Appendices for Diversified Energy:

A Business Model Built to Fail Appalachia

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The Ohio River Valley Institute is an independent, nonprofit research and communications center founded in 2020. We equip the region's residents and decision-makers with the policy research and practical tools they need to advance long-term solutions to some of Appalachia's most significant challenges. Our work includes in-depth research, commentary, and analysis, delivered online, by email, and in-person to policy champions, emerging leaders, and a range of community partners.

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Glossary

Bbls or Bbls/day: barrels of oil

Bcf: one billion cubic feet of natural gas

BOE: barrel of oil equivalent (one barrel of oil = 6,000 Mcf)

BOED or BOE/day: barrel of oil equivalent per day

Btu: British thermal unit (a heat unit). The heat required to raise the temperature of a one-pound mass of water by one degree Fahrenheit.

CO2e: Carbon dioxide equivalents.

Mbbls: one thousand barrels of oil (1,000 barrels)

MMbbl: one million barrels of oil (1,000,000 barrels)

Mcf: one thousand cubic feet of natural gas

MCFD or Mcf/day: one thousand cubic feet of natural gas per day

MCFE or Mcfe: one thousand cubic feet of natural gas equivalent (one barrel of oil = 6,000 Mcf)

Tcf: one trillion cubic feet of natural gas

GHG: Greenhouse gas

Methane (CH4): A potent greenhouse gas that is the largest constituent of natural gas. Methane's global warming potential is more than 80 times greater than carbon dioxide over 20 years.

Cfpd (cubic feet per day): A measure of gas production or leakage from a well

NRM: No reliable measurement. A possible response in a required well gas leakage report

I: Inaccessible. A possible response in a required well gas leakage report.

NA: Not applicable. A possible response in a required well gas leakage report.

PADEP: Pennsylvania Department of Environmental Protection

Psig: Pounds per square inch gauge. A measure of fluid pressure.

High-producing (or nonstripper) well: an oil or gas well producing more than 15 BOED (90 Mcfe/day).

Stripper well: an oil or gas well producing less than 15 BOED (90 MCfe/day), as defined by EIA/IRS.

Marginal well: an oil or gas well producing less than 10 BOED (60 MCFe/day), as defined by IOGCC.

Financially distressed well: an oil or gas well producing less than 5 BOED (30 MCFe/day), as defined by COGCC.

Uneconomic well: an oil or gas well producing less than 1 BOED (6 MCFe/day), as defined by COGCC. As defined by ORVI, a well producing *less than 0.2 BOED (1.2 Mcfe/day)*.

