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# Shale Investment Dashboard in Ohio Q1 and Q2 2019

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# SHALE INVESTMENT DASHBOARD IN OHIO Q1 AND Q2 2019

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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 2019. 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 2019 can be summarized as follows:

**Total Estimated Upstream Utica Investment: January – June 2019**

| | |
|---|---|
| Lease Renewals and New Leases | **$344,000,000** |
| Drilling | **$1,810,300,000** |
| Roads | **$8,820,000** |
| Lease Operating Expenses | **$228,060,000** |
| Royalties | **$908,150,000** |
| **Total Estimated Upstream Investment** | **$3,299,330,000** |

**Total Estimated Midstream Investment: January – June 2019**

| | |
|---|---|
| Gathering Lines | **$83,292,000** |
| Interstate Pipelines | **$259,366,000** |
| Gathering System Compression and Dehydration | **$118,032,000** |
| **Total Estimated Midstream Investment** | **$460,690,000** |

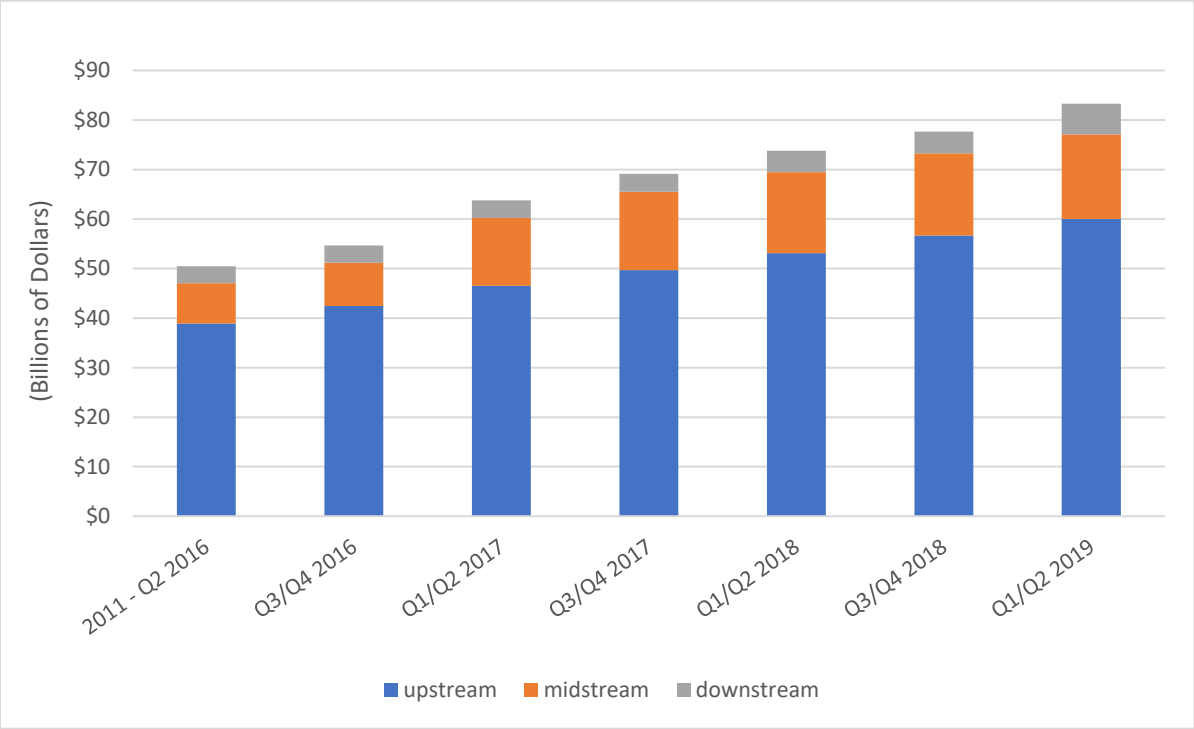
**Total Estimated Downstream Investment: January – June 2019**

| | |
|---|---|
| Natural Gas Power Plants | **$1,800,000,000** |
| Petrochemical Plants | **$800,000** |
| **Total Estimated Downstream Investment** | **$1,800,800,000** |

[1] The six previous reports on shale investment in Ohio up to December 2018 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/

Total investment from January through June 2019 was approximately $5.5 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 2019 is estimated to be around $83.3 billion. Of this, $57.1 billion was in upstream, $20.0 billion in midstream, and $6.2 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 slightly down in the first half of 2019 compared to the second half of 2018, even though drilling investments were up. This is largely explained by lower production volumes and commodity prices during the first half of 2019 compared to the previous 6-month period. As determined from Ohio Department of Natural Resources Division of Oil and Gas (ODNR) data for shale well drilling, 147 new wells were drilled during the first and second quarters of 2019, 30 more than that drilled in the second half of the previous year. Yet ODNR production data indicate that the volume of gas-equivalent shale production in the first half of 2019 was 3.6% lower than in the second half of 2018. While new well development continued to be concentrated more in the southern counties, due especially to drilling in Belmont County which had the highest number of new wells with 51, new well drilling picked up in northern

[2] Numbers may not add up precisely due to rounding.

counties such as Jefferson and Harrison as well which had the second and third highest number of new wells, with 29 and 27, respectively.

Ascent and Gulfport were once again the top producers for Q1 and Q2 of 2019, having produced 385.7 and 195.8 billion cubic feet equivalent (Bcfe), respectively. Rice Drilling was third in production at 170.3 Bcfe, followed by Encino Acquisition Partners at 162.2 Bcfe,[3] Eclipse Resources at 100.8 Bcfe, and Antero Resources at 91.7 Bcfe. These six companies made up around 86.1% of the total production for the first half of 2019.

The first half of 2019 in Ohio saw a near doubling in midstream investment compared to the latter half of 2018, with spending focused on gathering system buildout ($83.3 million), gathering system compression and dehydration ($118.0 million), and interstate pipelines ($259.4 million). The development of new processing facilities and underground storage for natural gas liquids is scheduled to begin in 2020 and will be included in future Shale Dashboards.

Two natural gas power plants broke ground in the first half of 2019, representing 1,667 megawatts of combined capacity and an investment of $1.8 billion. Additional downstream investment during this period included nearly $1 million in residential land purchases related to PTT Global's proposed petrochemical complex in Belmont County, where planning is ongoing, and a final investment decision is expected in mid-2020. Other large downstream projects being tracked for future Shale Dashboards include a 105.5 MW combined heat and power (CHP) facility on the campus of The Ohio State University.

## 1. INTRODUCTION

This is the seventh CSU study reporting investment resulting from oil and gas development in Ohio related to the Utica and Point Pleasant formations (hereinafter, the "Utica"). This analysis looks at investment made in Ohio between January 1 and June 30, 2019, 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

[3] Includes production for wells that Encino was in the process of taking over from Chesapeake Energy during the first half of 2019.

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 seventh 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 2019.[4] 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 147 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, 2019.[5] This represents a 25.6% increase in new well development compared to the second half of 2018. The total number of producing wells in the Utica was 2,223 on June 30, 2019, a 4.9% increase from the end of December 2018. Total production in billion cubic feet equivalent (Bcfe) for this period was 1,285 Bcfe, led by Belmont County with 450 Bcfe. Monroe County was second with 279 Bcfe, followed by Jefferson County with 235 Bcfe.[6]

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 2019 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. Table 1 provides a summary of cumulative production and production for the first and second

[4] *See fn 1, supra*.

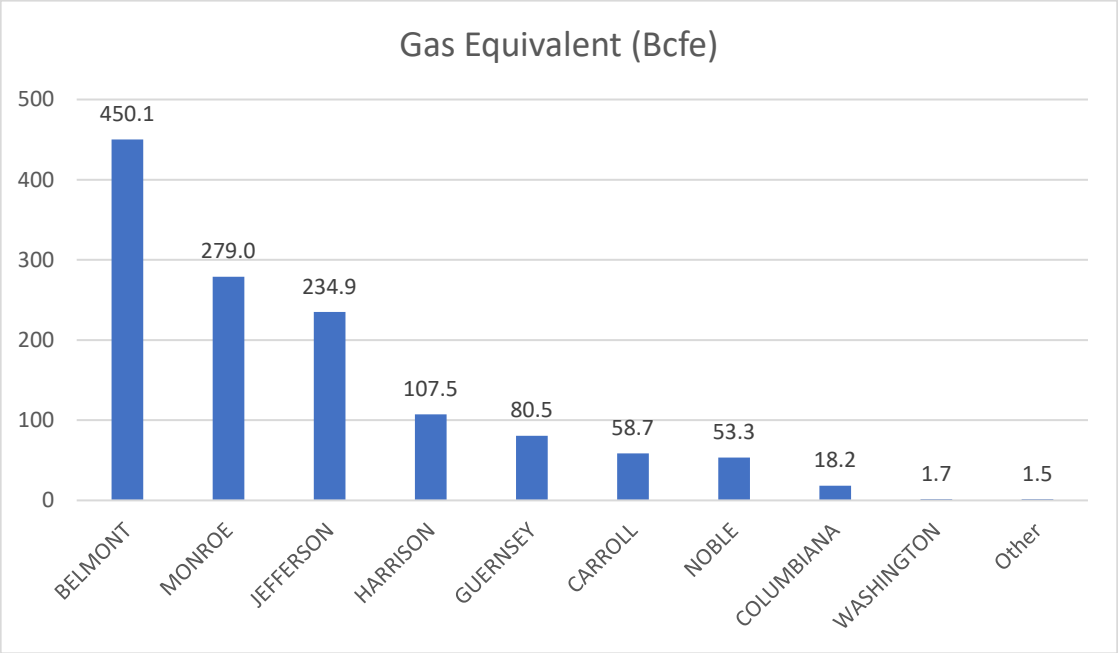
[5] The number of new wells was determined using ODNR Cumulative Permitting Activity reports for the beginning and end of the 6-month period (*see* http://oilandgas.ohiodnr.gov/shale). Wells are assigned an American Petroleum Institute API number, which is included in the ODNR reports. Wells were considered 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.

[6] 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 purpose of this Study, oil and gas production is combined as gas equivalents (Mcfe) based on the energy content of oil and gas, measured as British thermal units (Btu). Gas equivalents were calculated using the following formula: Gas Equivalents (Mcfe) = Oil (bbl) x 5.659 Mcf/bbl + Gas (Mcf).

quarters of 2019. Total cumulative production in billions of cubic feet equivalent (Bcfe) by county and by operator through June 2019 can be found in Appendix A as Figures 6 and 7. New drilling and production have been moving steadily from the north (primarily Carroll County) to the south (primarily Belmont County) since 2014.

