Gulfport's unit lease operating expenses for 2018 as reported in company financial statements.

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

County	Production Wells	Lease Operating Expense for Period
BELMONT	561	\$57,222,000
CARROLL	476	\$48,552,000
COLUMBIANA	87	\$8,874,000
COSHOCTON	1	\$102,000
GUERNSEY	237	\$24,174,000
HARRISON	415	\$42,330,000
JEFFERSON	233	\$23,766,000
MAHONING	13	\$1,326,000
MONROE	384	\$39,168,000
MORGAN	2	\$204,000
MUSKINGUM	1	\$102,000
NOBLE	171	\$17,442,000
PORTAGE	1	\$102,000
STARK	2	\$204,000
TRUMBULL	7	\$714,000
TUSCARAWAS	7	\$714,000
WASHINGTON	11	\$1,122,000
WAYNE	1	\$102,000
Total	2,610	\$266,220,000

Table 8: Estimated Lease Operating Expenses for January – June 2020 by Operator

Operator	Production Wells	Lease Operating Expense for Period
ANTERO RESOURCES CORPORATION	223	\$22,746,000
ARTEX ENERGY GROUP LLC	6	\$612,000
ASCENT RESOURCES UTICA LLC	565	\$57,630,000
ATLAS NOBLE LLC	12	\$1,224,000
CHESAPEAKE EXPLORATION LLC	1	\$102,000
CHEVRON APPALACHIA LLC	4	\$408,000
CNX GAS COMPANY LLC	42	\$4,284,000
DIVERSIFIED PRODUCTION LLC	15	\$1,530,000
EAP OHIO LLC	801	\$81,702,000
ECLIPSE RESOURCES I LP	176	\$17,952,000
EQUINOR USA ONSHORE PROPERTIES	45	\$4,590,000
GEOPETRO LLC	4	\$408,000
GULFPORT APPALACHIA LLC	381	\$38,862,000
HILCORP ENERGY COMPANY	23	\$2,346,000
NORTHWOOD ENERGY CORP	6	\$612,000
PENNENERGY RESOURCES LLC	40	\$4,080,000
PIN OAK ENERGY PARTNERS LLC	23	\$2,346,000
RICE DRILLING D LLC	132	\$13,464,000
TRIAD HUNTER LLC	21	\$2,142,000
UTICA RESOURCE OPERATING LLC	31	\$3,162,000
XTO ENERGY INC.	59	\$6,018,000
Total	2,610	\$266,220,000

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 January and June 2020 were around \$535.5 million. The breakdown by quarter for oil, residue gas and natural gas liquids is set forth in Tables 9, 10, and 11 below. The average price for natural gas was \$1.58/MMBtu during the first half of 2020, down from \$1.95 in the second half of 2019.¹⁴ Regional oil prices decreased from an average of \$41.07 /bbl during the first quarter of 2020 to \$19.65/bbl for the second quarter.¹⁵ For comparison, regional oil prices averaged \$47.27 and \$53.85 per barrel in the first and second quarters of 2019, respectively.

¹⁴ Reflects average Columbia-Appalachia natural gas prices over the respective periods. See https://www.naturalgasintel.com/data/data_products/bidweek?region_id=appalachia&location_id=NEATCO.

¹⁵ See <https://ergon.com>

**Table 9: Total Royalties from Oil
January – June 2020 (in millions of dollars)**

Year	Quarter	Oil Price \$/bbl	Oil Royalty (20%) \$/bbl	Royalty (\$mm)
2020	2	\$19.65	\$3.93	\$20.36
2020	1	\$41.07	\$8.21	\$48.36
			Subtotal	\$68.72

**Table 10: Total Royalties from Residue Gas
January – June 2020 (in millions of dollars)**

Year	Quarter	Residue Gas Price \$/Mcf	Residue Gas Royalty (20%) \$/Mcf	Royalty (\$mm)
2020	2	1.66	\$0.33	\$179.16
2020	1	1.82	\$0.36	\$195.03
			Subtotal	\$374.18

**Table 11: Total Royalties from Natural Gas Liquids
January – June 2020 (in millions of dollars)**

Year	Quarter	NGL Price \$/bbl	NGL Royalty (20%) \$/bbl	Royalty (\$mm)
2020	2	5.89	1.18	\$29.53
2020	1	12.32	2.46	\$63.07
			Subtotal	\$92.60

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.¹⁶ 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.¹⁷

¹⁶ *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. 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.

¹⁷ 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
January – June 2020 (in millions of dollars)**

Operator	Acreage not held for production	Estimated Bonus Investment (\$mm)
ANTERO RESOURCES CORPORATION ¹⁸	21,590	10.8
ASCENT RESOURCES UTICA HOLDINGS, LLC	84,232	42.1
EAP OHIO LLC ¹⁹	246,831	123.4
Southwest Energy Company (Montage Resources) ²⁰	58,840	29.4
GULFPORT ENERGY CORPORATION	48,216	24.1
Rice Drilling D LLC (EQT)	35,755	17.9
Total	495,464	247.7

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 INGAA Foundation. Similarly, compressor

¹⁸ 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.

¹⁹ 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.

²⁰ 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.

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.

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 first 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
January – June 2020**

Company	Additions to Infrastructure	Total Amount (\$mm)
TC Energy (Buckeye XPress Project) ²¹	• 66.1 miles of 36" pipeline	\$700.0
Dominion Energy (Tri-West Project) ²²	• 1.7 miles of 20" pipeline	\$6.4
Blue Racer Midstream LLC	• 0.53 miles of 10.8" pipeline	\$1.1
Cardinal Gas Services (Williams)	• 3.9 miles of 8.6" pipeline • 1.9 miles of 10.8" pipeline	\$10.3
	Total	\$717.8

Source for Gathering Line Mileage and Diameter Data: PUCO Gathering Construction Reports (2020)

²¹ See <https://www.spglobal.com/platts/en/market-insights/latest-news/natural-gas/012420-ferc-approves-columbias-275-mmcf-buckeye-xpress-pipeline-expansion>

²² See Tri-West Project Weekly Status Reports under FERC Docket No. CP20-23-000 at <https://elibrary.ferc.gov/eLibrary/search>