Active well: a currently producing well or a well used for storage or disposal

Inactive well: a well that has not produced oil or gas for one year

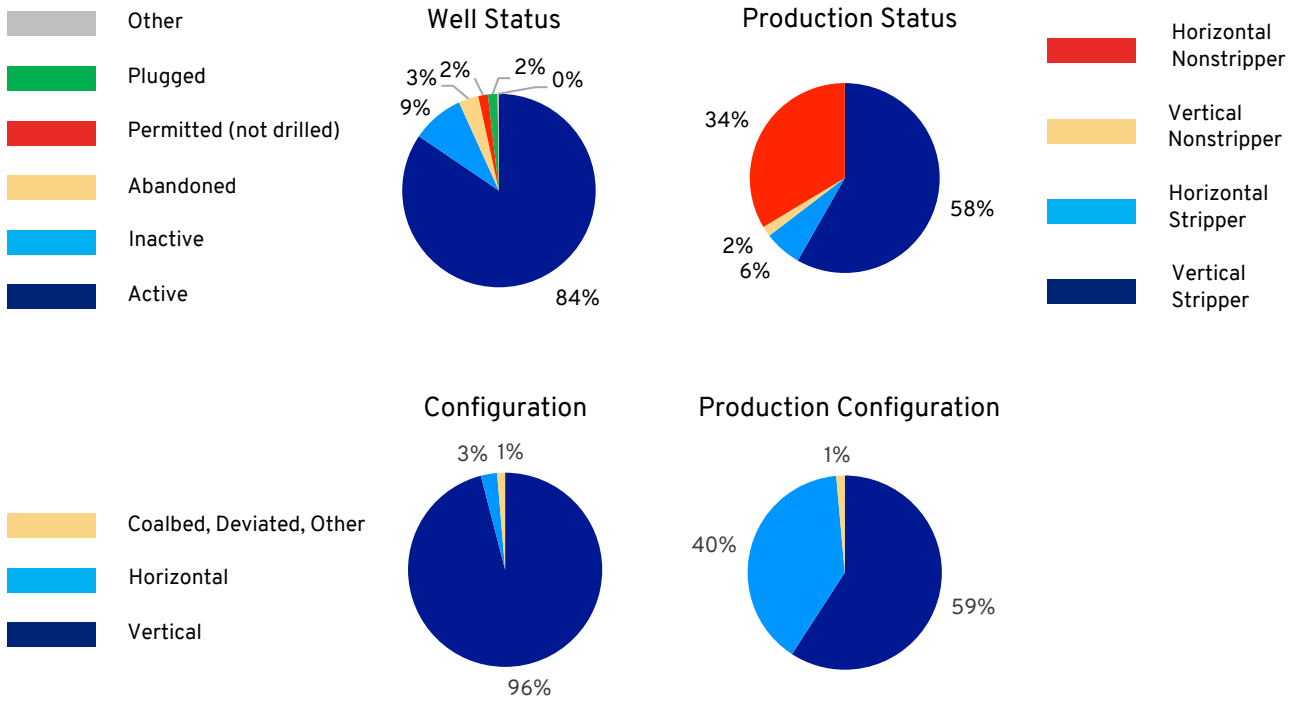
Abandoned well: an unplugged, inactive well

Orphaned Well: An unplugged well where the owner is insolvent or there is no owner of record. Orphaned wells, if they are plugged, are usually plugged by federal and state regulatory agencies.

Decommissioning: When a well reaches its end of producing life, operators are legally obligated to plug the well, remove surface equipment, and restore the wellsite to its original state. This is commonly referred to as plugging and abandoning a well, or "P&A".

Appendix 1: Additional Detail on Diversified Wells

Figure 1A1: Diversified Wells by Well Status, Production Status, and Configuration, 2020



Source: ORVI analysis of TCF Upstream Database

Appendix 2: Calculating State Decommissioning (Plugging and Wellsite Restoration) Costs

Factors Impacting Decommissioning Costs

Decommissioning costs associated with plugging *and* well site restoration (P&A cost) can vary dramatically, depending on several factors, from a few thousand dollars to more than one million dollars.[1] For example, if the integrity of the well casings and/or cement is poor or the wellbore has collapsed, then the well will have to be redrilled, increasing the costs and length of time to plug the well. If the well is leaking gas and/or oil, the source of the leaking must first be determined, an expense in itself, and then remediation in addition to plugging might be required. Costs for plugging wells also increase depending on the depth; the deeper the well, the more expensive it is to plug. Other factors include the extent of surface contamination that needs to be remediated and whether tanks and equipment need to be removed. There are also variations in how much plugging companies charge based on market competition. The age of the well is also a factor, with older wells generally costing more to plug. The type of well can also impact plugging costs, with gas wells typically costing more to plug than oil wells.

The terrain surrounding a well (site location and surface characteristics) is also a factor. Plugging often requires very heavy drilling equipment (rigs), sometimes requiring the building of roads to reach wells or navigating difficult site conditions. The cost dramatically increases if a well has contaminated groundwater or if it is located near homes or buildings. Plugging costs of conventional and unconventional wells can also differ due to the relative complexity of the well construction.