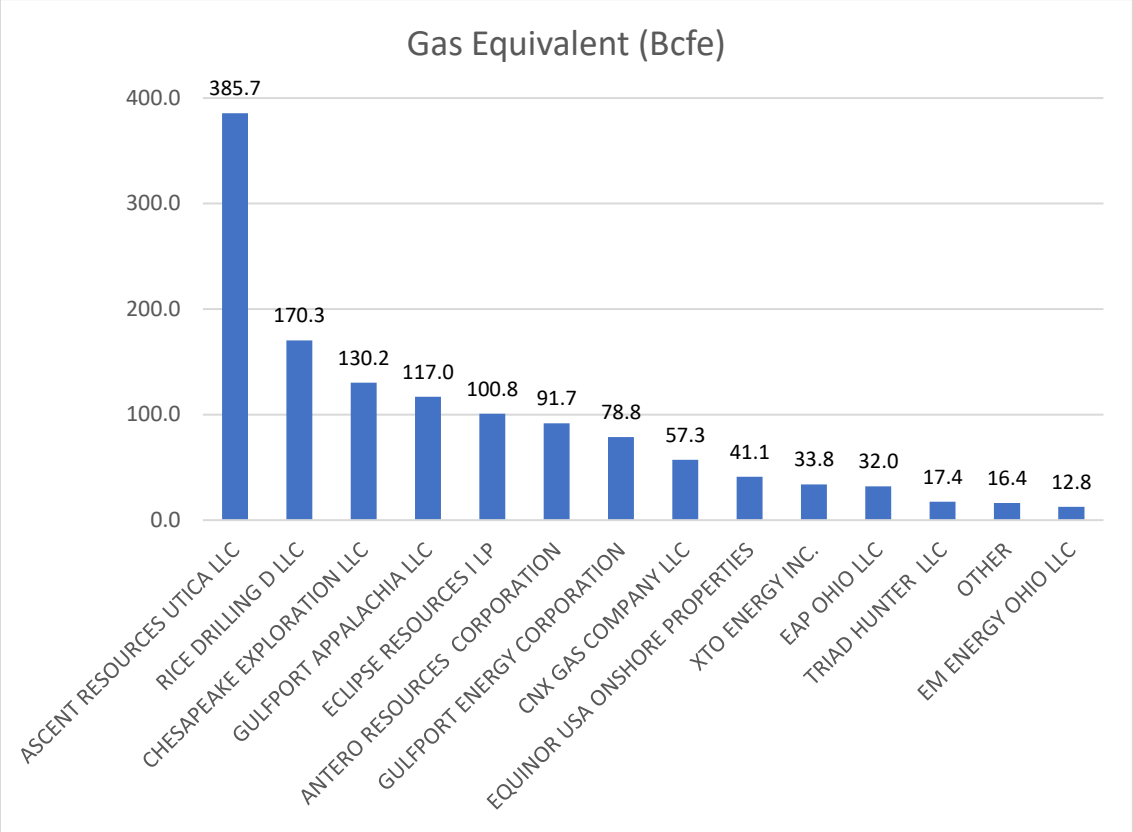
Total production in quarters 1 and 2 for 2019 is set forth by county and operator in Figures 2 and 3 below.

**Figure 2: Production by County for Q1 and Q2 of 2019**




Source: ODNR (2020).

**Figure 3: Production by Operator for Q1 and Q2 2019[7]**




Source: ODNR (2020).

## 2. Production Analysis.

Production can be summarized through the use of tables that show gas equivalent production measured in billions of cubic feet equivalent as a function of time. This summary is set forth in Table 1. Despite a slowed drilling rate, production has increased in all but two quarters since 2013. Table 2 sets forth production by county for the first half of 2019. Figure 4 sets forth the geographic distribution of production for the same period.

[7] While EAP's deal to purchase Chesapeake's Ohio Utica assets was completed in 2018, the legal and operational transition of these assets to EAP did not commence until the first quarter of 2019 and was not complete as of the second quarter. *See* https://www.shaledirectories.com/blog/encino-says-theyll-do-it-better-in-the-utica-than-chesapeake-did/. *See also* ODNR Current Well Production, 2nd Quarter 2019.

## Table 1: Shale Production by Reporting Period

| Year | Quarter | Production Wells | Gas (Mcfe) | Oil (bbl) | Gas Equivalents (Mcfe) | Gas Equivalent Production (% Change from Previous Quarter) |
|---|---|---|---|---|---|---|
| 2019 | 2 | 2317 | 614,218,362 | 5,813,755 | 647,118,402 | 1.4 |
| 2019 | 1 | 2228 | 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** | **6,951,302,486** | **89,841,830** | **7,459,858,256** | |

Source: ODNR (2019).

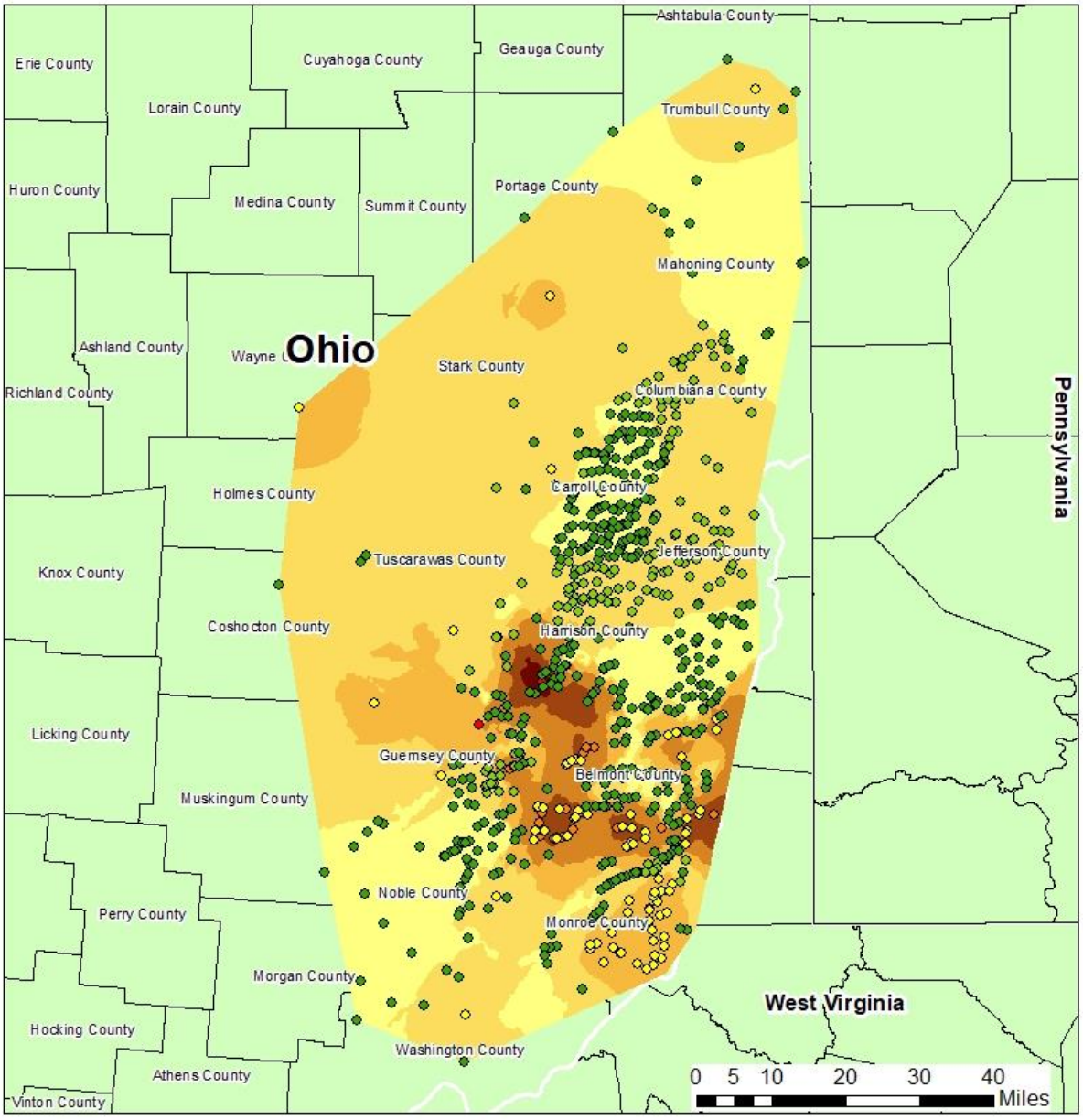
## Table 2: Production by County for January - June 2019

| County | Gas (Mcfe) | Oil (bbl) | Gas Equivalents (Mcfe) | Producing Wells[8] |
|---|---|---|---|---|
| BELMONT | 450,036,768 | 11,623 | 450,102,543 | 468 |
| CARROLL | 51,143,745 | 1,334,411 | 58,695,177 | 470 |
| COLUMBIANA | 18,040,533 | 19,367 | 18,150,131 | 73 |
| COSHOCTON | 16,734 | 166 | 17,673 | 1 |
| GUERNSEY | 44,236,202 | 6,407,614 | 80,496,890 | 209 |
| HARRISON | 93,331,434 | 2,494,966 | 107,450,447 | 355 |
| JEFFERSON | 234,855,674 | 10 | 234,855,731 | 164 |
| MAHONING | 672,438 | 4,781 | 699,494 | 12 |
| MONROE | 278,540,423 | 81,203 | 278,999,951 | 322 |
| MORGAN | 92,909 | 4,249 | 116,954 | 2 |
| MUSKINGUM | 18,013 | 543 | 21,086 | 1 |
| NOBLE | 50,569,077 | 490,082 | 53,342,451 | 168 |
| PORTAGE | 19,477 | 171 | 20,445 | 1 |
| STARK | 56,144 | 1,323 | 63,631 | 2 |
| TRUMBULL | 231,222 | 2,365 | 244,606 | 7 |
| TUSCARAWAS | 194,360 | 16,284 | 286,511 | 7 |
| WASHINGTON | 1,604,122 | 18,133 | 1,706,737 | 11 |
| WAYNE | 11,478 | 0 | 11,478 | 1 |
| **Total** | **1,223,670,753** | **10,887,291** | **1,285,281,933** | **2,273** |

Source: ODNR (2019)

[8] Represents the average number of production wells for the first and second quarters of 2019.