Table 14: Additional Midstream Investment, January – June 2020

Company	Additions to Infrastructure	Estimated Investment (\$mm)
Columbia Pipeline Group	<ul style="list-style-type: none"> 225 MMscfd of dehydration in Hocking county 	3.60
Dominion Resource Services	<ul style="list-style-type: none"> 690 hp of compression at Siron station, Guernsey county 	2.49
Diversified Gas & Oil PLC	<ul style="list-style-type: none"> 60 hp of compression in Geauga county 40 hp of compression in Lake county 	0.36
East Ohio Gas	<ul style="list-style-type: none"> 7,600 hp of compression at Augusta station, Carroll county 	27.45
Eclipse Resources	<ul style="list-style-type: none"> 330 hp of compression in Guernsey county 1,885 hp of compression in Monroe county 40 MMscfd of dehydration in Monroe county 	8.96
EQM Olympus Midstream	<ul style="list-style-type: none"> 54 MMscfd of dehydration in Watkins facility in Belmont county 108 MMscfd of dehydration in Dornon facility in Belmont county 99 MMscfd of dehydration in Fankhauser facility in Belmont county 144 MMscfd of dehydration in Horseshoe facility in Monroe county 	7.70
Strike Force East	<ul style="list-style-type: none"> 160 MMscfd of dehydration Shannon facility and Shimble facility in Belmont county 	3.30
Strike Force South	<ul style="list-style-type: none"> 176 MMscfd of dehydration Paulus facility and Potter facility in Monroe county Claugus facility in Belmont county 	3.78
Sunoco Partners Marketing & Terminals LP	<ul style="list-style-type: none"> 45,323-barrel internal floating roof storage tank in Cuyahoga county 	0.68
Williams	<ul style="list-style-type: none"> 2,010 hp of compression and 130 MMscfd of dehydration in Salem compressor station, Jefferson county 	9.66
	Total	67.99

Adding together the amounts in Tables 13 and 14 yields a total midstream investment for the first half of 2020 of \$785.8 million. This was \$669.7 million more than the amount of midstream investment captured in the last shale investment report that covered the second half of 2019. The difference in investment between the two periods was largely due to the \$700 million spent

by TC Energy on the Buckeye XPress pipeline project.²³ This upgrade to Columbia Gas Transmission's system in Ohio, which FERC approved in January 2020, entered into service in January 2021.²⁴

No new midstream processing capacity was added during the first half of 2020. However, MarkWest completed an additional 80,000 barrels per day of fractionation capacity in the third quarter of 2020.²⁵ This investment, likely in excess of \$100 million, will be included in the next shale investment report covering the second half of 2020.

NGL storage, critical to balancing the supply and demand of petrochemical feedstocks, will continue to be tracked for midstream investment. Such projects include MPLX's Hopedale NGL Caverns and the Mountaineer NGL storage project in Monroe County, the latter of which is still expected to move forward following a permitting and review process in September 2020.²⁶ With growing demand for green hydrogen, Mountaineer NGL announced in January 2021 that it is exploring plans for carbon-free hydrogen storage in its new storage hub near Clarington in Monroe County.²⁷ This proposal follows the initiative of Long Ridge to transition its 485 MW combined-cycle power plant in Hannibal, Ohio to operate on carbon-free hydrogen. The Long Ridge Energy Terminal, which will begin commercial operation in November 2021, will be the first purpose-built hydrogen-burning power plant in the United States.²⁸

Cumulative midstream investments through the middle of 2020 are set forth in Table 19 in Appendix A.

²³ The estimated cost of the Buckeye XPress was \$709 million overall. However, a small portion of upgrade activities took place in West Virginia. According to the project's FERC application, 98.7% of new plant in service for the expansion was in Ohio. See FERC docket no. CP18-137, *Abbreviated Application of Columbia Gas Transmission, LLC for a Certificate of Public Convenience and Necessity and Abandonment Authority (Buckeye XPress Project)*, filed on March 26, 2018.

²⁴ See <https://www.tcenergy.com/siteassets/pdfs/investors/reports-and-filings/annual-and-quarterly-reports/2020/tc-2020-q1-quarterly-report.pdf>. See also: <https://www.tcenergy.com/stories/2021/2021-01-19buckeyes-xpress-project-enters-service/>

²⁵ http://www.mplx.com/content/documents/mplx/investor_center/2020/MPLX_3Q20_Conf_Call_Slides.pdf
http://www.mplx.com/content/documents/mplx/investor_center/2020/MPLX_4Q19_Conf_Call_Slides_vFinal.pdf

²⁶ <https://www.naturalgasintel.com/mountaineer-ngl-storage-pulls-key-ohio-permits-but-project-still-moving-ahead/>

²⁷ <https://www.timesleaderonline.com/news/local-news/2021/01/mountaineer-ngl-storage-llc-exploring-green-hydrogen-demand/>

²⁸ <https://www.longridgeenergy.com/news/2020-10-13-long-ridge-energy-terminal-partners-with-new-fortress-energy-and-ge-to-transition-power-plant-to-zero-carbon-hydrogen>

D. DOWNSTREAM DEVELOPMENT

1. Combined Heat and Natural Gas Power Plants

Over the past eight 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. This report includes investment for the \$1.6 billion Guernsey Power Station, major construction for which began in early 2020.²⁹ This power plant, located in Valley Township, Guernsey County, is anticipated to come online in the third quarter of 2022.³⁰ In January 2020, Harrison Power LLC and its parent company EmberClear initiated an engineering, procurement and construction services contract for a 1,085 MW power plant in Harrison county. Plant construction is expected to begin in the first half of 2021 and will cost about \$1 billion.³¹ This investment will be included in a future Shale report.

EmberClear has also suggested that it may develop a hydrogen production and storage facility near the Harrison project in the future. The company has identified geological formations within 5 to 10 miles of the Harrison Power Station to store hydrogen and plans to work with Mitsubishi Power on its hydrogen projects.³² In September 2020, Mitsubishi Power announced a multibillion-dollar series of projects—including at the aforementioned Harrison Power Station—that will be the first of their kind to integrate green hydrogen production with renewable power generation and energy storage.³³ Projects such as these are likely to drive hydrogen storage capacity growth in the region, including natural gas-based hydrogen. Mountaineer NGL Storage, LLC, for example, will offer up to 2 million barrels of initial stage hydrogen storage at its Appalachian Storage Hub in Monroe County as it explores interest in green hydrogen, particularly at the nearby Long Ridge Energy Generation facility where plans are being developed to transition to hydrogen-based power generation.³⁴ The Study Team will track hydrogen developments at these and other natural gas power plants in Ohio for future shale investment reports.