Another important factor in cost is the availability of contractors and the number of wells included in a contract. The cost of plugging and well site restoration usually decreases with the number of wells included in a contract. Well plugging services are usually willing to make lower bids to obtain larger contracts because they can benefit from the economies of scale. One recent study of well plugging contracts in Pennsylvania found that the average well reclamation costs per foot of well for large contracts is one-third of the cost of small contracts.[2]

Studies and Surveys of Decommissioning Costs

The most comprehensive study of oil and gas well decommissioning costs (to the authors' knowledge) was published by Daniel Raimi (Resources for the Future) and others in *Environmental Science & Technology* in July of 2021.[3] The study examined over 19,000 wells in five states (Kansas, Montana, New Mexico, Pennsylvania, and Texas) and found that the average cost to plug a well and restore the wellsite of an orphaned or abandoned well was $75,579 per well. In Pennsylvania, where Diversified owns nearly a third of its wells, the study found the average plugging and well restoration cost to be $48,703 (2019 dollars) per well.

According to a 2021 survey by the Interstate Oil and Gas Compact Commission (IOGCC) of its 31 member states, the average plugging cost alone per orphan well was $30,450 for 4,063 wells in 23 states in 2020.[4] While the 2021 IOGCC survey did not include estimates for the average restoration cost per orphan well, the IOGCC's 2020 survey found the average cost to restore 1,554 sites to be $5,078 per well in 2018. Adding these two figures (without adjusting for inflation) brings the total decommissioning cost to about $35,500 per well.

A closer look at average well plugging costs in IOGCC's 2021 report reveals that plugging and restoration costs can vary wildly by state, especially considering the small number of wells and sites included in the survey. The states where Diversified has a large majority of its wells have much higher plugging costs, on average. For example, in 2020, according to the 2021 IOGCC survey, Pennsylvania plugged 18 wells at an average cost of $83,319 per well. In Ohio, 150 orphaned wells were plugged at a per-well cost of $93,569. In West Virginia, a single well was plugged at a cost of $185,829. Kentucky, however, had the lowest per-well plugging cost in the survey at $4,332 per well. Between 2018 and 2020, a total of 702 wells were plugged in these four states at an average cost of $44,684.[5]

Estimating Diversified's Decommissioning Costs

Table 1A2 on the following page shows the roughly 65,000 unplugged and undrilled wells Diversified owns in each state and the estimated decommissioning costs for their wells using the best available data (largest sample size).[6] Based on this information, the **average per well decommissioning cost is $53,300 per well** for Diversified's well inventory based on the distribution of their wells in each state. Diversified maintains that plugging costs were roughly $22,500 per well in 2021,[7] about $31,000 less than what the best estimates show in their respective states. Diversified also owns around 2,000 horizontal wells, many of which are older high-volume hydraulic fracturing wells that can cost several times as much to decommission as conventional wells.[8]

Table 1A2: Decommissioning Costs (Plugging and Site Remediation) Based on Best Available Data

TABLE 1A2 Decommissioning Costs (Plugging + Site Remediation) Based on Best Available Data					
State	Average Plugging Cost Per Well	Diversified Wells*	Diversified P&A Cost	Source	Well Count (Sample Size)
Kentucky	$4,349	8,277	$35,996,673	IOGCC 2021 (2018-2020)	373
Ohio	$88,406	8,090	$715,204,540	IOGCC 2021 (2018-2020)	293
Pennsylvania	$48,703	21,679	$1,055,832,337	Raimi et al (2021)	717
West Virginia	$66,884	22,889	$1,530,907,876	WVDEP (2008-2020)	103
Virginia	$46,329	776	$35,951,304	IOGCC 2020 (2018)	15
Tennessee	$2,409	642	$1,546,578	IOGCC 2021 (2018-2020)	176
New York	$39,279	24	$942,696	IOGCC 2021 (2018-2020)	188
Louisiana	$47,825	1,370	$65,520,250	IOGCC 2021 (2018-2020)	355
Texas	$21,131	590	$12,467,570	IOGCC 2021 (2018-2020)	4,584
Oklahoma	$14,914	660	$9,843,240	IOGCC 2021 (2018-2020)	297
TOTAL	**$53,298**	**64,997**	**$3,464,213,064**		**7,101**