## Figure 4: Distribution of Gas Equivalent Production for January – June 2019



Of the 2,636 total wells identified from the ODNR records for cumulative drilling activity as of June 2019, 173 were in the process of drilling, 240 wells had been drilled and were awaiting markets, and 2,223[9] were in the production phase. *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 2019

| Well Status | No. of Wells |
|---|---|
| Drilled | 240 |
| Drilling | 173 |
| Producing | 2,223 |
| **Total** | **2,636** |

Source: Ohio Department of Natural Resources (2019)

### Table 4: Well Status by County (June 2019)

| County | Drilled | Drilling | Producing | Total |
|---|---|---|---|---|
| ASHLAND | 1 | 0 | 0 | 1 |
| BELMONT | 64 | 48 | 456 | 568 |
| CARROLL | 7 | 1 | 468 | 476 |
| COLUMBIANA | 14 | 0 | 74 | 88 |
| COSHOCTON | 1 | 0 | 1 | 2 |
| GUERNSEY | 13 | 26 | 200 | 239 |
| HARRISON | 26 | 25 | 356 | 407 |
| JEFFERSON | 23 | 33 | 155 | 211 |
| KNOX | 1 | 0 | 0 | 1 |
| MAHONING | 1 | 0 | 13 | 14 |
| MEDINA | 1 | 0 | 0 | 1 |
| MONROE | 65 | 28 | 302 | 395 |
| MORGAN | 1 | 0 | 2 | 3 |
| MUSKINGUM | 0 | 0 | 1 | 1 |
| NOBLE | 4 | 10 | 166 | 180 |
| PORTAGE | 7 | 1 | 1 | 9 |
| STARK | 5 | 0 | 2 | 7 |
| TRUMBULL | 3 | 1 | 7 | 11 |
| TUSCARAWAS | 2 | 0 | 7 | 9 |
| WASHINGTON | 1 | 0 | 11 | 12 |
| WAYNE | 0 | 0 | 1 | 1 |
| **Total** | **240** | **173** | **2,223** | **2,636** |

Source: ODNR (2020)

[9] 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) after reviewing recent drilling surveys that indicated an extra 1,700 of lateral length on average for wells drilled in southern counties.

This section covers upstream investments between January and June of 2019. Cumulative upstream investments to date in Ohio, including 2011-2018, are set forth in Table 19 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 51 new wells and an investment of around $661.0 million between January and June of 2019. Jefferson and Harrison Counties were second and third, with 29 and 27 new wells, respectively, to go along with $332.3 and $310.4 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[10] describing Road Use Maintenance Agreements (RUMAs) that companies have entered into with local governments for infrastructure improvements since Utica production began in 2011. 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.[11]

Ascent Utica Resources LLC, nearly half of whose new wells were in the lower cost, more northerly counties, was the leading operator investor during the six-month period, with 69 new wells and an estimated $844.7 million invested, followed by Gulfport and EAP Ohio, both with 15 new wells and an estimated $192.4 million and $171.9 million invested, respectively.[12] Rice Drilling drilled 11 wells for an estimated investment of $142.6 million, followed by Eclipse Resources who drilled 8 wells for an estimated investment of $103.2 million. *See* Table 6.

[10] *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

[11] The previously used method for determining road investments was a rule-of-thumb estimate based on an analysis by this study team of lease operating expenses for Gulfport Energy, as obtained from company financial reports.

[12] The difference in the amount invested for the same number of wells is due to EAP Ohio having drilled a larger share of its wells in the less costly northern counties.

### Table 5: Estimated Upstream Shale Investment by County, January-June 2019

| County | No. of New Wells | Drilling ($) | Roads ($) | Total Amount ($) |
|---|---|---|---|---|
| BELMONT | 51 | $657,900,000 | $3,060,000 | $660,960,000 |
| COLUMBIANA | 2 | $22,800,000 | $120,000 | $22,920,000 |
| GUERNSEY | 19 | $245,100,000 | $1,140,000 | $246,240,000 |
| HARRISON | 27 | $308,800,000 | $1,620,000 | $310,420,000 |
| JEFFERSON | 29 | $330,600,000 | $1,740,000 | $332,340,000 |
| MONROE | 18 | $232,200,000 | $1,080,000 | $233,280,000 |
| NOBLE | 1 | $12,900,000 | $60,000 | $12,960,000 |
| **Total** | **147** | **$1,810,300,000** | **$8,820,000** | **$1,819,120,000**[13] |

Source: The Authors (2020)

### Table 6: Estimated Upstream Shale Investment in Ohio by Company, January-June 2019

| Operators | No. of Wells | Drilling | Roads | Total Amount ($) |
|---|---|---|---|---|
| ASCENT RESOURCES UTICA LLC | 69 | $840,600,000 | $4,140,000 | $844,740,000 |
| CHESAPEAKE EXPLORATION LLC | 4 | $45,600,000 | $240,000 | $45,840,000 |
| CNX GAS COMPANY LLC | 2 | $25,800,000 | $120,000 | $25,920,000 |
| EAP OHIO LLC | 15 | $171,000,000 | $900,000 | $171,900,000 |
| ECLIPSE RESOURCES I LP | 8 | $103,200,000 | $480,000 | $103,680,000 |
| EM ENERGY OHIO LLC | 1 | $12,900,000 | $60,000 | $12,960,000 |
| EQUINOR USA ONSHORE PROPERTIES INC. | 6 | $77,400,000 | $360,000 | $77,760,000 |
| GULFPORT APPALACHIA LLC | 15 | $191,500,000 | $900,000 | $192,400,000 |
| GULFPORT ENERGY CORPORATION | 2 | $22,800,000 | $120,000 | $22,920,000 |
| HILCORP ENERGY COMPANY | 2 | $22,800,000 | $120,000 | $22,920,000 |
| RICE DRILLING D LLC | 11 | $141,900,000 | $660,000 | $142,560,000 |
| TRIAD HUNTER LLC | 5 | $64,500,000 | $300,000 | $64,800,000 |
| UTICA RESOURCE OPERATING LLC | 1 | $12,900,000 | $60,000 | $12,960,000 |
| XTO ENERGY INC. | 6 | $77,400,000 | $360,000 | $77,760,000 |
| **Total** | **147** | **$1,810,300,000** | **$8,820,000** | **$1,819,120,000**[14] |

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.[15] These investments are set forth below. Consistent with total number of production wells, Carroll

[13] Excludes royalties, bonuses for undeveloped acreage and lease operating expenses.

[14] *Id.*

[15] 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.

County and Belmont County lead the lease operating expense investment, with an estimated $49.1 and $46.8 million invested, respectively.

**Table 7: Estimated Lease Operating Expenses for January – June 2019 by County**

| County | No. of Production Wells[16] | Lease Operating Expenses for Period |
|---|---|---|
| BELMONT | 446 | $46,830,000 |
| CARROLL | 468 | $49,140,000 |
| COLUMBIANA | 73 | $7,665,000 |
| COSHOCTON | 1 | $105,000 |
| GUERNSEY | 193 | $20,265,000 |
| HARRISON | 352 | $36,960,000 |
| JEFFERSON | 141 | $14,805,000 |
| MAHONING | 13 | $1,365,000 |
| MONROE | 290 | $30,450,000 |
| MORGAN | 2 | $210,000 |
| MUSKINGUM | 1 | $105,000 |
| NOBLE | 164 | $17,220,000 |
| PORTAGE | 1 | $105,000 |
| STARK | 2 | $210,000 |
| TRUMBULL | 7 | $735,000 |
| TUSCARAWAS | 7 | $735,000 |
| WASHINGTON | 11 | $1,155,000 |
| WAYNE | 1 | $105,000 |
| | **Total** | **$228,060,000** |

[16] The number of wells producing was determined by taking the average of the number of such wells as identified by ODNR on January 1, 2019 and June 30, 2019. It is assumed that this number of average production wells incurred lease operating expenses for all six months.

### Table 8: Estimated Lease Operating Expenses for January – June 2019 by Operator

| Operator | No. of Production Wells | Lease Operating Expenses for Period |
|---|---|---|
| ANTERO RESOURCES CORPORATION | 218 | $22,890,000 |
| ARTEX OIL COMPANY | 6 | $630,000 |
| ASCENT RESOURCES UTICA LLC | 399 | $41,895,000 |
| ATLAS NOBLE LLC | 12 | $1,260,000 |
| CHESAPEAKE EXPLORATION LLC | 352 | $36,960,000 |
| CHEVRON APPALACHIA LLC | 8 | $840,000 |
| CNX GAS COMPANY LLC | 38 | $3,990,000 |
| EAP OHIO LLC | 380 | $39,900,000 |
| ECLIPSE RESOURCES I LP | 129 | $13,545,000 |
| EM ENERGY OHIO LLC | 11 | $1,155,000 |
| ENERVEST OPERATING LLC | 5 | $525,000 |
| EQUINOR USA ONSHORE PROPERTIES INC. | 22 | $2,310,000 |
| GEOPETRO LLC | 2 | $210,000 |
| GULFPORT APPALACHIA LLC | 169 | $17,745,000 |
| GULFPORT ENERGY CORPORATION | 152 | $15,960,000 |
| HILCORP ENERGY COMPANY | 15 | $1,575,000 |
| M & R INVESTMENTS OHIO LLC | 1 | $105,000 |
| NORTHWOOD ENERGY CORP | 6 | $630,000 |
| PENNENERGY RESOURCES LLC | 40 | $4,200,000 |
| PIN OAK ENERGY PARTNERS LLC | 12 | $1,260,000 |
| PROTEGE ENERGY III LLC | 1 | $105,000 |
| RICE DRILLING D LLC | 108 | $11,340,000 |
| TRIAD HUNTER LLC | 13 | $1,365,000 |
| UTICA RESOURCE OPERATING LLC | 28 | $2,940,000 |
| XTO ENERGY INC. | 49 | $5,145,000 |
| | **Total** | **$228,060,000** |

## 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 2019 were around $908 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

$2.65/MMBtu during the first half of 2019, down from $3.19 in the second half of 2018.[17] Regional oil prices increased from $47.27/bbl for the first quarter of 2019 to $53.85/bbl for the second quarter, on average.