Low natural gas prices have continued to spur regional development of combined heat and power (CHP) plants. CHP plants are usually designed for heat or steam generation, with electricity as a secondary product, thereby improving overall system efficiency. Table 15 shows the estimated investment for CHP plants in Ohio during the Study period.

²⁹ http://arganinc.com/wp-content/uploads/2020/05/Argan-2020-Annual-Report_final.pdf

³⁰ <https://guernseypowerstation.com/faq-2/>

³¹ See <https://opsb.ohio.gov/>. See also <https://www.dispatch.com/news/20200112/argan-subsi-dary-scores-1085-mw-power-project-in-harrison-county>. See also <https://emberclear.com/harrison/>

³² <https://emberclear.com/harrison/>

³³ <https://power.mhi.com/regions/amer/news/20200902.html>. See also <https://www.world-energy.org/article/12157.html>

³⁴ See <https://www.wtrf.com/news/ohio-headlines/company-exploring-green-hydrogen-storage-in-the-ohio-valley>; See also <https://fuelcellworks.com/news/leading-the-way-to-carbon-free-generation-long-ridge-energy-terminal-to-add-hydrogen-fuel-capability/>

Table 15. Gas-fired Power Generation and CHP Plants

City	Facility Type	Facility Name	Capacity (MW)	Estimated Investment (\$mm)
Valley Township	Gas-fired Power Generation	Guernsey Power Station	1,875	1,600
Upper Sandusky	CHP	Kalmbach Feeds ³⁵	0.8	2.37 ³⁶

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 to go along with an Ohio EPA Air Pollution Permit-to-Install issued in October 2019.³⁷ Additionally, in the fourth quarter of 2020 the project received a building permit from the Ohio Department of Industrial Compliance as well as notice from both ODOT's Office of Aviation and the Federal Aviation Administration determining that the use of cranes to construct the CHP facility would not constitute an obstruction to air traffic.³⁸ A timeline for construction of the plant is still being finalized.³⁹ 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 proposed CHP project at Ohio State, including their current status, are set forth in Figure 6 below.

³⁵ See U.S. Department of Energy. CHP Installation Database. <https://doe.icfwebservices.com/chp>

³⁶ Estimated investment is based on an inflation-adjusted total installed cost of \$2,957/kW for an 800 kW gas spark ignition CHP plant as derived from the U.S. EPA's 2017 *Catalog of CHP Technologies*. See <https://www.epa.gov/chp/catalog-chp-technologies>

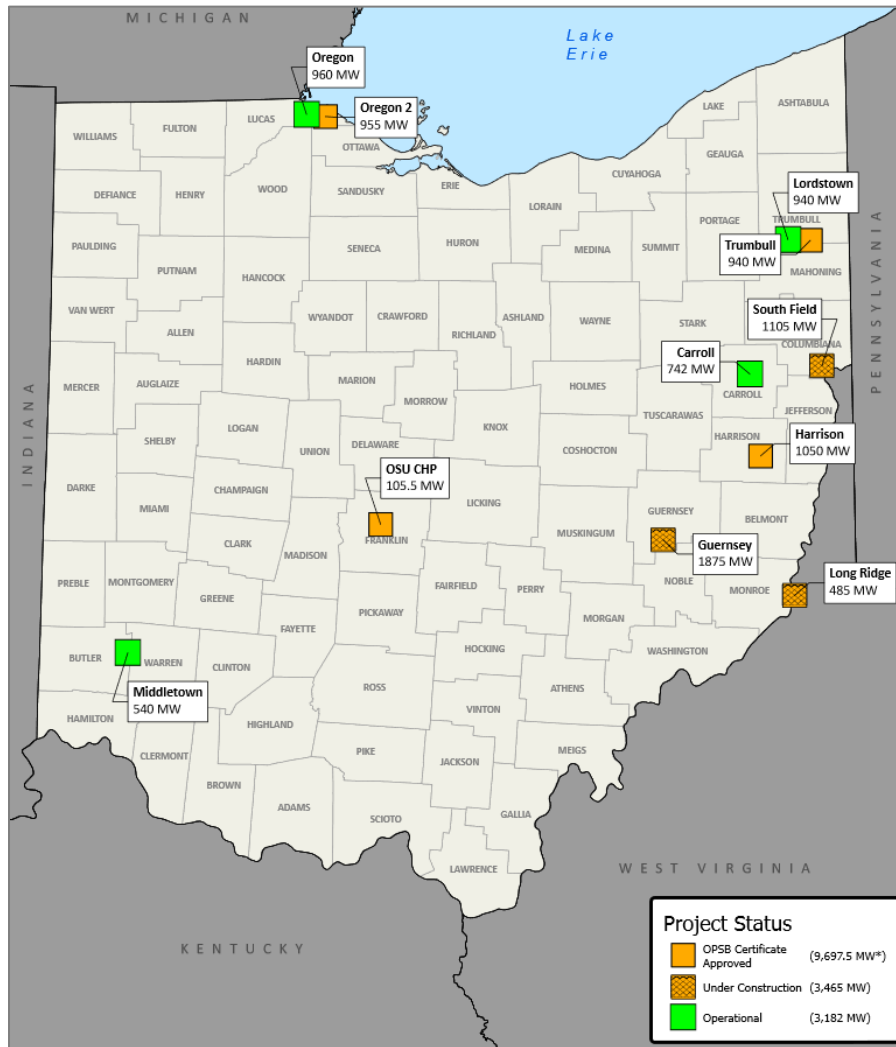
³⁷ See <https://buildingthefuture.osu.edu/news/2020/09/18/news-ohio-state-gains-approval-chp>. See also http://wwwapp.epa.ohio.gov/dapc/permits_issued/1911791.pdf

³⁸ See PUCO Case No. 19-1641-EL-BGN, document record dated 01/06/2021, *Notice of Permits electronically filed by Mr. James F Lang on behalf of The Ohio State University*.