Source: Interstate Oil and Gas Compact Commission (2021), West Virginia Department of Environmental Protection (2021), Raimi et. al. (2021)

For Kentucky, Ohio, Tennessee, New York, Louisiana, Texas, and Oklahoma, Table 1A2 uses IOGCC data from three years, 2018, 2019, and 2020. The estimated plugging costs are not adjusted for inflation. It should be noted that while Kentucky's average plugging cost per well is $4,349, Diversified has noted (2018) that it typically costs them $28,000 to plug a well in Kentucky.[9] This large discrepancy could be because Diversified owns a large share of Kentucky's horizontal wells, which are deeper than shallow conventional wells and more expensive to plug. (Kentucky has many shallow wells, which is one reason plugging costs are comparatively lower in Kentucky).

In December 2021, the Kentucky Division of Oil and Gas (KYDOG) submitted a notice of intent letter to the US Department of Interior (DOI) to apply for funds for the formula grant orphaned well program as part of the 2021 Infrastructure Investment and Jobs Act.[10] The KYDOG estimated it would cost $235 million to plug and reclaim 11,728 orphaned wells, about $20,000 per well. In Ohio, the Department of Natural Resources estimated these costs at $78,800 per well based on 19,662 orphaned wells in its notice of intent to the DOI.[11] This is about $9,600 less per well than the average plugging cost per well Ohio reported to IOGCC over three years. In their notice of intent letter to the DOI, Texas estimated a per-well plugging cost of $65,140 while Louisiana estimated a cost of $87,230.

For Pennsylvania, the decommissioning cost estimate is from Raimi *et al.* (2021) which includes data for 717 wells.[12] The Pennsylvania Department of Environmental Protection (PADEP) estimated in 2021 that the average plugging cost per well was $33,000, while a recent report by Jeremy Weber (University of Pittsburgh) commissioned by the Sierra Club finds that the average plugging cost in Pennsylvania is between $25,000 and $36,000 for conventional wells and $70,000 and $83,000 for unconventional wells.[13] The PADEP also submitted a notice of intent letter to the DOI to apply for funds for the formula grant orphaned well program. The PADEP estimated it would cost $1.8 billion to plug and reclaim 26,908 orphaned wells, or about $68,000 per well.[14]

For West Virginia, the estimate is well plugging expenditure data derived from the West Virginia Department of Environmental Protection (WVDEP) that included 103 plugged orphan wells plugged between 2007 and 2019.[15] The average plugging cost for these wells was $54,400. Adjusting for inflation (2021 dollars), this number rises to about $67,000 per well. Like Kentucky and Pennsylvania, the WVDEP also submitted a notice of intent to apply to the DOI for funds for the formula grant orphaned well program. The WVDEP estimated it would cost $991 million to plug and reclaim 6,309 orphan wells, or about $157,000 per well.[16]

For Virginia, IOGCC's 2020 survey showed that Virginia plugged 14 wells in 2018 with an average per-well cost of $41,649 compared to a cost of $111,854 for one well in 2020 in IOGCC's 2021 survey.[17] Combining these two figures provides an estimated P&A cost of $46,329.

Using the best available data reveals a cost of $3.5 billion to decommission the estimated 65,000 wells in Diversified's well inventory. This is an average per-well decommissioning cost of roughly $54,000. Using well plugging costs submitted to the DOI in 2021 from KY, OH, PA, WV, LA, and TX, along with the IOGCC estimates above for VA, NY, TN, and OK, puts the total decommissioning cost at $6 billion, or $93,500 per well.