**Table 9: Total Royalties from Oil**
**January – June 2019 (in millions of dollars)**

| Year | Quarter | Oil Price[18] $/bbl | Oil Royalty (20%) $/bbl | Royalty ($mm) |
|---|---|---|---|---|
| 2019 | 2 | $53.85 | $10.77 | $62.61 |
| 2019 | 1 | $47.27 | $9.45 | $47.97 |
| | | | **Subtotal** | **$110.58** |

**Table 10: Total Royalties from Residue Gas**
**January – June 2019 (in millions of dollars)**

| Year | Quarter | Residue Gas Price[19] $/Mcf | Residue Gas Royalty (20%) $/Mcf | Royalty ($mm) |
|---|---|---|---|---|
| 2019 | 2 | $2.51 | $0.502 | $271.17 |
| 2019 | 1 | $3.32 | $0.664 | $356.01 |
| | | | **Subtotal** | **$627.18** |

**Table 11: Total Royalties from Natural Gas Liquids**
**January – June 2019 (in millions of dollars)**

| Year | Quarter | NGL Price $/bbl | NGL Royalty (20%) $/bbl | Royalty ($mm) |
|---|---|---|---|---|
| 2019 | 2 | $16.16 | $3.23 | $94.33 |
| 2019 | 1 | $14.18 | $2.84 | $76.06 |
| | | | **Subtotal** | **$170.39** |

## 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 eight drilling companies in the region. These eight companies have together drilled over 80% of the Utica wells to date, and it is assumed that they likewise control over 80% of the leases. The estimated investments into undeveloped acreage is set forth below in Table 12.

There are several potential sources of error in this estimate. All estimates assume $5000/acre lease bonus for new leases and for five-year renewals, which may not accurately reflect actual lease bonus rates. Additional factors that may make the estimate inaccurate include the

[17] 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.
[18] http://ergon.com/prices
[19] Based on conversion factor of 1.1 MMBtu/Mcf.10-K

following: (1) only net undeveloped lease acreage was used to avoid possible double counting (producing companies often collaborate on development), although bonuses would have been paid on the gross lease acreage; and (2) the assumption that new or renewed leases make up 20% of undeveloped acreage during the six month period may be too high or too low. The 20% assumption is based upon the notion that leases typically contain 5-year primary terms, and as a result around 20% of leases require bonus payments each year to maintain the acreage.

**Table 12: Total Est. Investments into Undeveloped Acreage (New & Renewed Leases) January - June 2019 (in millions of dollars)**

| Operator | Undeveloped Acreage | Estimated Bonus Investment ($mm) |
|---|---|---|
| ANTERO RESOURCES CORPORATION | 50,014 | 25.0 |
| ASCENT RESOURCES UTICA HOLDINGS, LLC | 241,524 | 120.8 |
| EAP OHIO LLC | 186,484[20] | 93.2 |
| ECLIPSE RESOURCES I LP (Montage Resources) | 59,133[21] | 29.6 |
| GULFPORT ENERGY CORPORATION | 119,428 | 59.7 |
| Rice Drilling D LLC (EQT) | 332,454 | 16.2 |
| **Total** | **689,037** | **344.5** |

[20] Undeveloped acreage for EAP Ohio, a privately held company, was determined by revising the net Ohio Utica acres that Encino Energy Partners purchased from Chesapeake Energy in 2018 based upon the average ratio of net undeveloped-to-total acreage in Ohio for the other operators listed in Table 12, all publicly traded, as gleaned from their FY 2019 10-K reports. *See* https://www.reuters.com/article/us-chesapeake-enrgy-divestiture/chesapeake-energy-plans-to-sell-utica-shale-stake-for-2-billion-idUSKBN1KG2YS.

[21] The FY 2019 10-K for Eclipse's parent company, Montage Resources, had not been released as of this writing. However, quarterly 10-Qs for FY 2019 described 240,600 net acres in Ohio as of June 30, 2019. The same proportion of undeveloped-to-developed acres for FY 2018 was used to estimate the unknown number of undeveloped net acres for the first half of 2019, given the known number of total net acres for this period.

## C. ESTIMATED MIDSTREAM INVESTMENTS

Midstream investment includes transmission and gathering pipelines, additional investments in storage facilities, and investments in compressor stations, which included compressor engines, dehydration units, and generators installed as part of these stations. Rail and transloading facilities for storing and handling natural liquids are also included.

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 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 2019. Table 13 sets forth gathering and transmission line investments while Table 14 sets forth all other midstream investments, including that for compression.[22]

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.

[22] For project mileage and compressor station deployment within Ohio, *see* https://www.ferc.gov/CalendarFiles. For compressor station horsepower ratings, *see* http://epawwwextp01.epa.ohio.gov:8080/ords/epaxp/f?p=999:10:0:

## Table 13: Midstream Transmission and Gathering Line Investment January – June 2019

| Company | Additions to Infrastructure | Total Amount ($mm) |
|---|---|---|
| Blue Racer Midstream | • 1.14 miles of 4.5" pipeline<br>• 1.20 miles of 8.6" pipeline<br>• 0.52 miles of 10.8" pipeline<br>• 5.21 miles of 16" pipeline | 19.74 |
| Cardinal Gas Services (Williams) | • 5.44 miles of 8.6" pipeline<br>• 2.80miles of 12.8" pipeline | 15.61 |
| Energy Transfer | • 15.87 miles of 16" pipeline for Mariner East 2 Expansion[23] (ME2X) | 47.98 |
| MarkWest (MPLX) | • 0.66 miles of 12" pipeline<br>• 11.67 miles of 20" pipeline | 45.60 |
| RH energytrans | • 12 miles of 12" pipeline for Risberg Pipeline project[24] | 27.21 |
| Falcon Pipeline (Shell Chemical) | • 13 miles of 10" pipeline and 30.4 miles of 12" pipeline for the Falcon Ethane Pipeline project.[25] | 93.49 |
| Utica Gas Services (Williams) | • 0.97 miles of 12.8" pipeline | 2.34 |
| Williams Ohio Valley Midstream | • 40.0 miles of 12" pipeline for Harrison Hub Pipeline project connecting fractionation facilities in Harrison County, OH and Moundsville, WV.[26] | 90.69 |
| | **Total** | **342.66** |

Source for Pipeline Length and Diameter (unless otherwise footnoted): PUCO Gathering Construction Reports (2020)

[23] *See following:* https://www.npms.phmsa.dot.gov; https://www.eia.gov/petroleum/xls/EIA_LiqPipProject.xlsx; https://articles2.marketrealist.com/2019/02/whats-ahead-for-energy-transfers-mariner-east-2-project/#; http://wwwapp.epa.ohio.gov/dsw/permits/Construction.pdf; https://www.alleghenyfront.org/mariner-east-2-pipeline-is-up-and-running-sunoco-says/

[24] *See* https://rhenergytrans.com/learn-more/. See *also* https://www.eia.gov/naturalgas/pipelines/EIA-NaturalGasPipelineProjects.xlsx

[25] http://web.epa.state.oh.us/dsw/401Applications/196337D/196337D%20DA%20Falcon%20Ethane%20Pipeline.pdf

[26] *See* http://edocpub.epa.ohio.gov/publicportal/ViewDocument.aspx?docid=934280. Also, https://s24.q4cdn.com/611644275/files/doc_presentations/2019/2019_European_Investor_Meetings-_FINAL.pdf. *See also* https://s24.q4cdn.com/611644275/files/doc_presentations/2019/2019_European_Investor_Meetings-_FINAL.pdf

**Table 14: Additional Midstream Investment, January through June 2019**

| Company | Additions to Infrastructure | Estimated Investment ($mm) |
|---|---|---|
| Dominion | • New Lyme Compressor Station, Ashtabula County<br>• 690 hp of compression<br>• 90 MMscfd of dehydration | 4.76 |
| EQM | • Big Kahuna Compressor Station, Belmont County<br>• 15,000 hp of compression<br>• 400 MMscfd of dehydration | 60.98 |
| Equitrans Midstream | • Cobra Compressor Station, Belmont County<br>• 7,500 hp of compression | 27.09 |
| MarkWest (MPLX) | • 1,380 MMscfd of dehydration in Jefferson and Belmont Counties<br>• Cameron, Friendship, Holmes, and Morelli Stations | 25.20 |
| | **Total** | **118.03** |

Source: Ohio EPA (2020)

Adding the amounts in the above tables yields a total midstream investment for the first half of 2019 of $460.7 million, a near twofold increase compared to the amount identified for the second half of 2018.

Forthcoming midstream projects that will be tracked for future Shale reports include the Appalachia to Texas Express (ATEX) liquid pipeline expansion and TransCanada's Buckeye Xpress expansion.[27] The ATEX project, slated to be placed in-service by 2022, will increase the capacity of the 1,200-mile pipeline that transports ethane from the Marcellus/Utica Basin to liquid storage facilities in Texas by 30%, from 145,000 barrels per day to 190,000.[28] The $709 million Buckeye Xpress expansion project to replace 60.8 miles of 20- and 24-inch-diameter pipeline with about 66.1 miles of new 36-inch-diameter pipeline in Ohio and West Virginia received FERC approval in January 2020 and is expected to be placed in-service for late 2020.[29]

MPLX is still planning to move forward with adding 80,000 barrels per day of C3+ fractionation capacity at the Hopedale NGL fractionation complex.[30] The company, through its subsidiary MarkWest, began receiving final permits-to-install from the Ohio EPA for this fifth fractionation plant at the Jewett, Ohio complex in the second half of 2019 and expects project completion in the second quarter of 2020.[31] According to the methodology we have used for estimating

[27] *See* https://www.eia.gov/petroleum/xls/EIA_LiqPipProject.xlsx. *See also* https://www.eia.gov/naturalgas/pipelines/EIA-NaturalGasPipelineProjects.xlsx
[28] https://pgjonline.com/news/2019/10-oct/enterprise-to-expand-atex-pipeline-after-successful-open-season
[29] *See* https://www.spglobal.com/platts/en/market-insights/latest-news/natural-gas/012420-ferc-approves-columbias-275-mmcfd-buckeye-xpress-pipeline-expansion. *See also* https://www.tcenergy.com/operations/natural-gas/buckeye-xpress-project/.
[30] http://www.mplx.com/content/documents/mplx/investor_center/2020/MPLX_4Q19_Conf_Call_Slides_vFinal.pdf
[31] *Id. See also* Ohio EPA Public Notices (https://ebiz.epa.ohio.gov/Notices/jsp/notice_search.jsp).

midstream investments, this would represent a $224 million investment. However, the published costs for recent fractionation projects in other parts of the country suggest that our rule-of-thumb for estimating investments for these kinds of projects may be low.[32] We will therefore revisit this portion of the midstream methodology in the next Shale report.