<http://dis.puc.state.oh.us/TiffToPDF/A1001001A21A06A80732F00967.pdf>

³⁹ The Ohio State University. (October 5, 2021). *District heating and cooling loop work to begin* (campus building projects website news section). <https://buildingthefuture.osu.edu/news/2020/10/05/district-heating-and-cooling-loop-work-begin>

Figure 6. Existing and Projected Natural Gas Power Plants



Source: Ohio Power Siting Board (2021)

2. CNG Stations and Other Downstream Investment

In the last Shale Investment report, we noted a CNG refueling station that the Greater Cleveland Regional Transit Authority was planning to install at one of its bus depots.⁴⁰ Trillium – the company tasked with the design and construction of this station – announced the project in June 2020, with completion scheduled for Fall 2020. This investment, along with any other additions to natural gas refueling infrastructure throughout the state, will be included in the next shale report.⁴¹

⁴⁰ See http://www.riderta.com/sites/default/files/events/2019-08-20BoardMinutes_0.pdf.

⁴¹ <https://www.trilliumcng.com/en/news/archive/2020/june/new-trillium-cng-refueling-station-to-power-cleveland-buses>. See also <https://www.trilliumcng.com/en/news/archive/2021/january/trillium-partners-with-metro-regional-transit-authority>

No other significant downstream investments took place in the first half of 2020. However, in December 2020, Petmin USA began construction for its pig iron manufacturing facility in Ashtabula after receiving final Ohio EPA approval in July 2020.⁴² The \$474 million plant, the first one in the U.S. dedicated to the production of high-grade nodular pig iron used in the metal casting industry, will use natural gas as a critical feedstock in reducing iron from its ore.⁴³ The project is scheduled for completion in 2022. Also, while not an investment for inclusion in this report, a recent downstream development worth noting is the \$100 million investment by Nutrien Lima Nitrogen at its ammonia production plant in Lima. The company announced in August 2020 that it would invest \$50 million in routine turnaround maintenance, and \$50 million in upgrades and expansion at its facility.⁴⁴

Cumulative downstream investments reported to date in Ohio, including 2011 through the first half of 2020, are set forth in Table 20 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 notably down in the first half of 2020 compared to the second half of 2019, driven by a period-to-period 15% decrease in total gas-equivalent production and a 48% decrease in new well development. While southerly Belmont County again led all counties in production and the number of new wells drilled during the Study period, more northerly Jefferson and Harrison Counties were the top two in terms of number of permits issued for oil and gas wells during the study period, suggesting that the center of gravity for upstream drilling activities in the Utica may be moving northward.⁴⁵ Altogether, upstream shale investment totaled approximately \$1.8 billion for the first half of 2020.

Midstream investment saw a considerable increase in the first half of 2020, resulting largely from the \$700 million Buckeye XPress pipeline expansion project that was allocated to this period. Another \$85.7 million was spent on gathering system buildout in Ohio. Combined, this \$785.7 million total for the period was the largest midstream investment we have tracked since the second half of 2017.

Downstream investments for the first half of 2020 were also up substantially, consisting almost entirely of the \$1.6 billion for the Guernsey Power Station that was allocated to this 6-month period when major construction began. Investments into CHP plants represented an additional

⁴² https://www.starbeacon.com/news/local_news/construction-on-petmins-ashtabula-facility-begins/article_99313771-8396-52f7-916f-3bc179521a50.html

⁴³ 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_tech_nologies/energiron_book_2014.pdf

⁴⁴ See <https://www.limaohio.com/news/423082/nutrien-plans-100-million-investment>

⁴⁵ See also Hilcorp's recent increased drilling activity in northerly Columbiana County. <https://businessjournaldaily.com/hilcorp-energy-remains-active-in-columbiana-county/>

\$2.4 million. CHP investments are likely to be significantly higher in future reports as large projects, such as the \$278 million CHP plant on the campus of Ohio State, come online.

Altogether, shale-related investment in Ohio for the first half of 2020, including upstream, midstream, and downstream, was around \$4.2 Billion. Cumulative total shale related investment since 2012 is around \$90.6 billion.

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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 June 2020