NGL storage plays a critical role in balancing seasonal supply and demand variations and reducing the operational risks for end users such as petrochemical plants that need a steady and reliable stream of feedstock.[33] There are currently two projects with a combined underground storage capacity for NGLs in the Utica of around 8 million barrels that are continuing to move forward, the investment for which will be included in future Shale reports. These include the Mountaineer NGL storage project in Monroe County, where construction is expected to begin during the first quarter of 2020, and MPLX's Hopedale NGL Caverns, which are projected to begin operations in 2021.[34]

Cumulative midstream investments through the middle of 2019 are set forth in Table 20 in Appendix A.

[32] *See* https://www.ingaa.org/File.aspx?id=34658. S*ee also* https://www.marketwatch.com/press-release/oneok-announces-additional-ngl-fractionation-and-pipeline-capacity-and-natural-gas-processing-capacity-2018-09-25.
[33] https://www.energy.gov/sites/prod/files/2018/12/f58/Nov%202018%20DOE%20Ethane%20Hub%20Report.pdf
[34] *See* https://marcellusdrilling.com/2019/08/mountaineer-ngl-storage-says-construction-begins-in-oh-1q20/. *See also*
http://www.mplx.com/content/documents/mplx/investor_center/2019/RBN_Energy_Export_Conference_5_21_19__Final.pdf

## D. Downstream Development

### 1. Natural Gas Power Plants

The nation has continued to see growth in natural gas-fired electricity generation. Within the PJM regional transmission territory that includes Ohio, the U.S. Energy Information Administration (EIA) forecasts that natural gas will fuel 39% of electricity generation in the PJM region in 2020, up from a share of 31% in 2018.[35] Over the past six 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. Two of these plants entered the construction phase in the first half of 2019. Investments for these gas-fired generation facilities are set forth in Table 15.

**Table 15. Natural Gas Power Plant Investments in Ohio, January - June 2019**

| Name | Owner | Location | County | Capacity (MW) | Investment ($mm) |
|---|---|---|---|---|---|
| Long Ridge Energy Center | Fortress Transportation and Infrastructure Investors Ltd | Hannibal, OH | Monroe | 485 | 500[36] |
| South Field Energy | Advanced Power | Wellsville, OH | Columbiana | 1,182 | 1,300[37] |
| | | | **Total** | **1,667** | **1,800** |

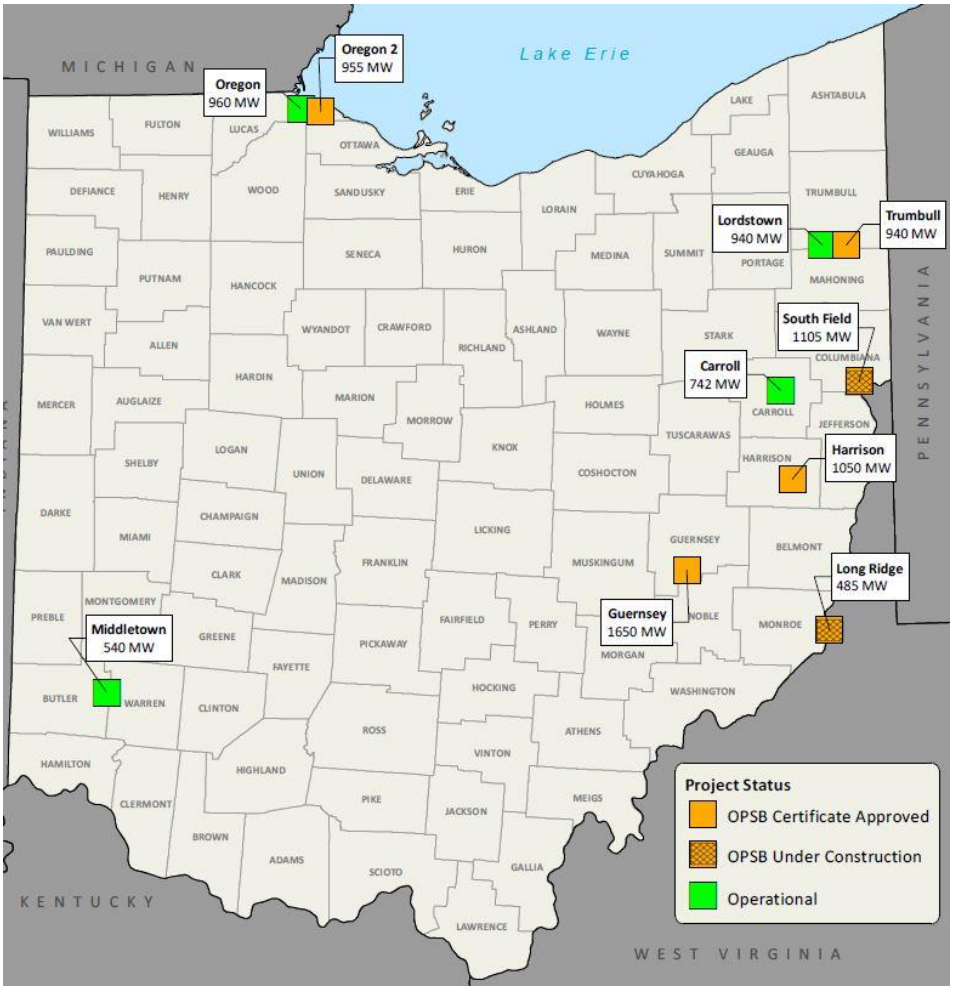
As with pipeline investments, expenditures for natural gas-fired generation facilities are considered for purposes of this report as one-time investments by the builder during the six-month Study window, since it is difficult to separate the investments into half-year segments. However, major projects such as pipelines and gas plants usually take a year or more to develop. The 10 current and projected natural gas power facilities across 8 locations, including their status as of August 2019, are set forth in Figure 5 below.

Construction on the $1.6 billion Guernsey Power Station began in the second half of 2019. Investment for this 1,650 MW plant will be included in the next Shale report.[38] While construction had not started on the Trumbull Energy Center as of February 2020, installation of the fully permitted and financed generation facility near Lordstown will likely begin before the summer of 2020.[39] Also, a January 2020 engineering, procurement and construction contract entered into by the developer of the Harrison Energy Center could lead to groundbreaking on the 1,085 MW facility before the end of this year.[40] While the Study Team was unable to ascertain a

[35] *See* https://www.eia.gov/todayinenergy/detail.php?id=41333
[36] https://wtov9.com/news/local/construction-begins-for-hannibal-gas-fired-power-plant
[37] https://www.southfieldenergy.com/news/south-field-energy-breaks-ground-for-1182-megawatt-energy-facility/
[38] https://www.naturalgasintel.com/articles/119477-massive-natural-gas-fired-power-plant-moving-forward-in-ohio
[39] *See* https://www.wfmj.com/story/41664957/lordstown-village-schools-may-compromise-on-dollar225k-income-tax-revenue
[40] https://wtov9.com/news/local/contract-signed-groundbreaking-date-coming-for-harrison-power-plant

timeline for the second power station in Oregon, OH, the developer's renewal in January 2020 of its EPA air permit suggests that the project may be moving forward.[41]

**Figure 5. Existing and Projected Natural Gas Power Plants**




Source: Ohio Power Siting Board
Source (except for Ohio State): U.S. DOE Combined Heat and Power Installation Database[42]
Note: Estimated investment is based on $1,394 per kW for a 15 MW gas turbine CHP plant and $1,760 per kW for a 7.5 MW gas turbine CHP plant.[43]

## 2. Petrochemical Plants and Future Near-term Downstream Investment

While no major petrochemical plant investments took place in the first half of 2019, PTT Global did continue accumulating residential property near the proposed site of the multi-billion ethane

[41] *See* https://www.epa.gov/nsr/oregon-energy-center
[42] https://doe.icfwebservices.com/chpdb/
[43] Derived from Combined heat and Power Cost-benefit Analysis tool available through the Center for Energy, Economic & Environmental Policy at Rutgers. *See* http://ceeep.rutgers.edu/wp-content/uploads/2015/07/CHP-Database-Technical-and-Financial-Parameters-v.4-06032015.xlsx

cracker in Belmont County. The company went from purchases of $125,000 in the second half of 2018 to $800,000 during the first half of 2019.[44] Additional progress on the project during the first half of 2019 included PTT's awarding Bechtel the engineering, procurement and construction contract for the ethane cracker in Dilles Bottom.[45] A final investment decision for the petrochemical complex is expected in mid-2020.[46]

As noted in the last Shale report, site preparation work for Petmin USA's $474 million pig iron plant in Ashtabula was scheduled to commence in the second half of 2019. According to Petmin's CEO, $50 million had been invested in the project as of October 2019, which will be included in the next Shale report.[47] Steelmaking based on Direct Reduction as will be employed at the Ashtabula plant fundamentally depends on natural gas to reduce iron ore to iron as part of the production process.[48]

Continued low natural gas prices have also led to an increase in the 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. While no CHP projects were undertaken during the first half of 2019, subsequent permitting progress on the proposed $288 million CHP plant on the campus of Ohio State University indicates that a large CHP investment will likely be included in a future report.[49] This progress includes the issuing of an Air Pollution Permit-to-Install by the Ohio EPA in the second half of 2019, and the filing of an application with the Ohio Power Siting Board for a certificate of environmental compatibility and public need to construct a CHP facility at Ohio State, where the approval process is currently nearing the end of the staff investigation phase as of this writing.[50]

No new compressed natural gas (CNG) stations were identified for the first half of 2019. However, the Greater Cleveland Regional Transit Authority authorized an expenditure of $5 million in August 2019 for a CNG fueling system with public access at one of its bus depots.[51] This investment will be included in the next Shale report.

[44] Belmont County Auditor (http://oh-belmont-auditor.publicaccessnow.com/). *See also* https://marcellusdrilling.com/2019/07/ptt-buying-homes-near-proposed-cracker-plant-in-belmont-county/

[45] https://www.icis.com/explore/resources/news/2019/06/20/10381121/bechtel-wins-epc-contract-for-ohio-petchem-project

[46] https://www.kallanishenergy.com/2020/02/28/fid-for-ohio-ethane-cracker-likely-in-mid-2020/

[47] *See* https://www.starbeacon.com/news/local_news/jobs-and-environment-petmin-local-officials-outline-future-pig-iron/article_958cfffb-d21a-500f-aabf-591b6715a327.html

[48] *See* https://www.tenova.com/fileadmin/user_upload/HYL_News_-_December_2018.pdf. *See also:* 1) https://petminusa.com/; 2) http://www.millennium-steel.com/wp-content/uploads/2017/05/pp024-030_ms17.pdf; 3) https://www.oilandgas360.com/jobs-and-environment-petmin-local-officials-outline-future-pig-iron-plants-impact/

[49] https://www.smartenergydecisions.com/news/2019/08/27/energy-efficient-chp-proposed-for-ohio-state

[50] *See* http://wwwapp.epa.ohio.gov/dapc/permits_issued/1911791.pdf. *See also* https://www.opsb.ohio.gov/siting-case-breakdown/19-1641-el-bgn-ohio-state-university-combined-heat-and-power-facility-franklin-county/

[51] http://www.riderta.com/sites/default/files/events/2019-08-20BoardMinutes_0.pdf

Cumulative downstream investments reported to date in Ohio, including 2011-2018, are set forth in Table 21 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

Upstream shale investment in Ohio continued to be active, with 147 new wells being developed in the first half of 2019. Production growth declined in the first and second quarters of 2019, with the total amount of extracted gas equivalents for this period being 3.6% less than for the second half of 2018, coinciding with an overall downward trend in natural gas prices for the region over this period after a spike in late 2018.[52] While upstream investment saw a slight decline of 6.8% during the first half of 2019 compared to the last 6 months of 2018, the overall amount spent on this segment during the Study period was still well over $3 billion.

Midstream spending was driven largely by interstate pipeline construction for both natural gas and natural gas liquids that took place in early 2019. Representing around $259 million in spending, these projects are part of an apparent uptick in pipeline construction. Subsequent pipeline projects are underway that will require an investment on par with what was spent in the first half of 2019, if not more. Significant gathering system buildout also continued during the first and second quarters of 2019, with an estimated $201 million spent altogether on gathering lines, compression, and dehydration.

Two natural gas power plants broke ground in the first half of 2019, totaling $1.8 billion in downstream investment. There was little other downstream spending. However, the PTT Global Petrochemical project continues to progress, and could ultimately represent an estimated $5 billion shale-related investment.[53] At the time of this report, the world economy has been under placed into considerable turmoil due to the corona virus pandemic, and it is too early to know how this may affect interest in long term investments in ethane crackers and other petrochemical plants.

Total shale related investment in Ohio for the first half of 2019, including upstream, midstream and downstream, was around $5.56 billion. Total investment from 2011 through mid-2019 is around $83.3 billion.

[52] *See* https://www.naturalgasintel.com/data/data_products/daily
[53] *See* https://marcellusdrilling.com/2017/12/ptt-global-final-decision-re-belmont-cracker-plant-late-again/

## About the Study Team

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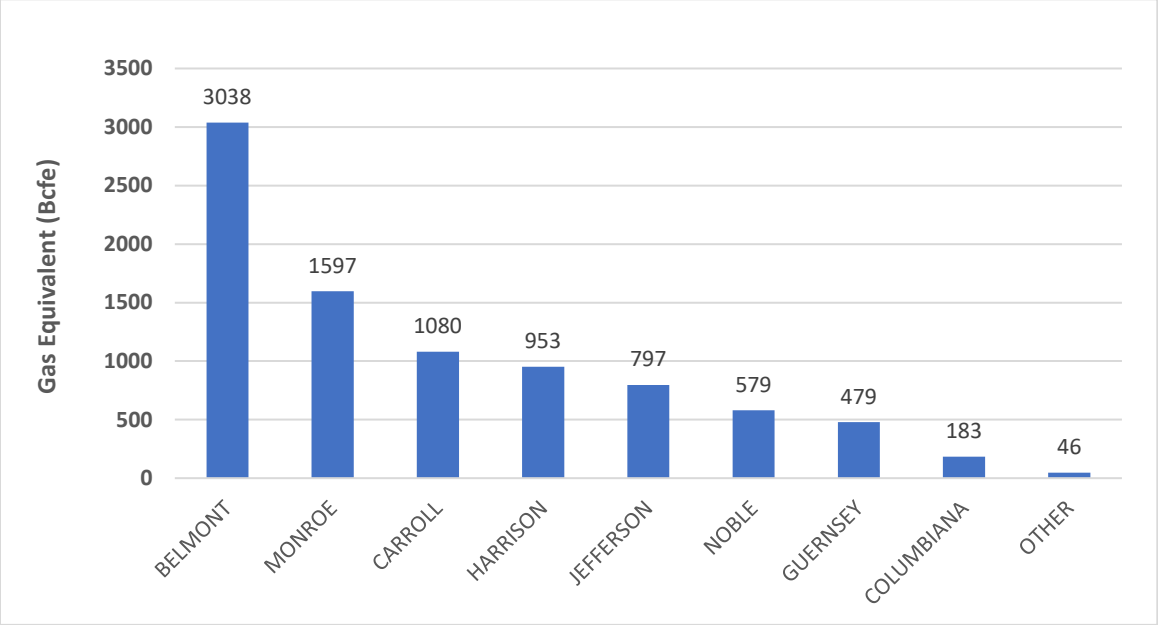
### About the Energy Policy Center

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/.

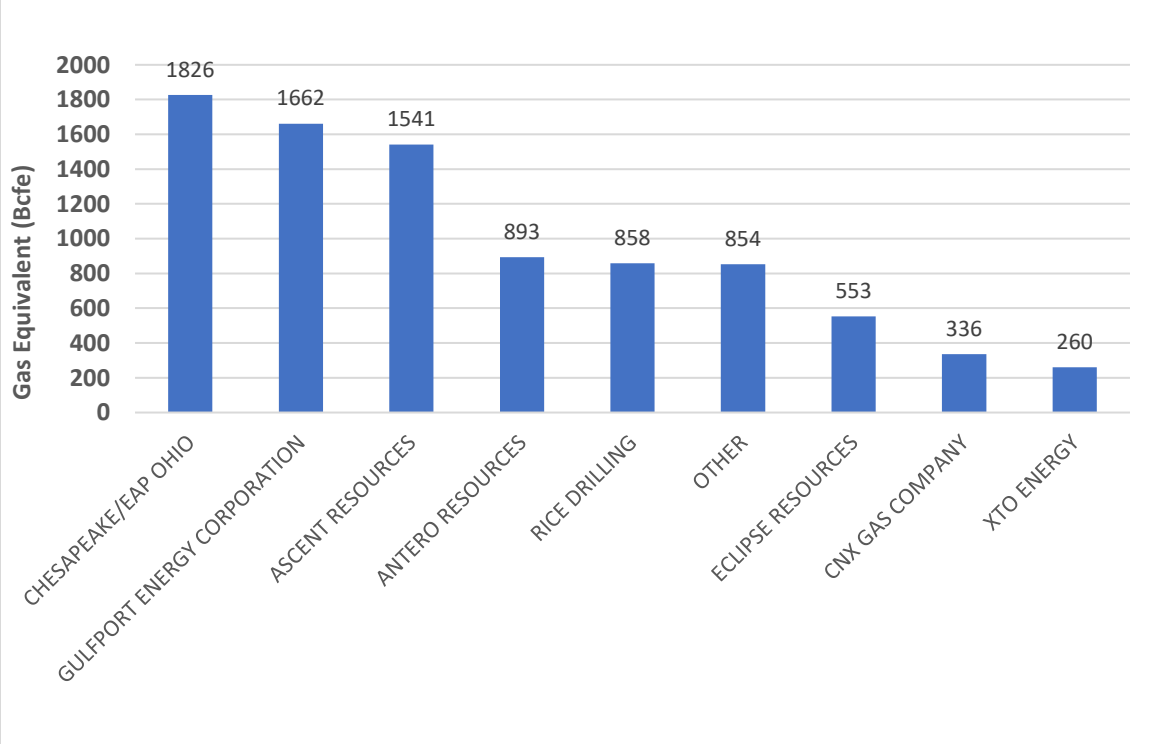
# 4. APPENDICES

## APPENDIX A. CUMULATIVE OHIO SHALE INVESTMENT

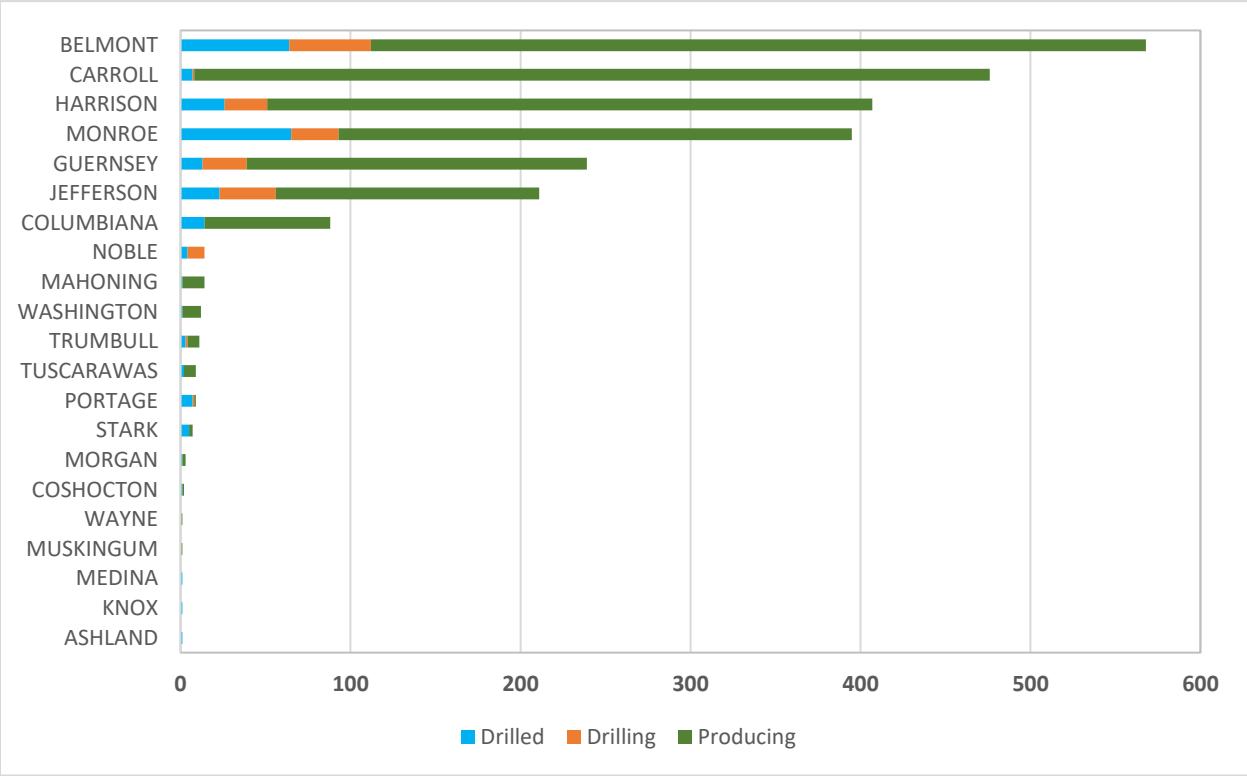
### Figure 6: Total Utica Production in Bcfe (Gas Equivalence) by County through June 2019