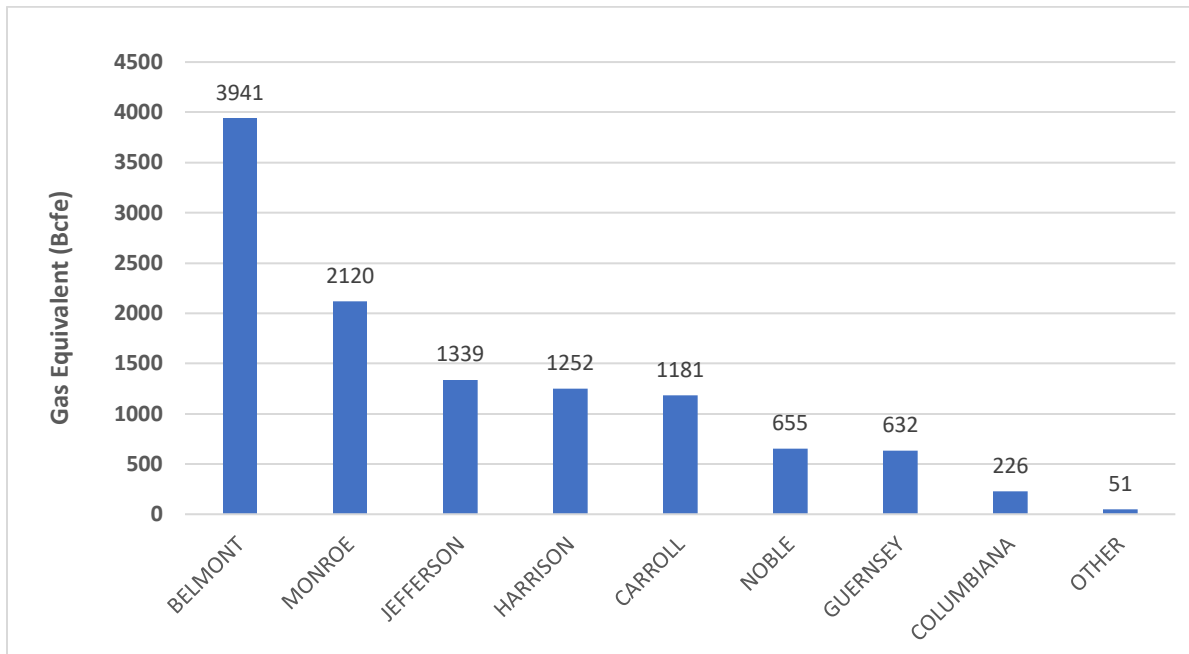


Figure 8: Total Utica Production in Bcfe by Operator through June 2020

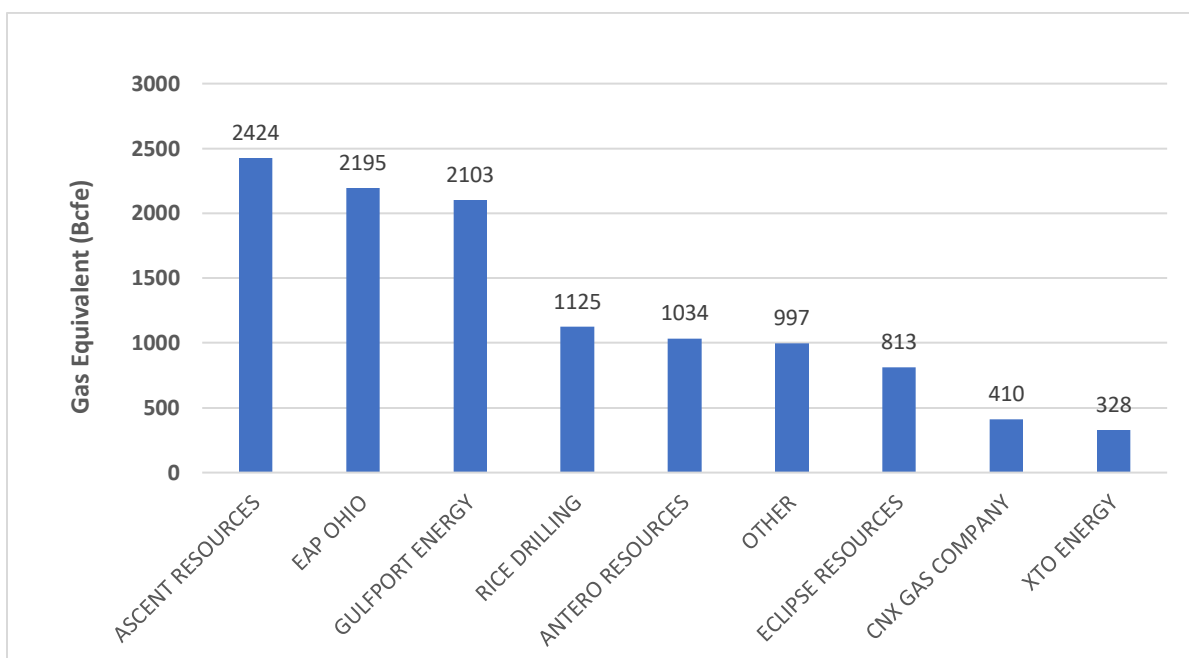
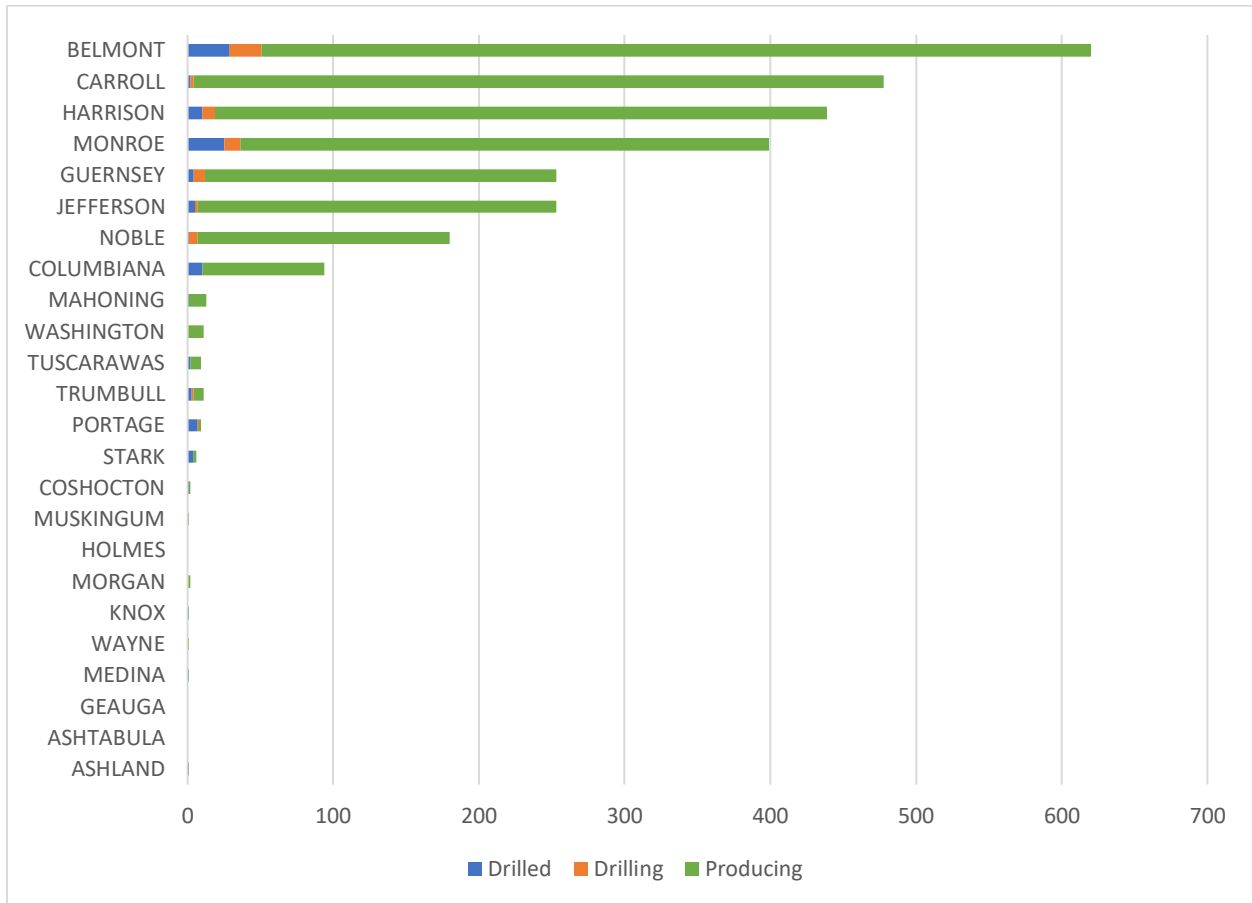


Figure 9: Cumulative Number of Wells by County



Source: Ohio Department of Natural Resources (December 2020)

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

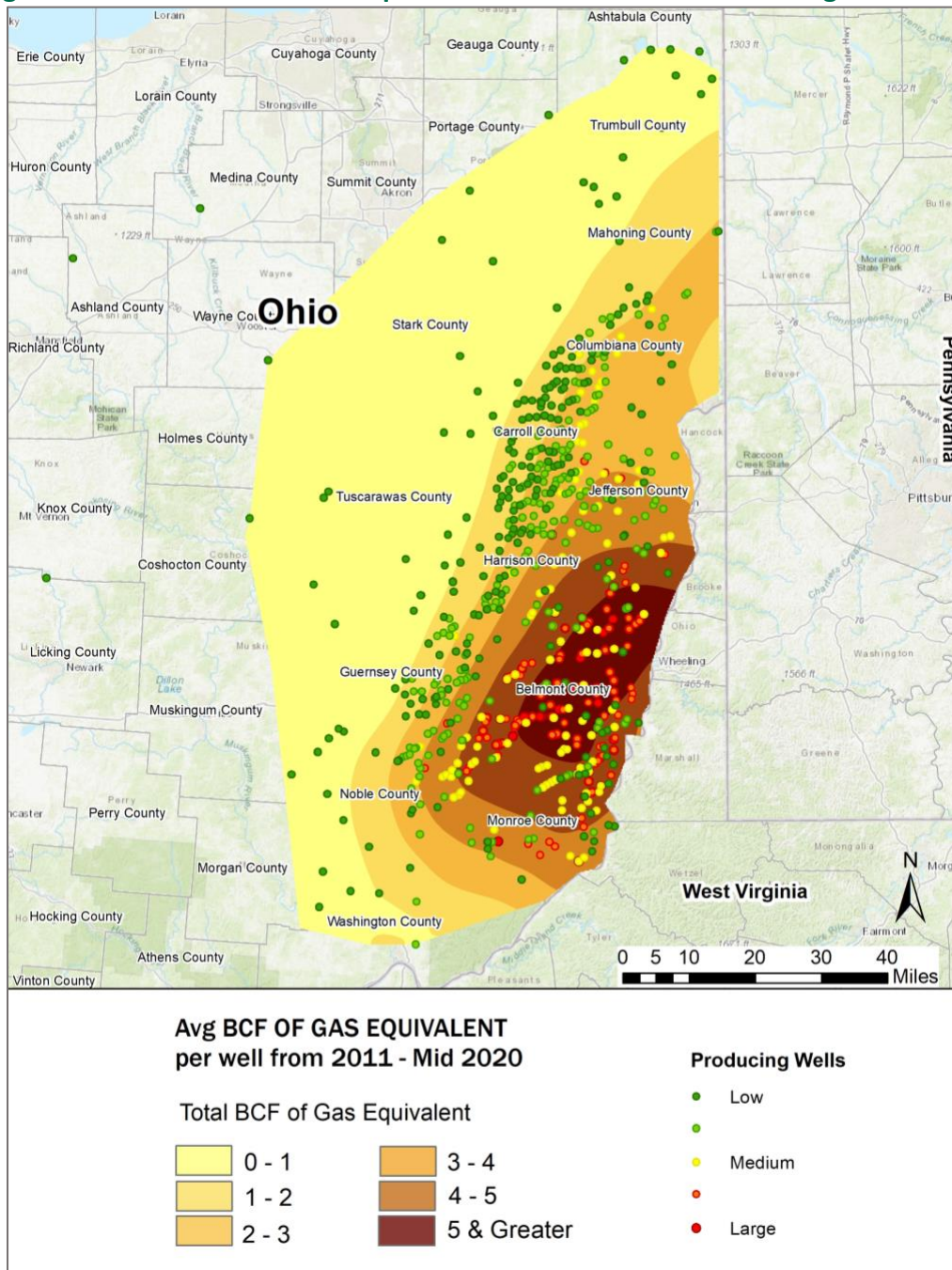
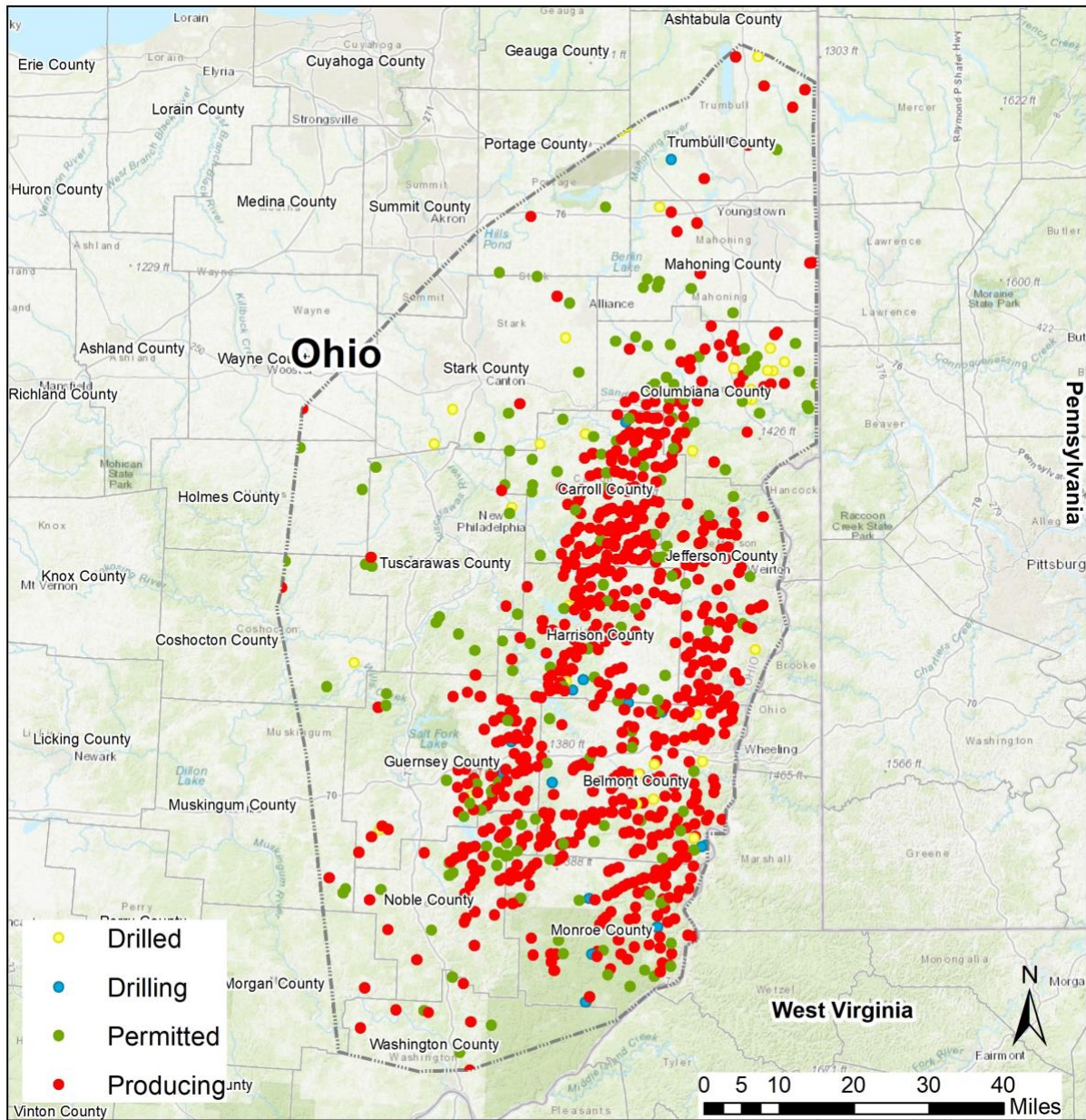