### Figure 7: Total Utica Production in Bcfe by Operator through June 2019

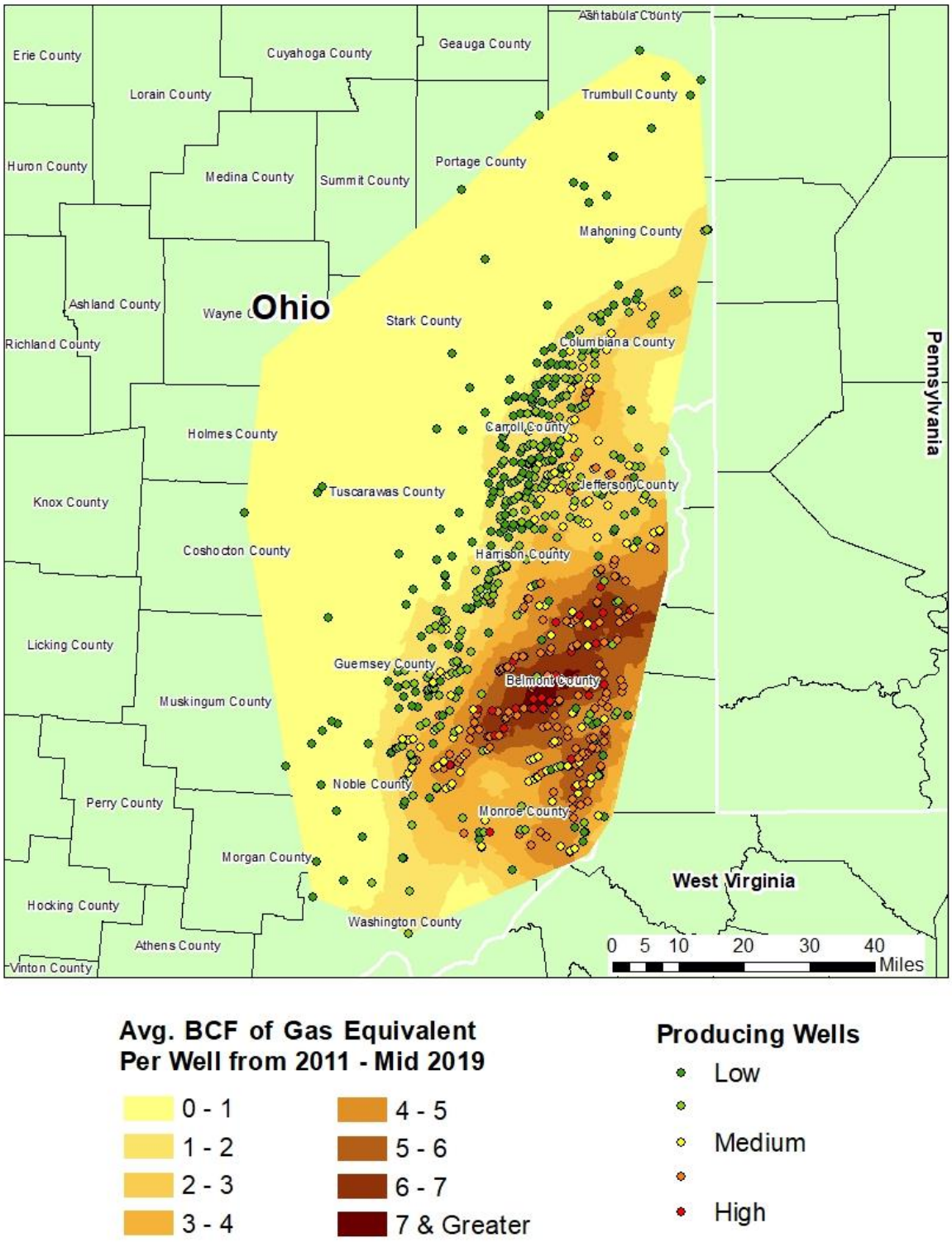


## Figure 8: Cumulative Number of Wells by County

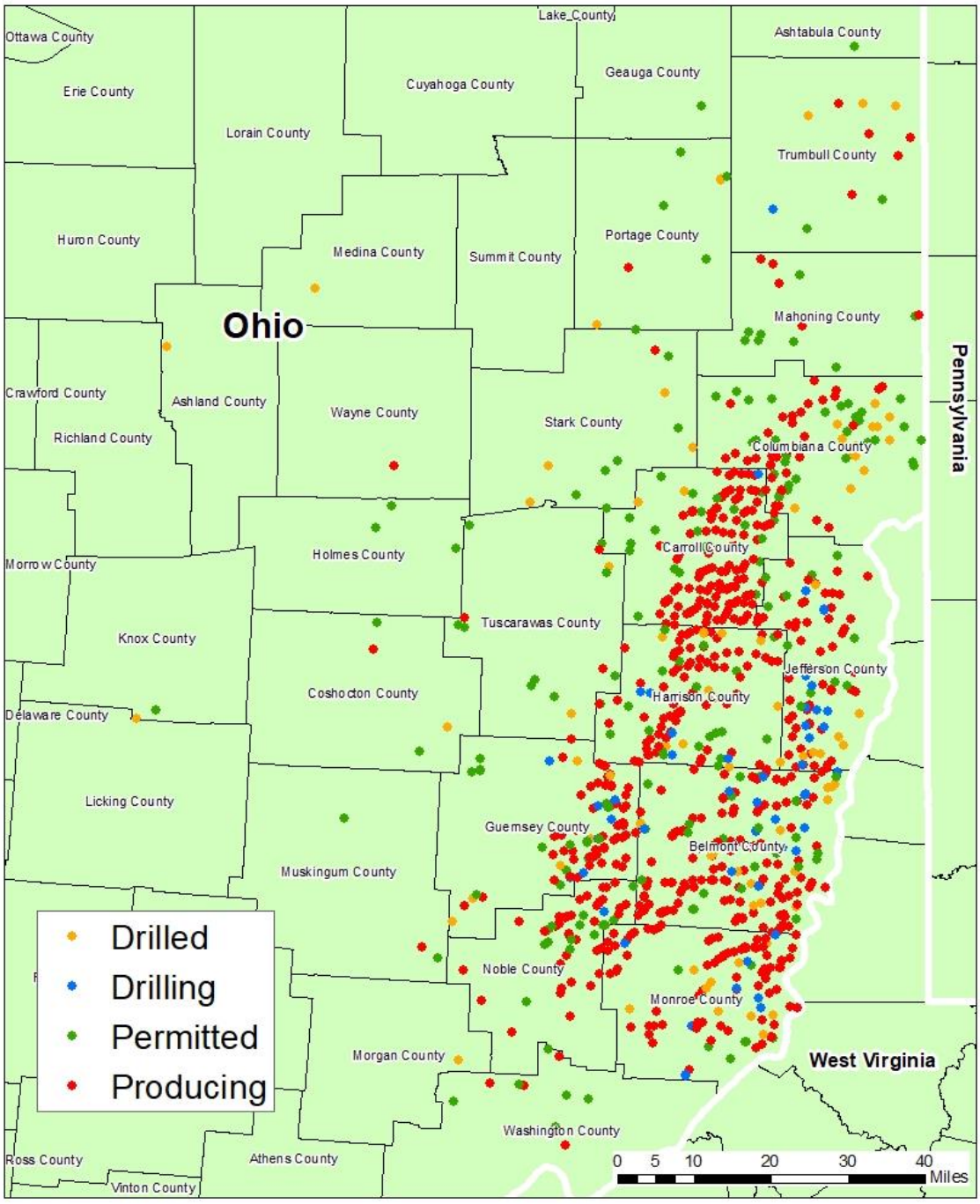



Source: Ohio Department of Natural Resources (July 2019)

## Figure 9: Distribution of Gas Equivalent Production for 2011 through June 2019



## Figure 10: Distribution of Utica Wells by Status as of June 2019




Source: ODNR (2019)

## Table 16: Utica Upstream Companies Drilling in Ohio

| Company | Cumulative No. of Wells |
|---|---|
| AMERICAN ENERGY UTICA LLC | 1 |
| ANTERO RESOURCES CORPORATION | 239 |
| ARSENAL RESOURCES LLC | 6 |
| ARTEX ENERGY GROUP LLC | 7 |
| ASCENT RESOURCES UTICA LLC | 547 |
| ATLAS NOBLE LLC | 12 |
| BP AMERICA PRODUCTION COMPANY | 1 |
| BRAMMER ENGINEERING INC | 2 |
| CHESAPEAKE APPALACHIA LLC | 1 |
| CHESAPEAKE EXPLORATION LLC | 32 |
| CHEVRON APPALACHIA LLC | 8 |
| CNX GAS COMPANY LLC | 41 |
| DEVON ENERGY PRODUCTION CO LP | 3 |
| EAP OHIO LLC | 762 |
| ECLIPSE RESOURCES I LP | 163 |
| EM ENERGY OHIO LLC | 17 |
| ENERVEST OPERATING LLC | 6 |
| EQT PRODUCTION COMPANY | 2 |
| EQUINOR USA ONSHORE PROPERTIES INC. | 36 |
| GEOPETRO LLC | 5 |
| GULFPORT APPALACHIA LLC | 387 |
| GULFPORT ENERGY CORPORATION | 12 |
| HG ENERGY LLC | 5 |
| HILCORP ENERGY COMPANY | 18 |
| M & R INVESTMENTS OHIO LLC | 1 |
| NORTHWOOD ENERGY CORP | 6 |
| PDC ENERGY INC | 1 |
| PENNENERGY RESOURCES LLC | 40 |
| PIN OAK ENERGY PARTNERS LLC | 13 |
| PROTEGE ENERGY III LLC | 1 |
| R E GAS DEVELOPMENT LLC | 1 |
| RICE DRILLING D LLC | 136 |
| STATOIL USA ONSHORE PROPERTIES INC | 4 |
| TRIAD HUNTER LLC | 25 |
| UTICA RESOURCE OPERATING LLC | 35 |
| XTO ENERGY INC. | 60 |
| **Total** | **2,636** |

Note: Cumulative Number of Wells are calculated based upon the total numbers of Drilled, Drilling, and Producing. Source: ODNR (June 29, 2019).