Figure 11: Distribution of Utica Wells by Status as of June 2020



Source: ODNR (2020)

Table 16: Utica Upstream Companies Drilling in Ohio

Operator	Cumulative no. of Wells
AMERICAN ENERGY UTICA LLC	1
ANTERO RESOURCES CORPORATION	234
ARTEX ENERGY GROUP LLC	7
ASCENT RESOURCES UTICA LLC	618
ATLAS NOBLE LLC	12
BP AMERICA PRODUCTION COMPANY	1
BRAMMER ENGINEERING INC	2
CHESAPEAKE EXPLORATION LLC	7
CNX GAS COMPANY LLC	46
DEVON ENERGY PRODUCTION CO LP	3
DIVERSIFIED PRODUCTION LLC	17
EAP OHIO LLC	829
ECLIPSE RESOURCES I LP	168
EQT PRODUCTION COMPANY	2
EQUINOR USA ONSHORE PROPERTIES INC.	39
GEOPETRO LLC	5
GULFPORT APPALACHIA LLC	408
GULFPORT ENERGY CORPORATION	8
HILCORP ENERGY COMPANY	23
NORTHWOOD ENERGY CORP	6
PENNENERGY RESOURCES LLC	40
PIN OAK ENERGY PARTNERS LLC	24
RICE DRILLING D LLC	148
STATOIL USA ONSHORE PROPERTIES INC	3
SUMMIT PETROLEUM INC	6
TRIAD HUNTER LLC	23
UTICA RESOURCE OPERATING LLC	33
XTO ENERGY INC.	59
Grand Total	2,772

Note: Cumulative Number of Wells are calculated based upon the total numbers of Drilled, Drilling, and Producing. Source: ODNR (June 30, 2020).

Table 17: Total Lease Operating Expenses through June 2020
(in millions of dollars)

Year	Period	Production Wells	Lease Operating Expenses for Period (\$mm)
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
		Total	1,914.9

Table 18: Cumulative Utica-Related Upstream Investments in Ohio through June 2020

Estimated Investments	Total Amount
Mineral Rights	\$25,172,273,000
Drilling	\$26,523,000,000
Roads	\$1,083,220,000
Lease Operating Expenses	\$1,914,891,000
Royalties	\$7,169,088,000
Total	\$61,862,472,000

Table 19: Cumulative Utica-Related Midstream Investments in Ohio through June 2020

Estimated Investments	Total Amount
Midstream Gathering	\$7,526,171,000
Processing Plants	\$1,259,300,000
Fractionation Plants	\$1,414,000,000
NGL Storage	\$261,000,000
Rail Loading Terminals	\$145,000,000
Transmission Pipelines	\$10,294,228,000
Total	\$20,899,699,000

Table 20: Cumulative Utica-Related Downstream Investments in Ohio through June 2020

Estimated Investments	Total Amount
Petrochemical Plants and Refineries	\$552,225,000
Other Industrial Plants	\$700,000,000
Natural Gas Refueling Stations	\$46,025,000
Natural Gas Power Plants	\$6,442,500,000
Combined Heat and Power (CHP) Plants	\$87,470,000
Total	\$7,828,220,000

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: Northern Counties - \$11.4 mm/well; Southern Counties - \$12.9 mm/well.⁴⁶
 - Equivalent true vertical depth (TVD) for wells in all counties.
 - Average drilling and completion costs of \$900 per lateral foot.⁴⁷
 - Average lateral length of 12,660 ft. for northern counties and 14,360 ft. for southern counties.⁴⁸
- Roads: average investments - approximately \$60,000 per well based on 2013 data from Carroll County Engineer's Office.⁴⁹

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 January 1, 2020 from the number existent as of June 30, 2020. This information was downloaded from the ODNR Oil and Gas Well database.⁵⁰

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 \$17,500/month, throughout the life of the well. This average expense was developed by the study team based on analysis of Ascent's and Gulfport's

⁴⁶ 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.

⁴⁷ 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>

⁴⁸ Calculated using well completion reports obtained from the ODNR's *Ohio Oil & Gas Well Database*.

⁴⁹ See fn 12, *supra*.

⁵⁰ <http://oilandgas.ohiodnr.gov/well-information/oil-gas-well-database>

lease operating expenses for first half of 2020, divided by the number of wells operated, as reported in their financial statements.⁵¹

For purposes of estimating the lease operating expenses for Q1 and Q2 2020, the Study Team assumed that all wells listed as “producing” by the Ohio Department of Natural Resources on January 1, 2020 were incurring this cost and continued to do so through June 30, 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.⁵²
- The residue energy content was around 1.1 MMBtu/Mcf.⁵³
- Residue gas in the Utica was selling at an average price of \$1.65 /MMBtu for Q1 and \$1.51 /MMBtu for Q2.⁵⁴ 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.⁵⁵
- Natural gas liquids were selling for around 30% of the listed price for Marcellus-Utica light crude oil.⁵⁶

⁵¹ See

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>

⁵² Based on industry interviews, experts citing API 12.3, Manual of Petroleum Measurements and Standards

⁵³ The EIA estimates that the average conversion should be 1.037 MMBtu/Mcf (see: 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.

⁵⁴ https://www.naturalgasintel.com/data/data_products/bidweek?region_id=appalachia&location_id=NEATCO. 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>

⁵⁵ Based on industry data.

⁵⁶ Based on industry interviews.

- Oil in the Utica region was selling for \$41.07 and \$19.65 per barrel, on average, during the first and the second quarter of 2020, respectively.⁵⁷
- 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 least, we assumed that approximately 20% of the undeveloped acreage identified will need to be renewed each year or is otherwise new.⁵⁸ 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.

⁵⁷ 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>

⁵⁸ 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 \$3,612 for the Midwest Region as obtained from the INGAA, as projected for 2019.⁵⁹

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.
 - \$2800 per bbl/d⁶⁰
 - \$100 mm per 36000 bbl/d unit (typical size of plant)
- 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.⁶¹

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

⁵⁹ *Id.*

⁶⁰ The Study Team will revisit the cost assumption for fractionation plants in the next report. INGAA's 2018 report on midstream infrastructure costs describes an average cost for NGL fractionation facilities of about \$6,300 per barrel per day of processed NGLs (see <https://www.ingaa.org/File.aspx?id=34658>). The published costs and throughput capacities of currently planned fractionation facilities in Texas suggests that an associated investment of about \$6,000 per barrel per day capacity is appropriate for these kinds of facilities (see <https://www.marketwatch.com/press-release/oneok-announces-additional-ngl-fractionation-and-pipeline-capacity-and-natural-gas-processing-capacity-2018-09-25>).

⁶¹ 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.

(INGAA).⁶² The estimated cost for natural gas pipelines for the Midwest Region as used in this analysis was \$188,943 per inch-mile, which included labor, raw materials, and permitting costs, as projected by the INGAA for 2019.

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

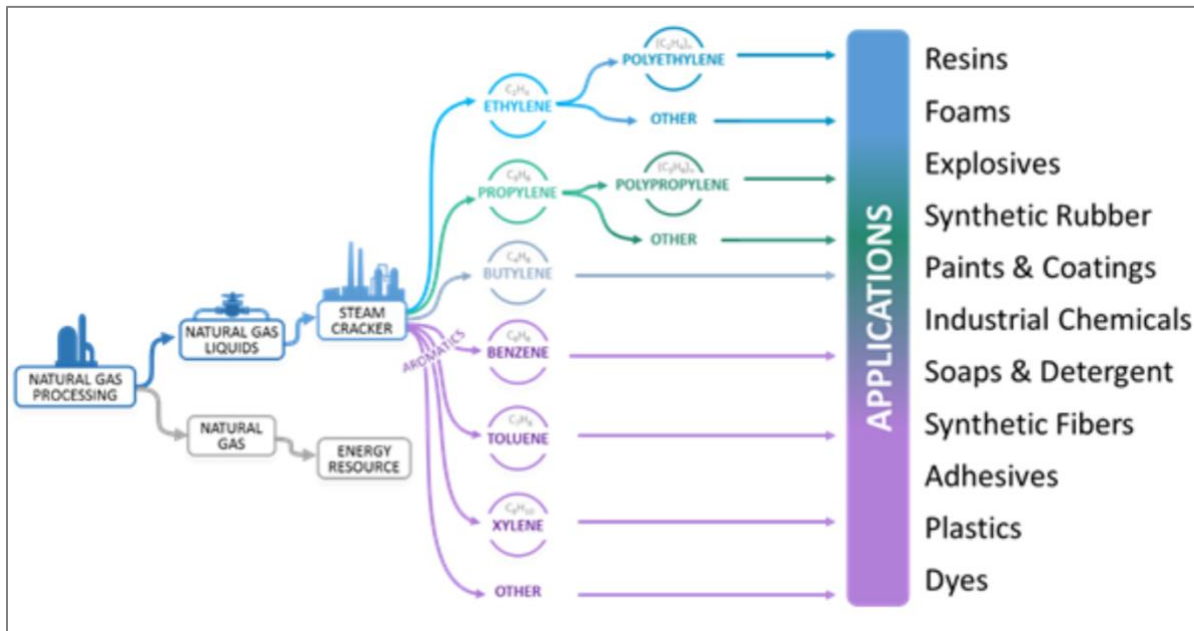
3261 – Plastics Product Manufacturing

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.

⁶² The INGAA Foundation, Inc. (2018). *North America Midstream Infrastructure through 2035*. <https://www.ingaa.org/File.aspx?id=34703>.

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.⁶³

Figure 12. Shale/Natural Gas Value Chain for Petrochemicals



⁶³ See

https://www.energy.gov/sites/prod/files/2020/06/f76/Appalachian%20Energy%20and%20Petrochemical%20Report_063020_v3.pdf