### Table 17: Total Lease Operating Expenses through June 2019 (in millions of dollars)

| Year | Period | Production Wells | Lease Operating Expenses for Period ($mm) |
|---|---|---|---|
| 2019 | Q1 and Q2 | 2173 | 228.06 |
| 2018 | Q3 and Q4 | 2200 | 231.0 |
| 2018 | Q1 and Q2 | 1874 | 191.15 |
| 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 | 30 |
| 2011 | Annual | 9 | 3 |
| | | **Total** | **1,416.2** |

### Table 18: Cumulative Utica-Related Upstream Investments in Ohio through June 2019

| Estimated Investments | Total Amount |
|---|---|
| Undeveloped Land | $16,153,370,000 |
| Developed Land | $2,664,000,000 |
| Lease Renewals | $5,763,171,000 |
| Drilling | $24,261,000,000 |
| Roads | $1,072,120,000 |
| Lease Operating Expenses | $1,386,486,000 |
| Royalties | $5,800,660,000 |
| **Total** | **$57,100,807,000** |

### Table 19: Cumulative Utica-Related Midstream Investments in Ohio through June 2019

| Estimated Investments | Total Amount |
|---|---|
| Midstream Gathering | $7,038,223,000 |
| Processing Plants | $1,538,600,000 |
| Fractionation Plants | $1,414,000,000 |
| NGL Storage | $241,000,000 |
| Rail Loading Terminals | $145,000,000 |
| Transmission Pipelines | $9,612,386,000 |
| **Total** | **$19,989,209,000** |

### Table 20: Cumulative Utica-Related Downstream Investments in Ohio through June 2019

| Estimated Investments | Total Amount |
|---|---|
| Petrochemical Plants and Refineries | $552,225,000 |
| Other Industrial Plants | $700,000,000 |
| Natural Gas Refueling Stations | $44,825,000 |
| Natural Gas Power Plants | $4,840,000,000 |
| Combined Heat and Power (CHP) Plants | $85,100,000 |
| **Total** | **$6,222,150,000** |

# 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.[54]
  - Equivalent true vertical depth (TVD) for wells in all counties.
  - Average drilling and completion costs of $900 per lateral foot.[55]
  - Average lateral length of 12,660 ft. for northern counties and 14,360 ft. for southern counties.[56]
- Roads: average investments - approximately $60,000 per well based on 2013 data from Carroll County Engineer's Office.[57]

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, 2019 from the number existent as of June 30, 2019. This information was downloaded from the ODNR Oil and Gas Well database.[58]

**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

[54] 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.

[55] 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

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

[57] *See fn 7, supra.*

[58] http://oilandgas.ohiodnr.gov/well-information/oil-gas-well-database

lease operating expenses for 2019, divided by the number of wells operated, as reported in their financial statements.[59]

For purposes of estimating the lease operating expenses for Q1 and Q2 2019, the Study Team assumed that all wells listed as "producing" by the Ohio Department of Natural Resources on January 1, 2019 were incurring this cost and continued to do so through June 30, 2019.

**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. [60]
- The residue energy content was around 1.1 MMBtu/Mcf.[61]
- Residue gas in the Utica was selling at an average price of $3.01/MMBtu for Q1 and $2.28/MMBtu for Q2.[62] 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.[63]
- Natural gas liquids were selling for around 30% of the listed price for Marcellus-Utica light crude oil.[64]

[59] *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

[60] Based on industry interviews, experts citing API 12.3, Manual of Petroleum Measurements and Standards

[61] 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.

[62] 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

[63] Based on industry data.

[64] Based on industry interviews.

- Oil in the Utica region was selling for $47.27 and $53.85 per barrel, on average, during the first and the second quarter of 2019, respectively.[65]
- 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. Accordingly, we have assumed that approximately 20% of the undeveloped acreage identified will need to be renewed each year or is otherwise new.[66] Since this Study covered six months, we assumed that half of this 20% was renewed or new during the Study period. However, this estimate is based upon total undeveloped acreage, and not allocated on a per well basis. This estimate may be high insofar as companies are not renewing all their acreage, and some acreage will be developed and not need renewal. However, it is also likely to be low insofar as the studies have only identified undeveloped acreage for the top six to nine operators in Ohio. Undeveloped acreage 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.

[65] *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

[66] 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.[67]

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/d[68]
  - $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.[69]

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

[67] *Id.*

[68] 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).

[69] 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).[70] 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

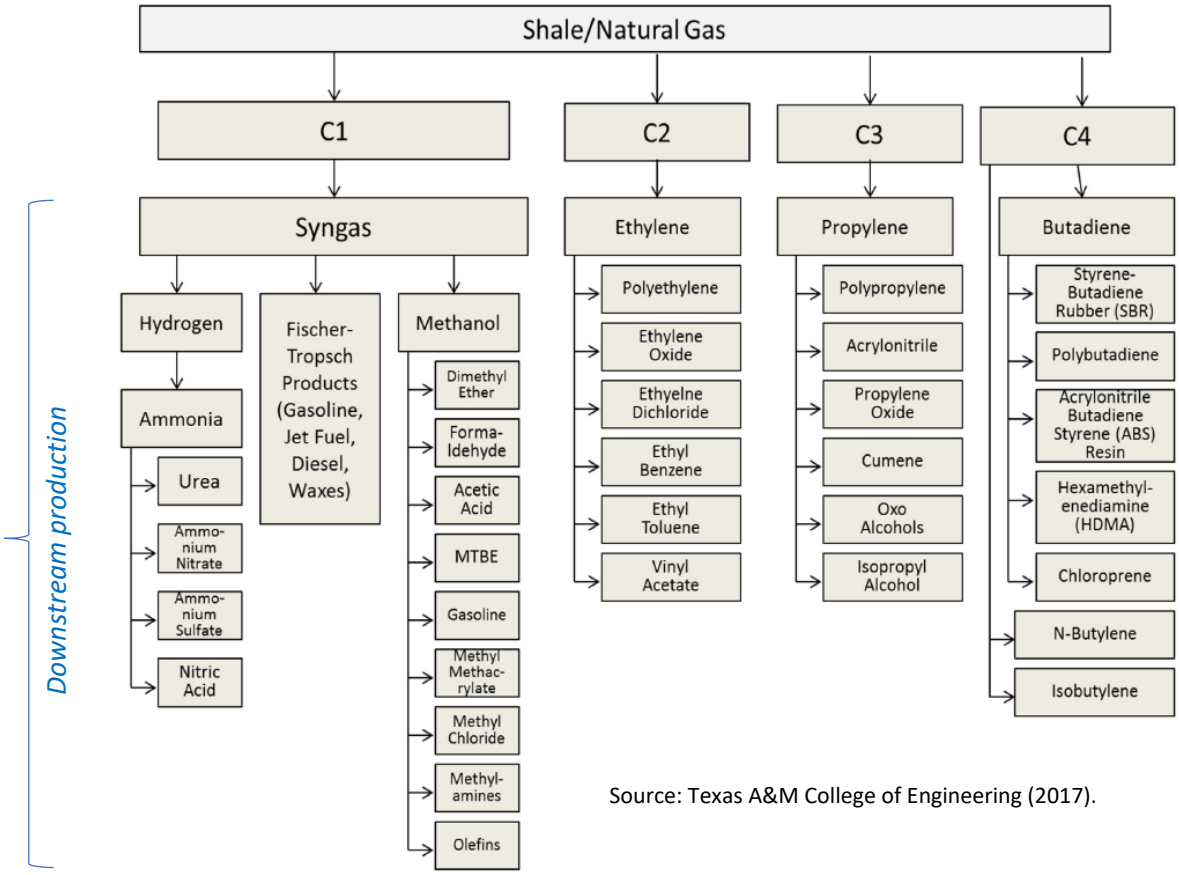
NAICS codes used to generate keywords for searches included the following:
3251 – Basic Chemical Manufacturing
3252 – Resin, Synthetic Rubber, and Artificial and Synthetic Fibers and Filaments Manufacturing
3253 – Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing
3255 – Paint, Coating, and Adhesive Manufacturing
3259 – Other Chemical Product and Preparation Manufacturing
3261 – Plastics Product Manufacturing

Downstream activities include the deployment of processes that turn hydrocarbons—particularly the light hydrocarbons methane (C1), ethane (C2), propane (C3), and the butanes (C4)—into higher-valued fuels and petrochemicals. Shale gas may be monetized into numerous resulting value-added products. Figure 10 shows the primary intermediates and products that can be manufactured from the main hydrocarbon components in shale gas as part of downstream

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

production.[71] At or near the top of this hierarchy are what have been called the four main "building blocks" for petrochemicals: ethylene, propylene, butadiene, and methanol.[72] The processes currently available for producing these critical downstream links in the shale gas value chain are listed in Table 21.[73] All of the products and processes shown in Figure 10 and Table 21 form the basis for additional search terms to identify downstream investment during the study period.

**Figure 11. Shale/Natural Gas Value Chain for Petrochemicals**




Source: Texas A&M College of Engineering (2017).

[71] *See* Al-Douri, A., Sengupta, D., & El-Halwagi, M. M. (2017). Shale gas monetization–A review of downstream processing to chemicals and fuels. *Journal of Natural Gas Science and Engineering*, *45*, 436-455.
[72] Al-Douri, A. F. (2016). *A systems framework for shale gas monetization* (Doctoral dissertation). https://oaktrust.library.tamu.edu/handle/1969.1/156938
[73] *See* Elbashir, N. O., El-Halwagi, M. M., Economou, I. G., & Hall, K. R. (Eds.). (2018). *Natural Gas Processing from Midstream to Downstream*. Wiley.

### Table 21. Downstream Production Processes for Petrochemical Building Blocks

| Petrochemical Building Block | Production Processes for Converting Shale Gas |
|---|---|
| Ethylene | • steam cracking hydrocarbons (e.g. naphtha, ethane, propane, etc.)<br>• oxidative coupling of methane (OCM)<br>• methanol-to-olefins (MTO) |
| Propylene | • by-product of ethylene manufacture from steam cracking hydrocarbons<br>• methanol-to-olefins (MTO)<br>• propane dehydrogenation (PDH) |
| Butadiene | • by-product of ethylene manufacture from steam cracking hydrocarbons<br>• dehydrogenation of n-butane (Houdry process)<br>• oxidative dehydrogenation of n-butane (Oxo-D)<br>• biomass-to-butadiene |
| Methanol | Synthesis from syngas reformed via:<br>• partial oxidation (POX)<br>• steam methane reforming (SMR)<br>• auto-thermal reforming (ATR)<br>• combined reforming (CR) |