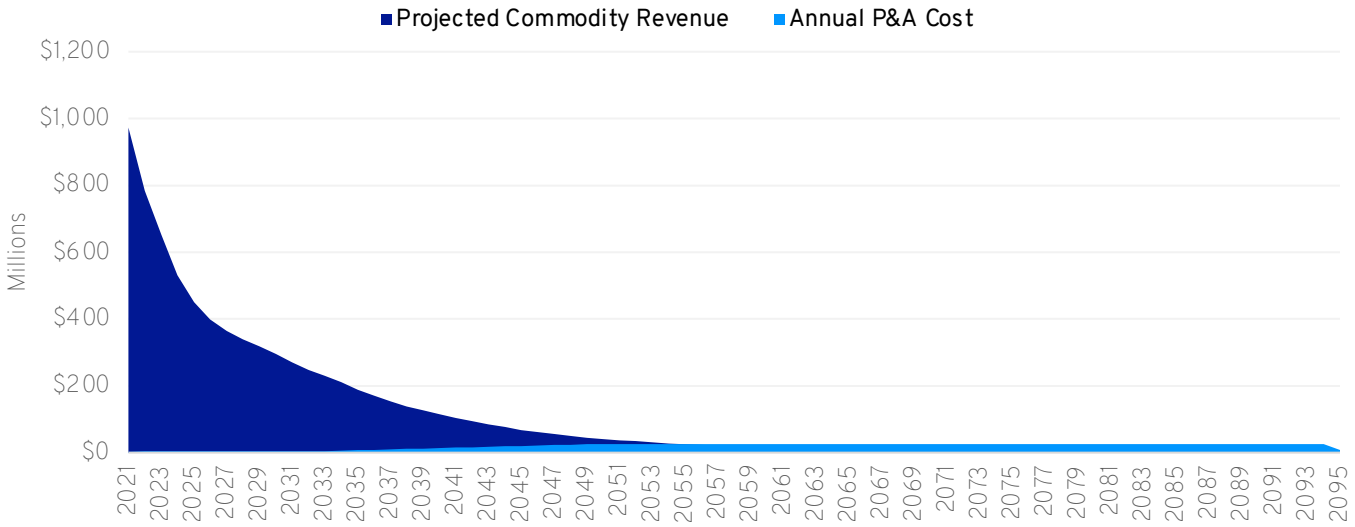
Appendix 3: Modeling Diversified's Projected Commodity Revenue and Plugging Costs

Below is a projection of whether revenues from the wells owned by Diversified as of 2021 will be sufficient to meet the retirement obligations on those wells. It does not consider future acquisitions, storage of gas that has yet to be sold, or the ability of Diversified to reactivate additional wells in its inventory or engage in other business activities that increase or decrease cash flows. It also does not consider revenue from other activities, such as midstream activities, or payments on outstanding or future debt; nor does it consider future tax changes or operation expenses. For example, according to Diversified Energy's 2021 Annual Report, total base operating expenses (base lease operating expense, production taxes, and transportation expenses) excluding mid-stream and G&A expenses were $231 million, or 24 percent of total commodity revenues ($973 million). This share climbs to 35 percent with the impact of derivative contracts, which lowered commodity revenues by $320 million in 2021.[18]

It also does not consider the impact of future policy changes, new technology, or how meeting global or US carbon reduction goals could significantly change future gas production. For example, according to projections from Princeton's Net-Zero America study, meeting net-zero emissions by 2050 in the US will "require the earlier than planned closure of an estimated 0.5 million gas wells during the first decade of transition, requiring $25 billion for plugging and abandoning wells in addition to other remediation costs."[19] Net-Zero's most optimistic scenario for natural gas, which includes a large share of CO_2 storage to enable more fossil fuel use, estimates that natural gas production will drop by 40 percent between 2019 and 2050.[20]

As described below, Figure 1A3 uses various inputs—including well plugging costs ($22,500 per well), production decline (9%), gas prices (EIA 2022), and a 75-year well plugging schedule—to project how much commodity revenue from current well inventories will be available to pay for plugging and abandonment (P&A) costs in the future based on a modified plugging schedule by Diversified. All projections are in 2021 dollars.

Figure 1A3: Projected Commodity Revenue from 2021 Well Inventory and P&A Costs, 2021-2095 (2021 Dollars)



Source: EIA AEO 2022 and Diversified Energy Annual Report 2021

These projections estimate that, by 2056, annual plugging costs will be higher than projected commodity revenue from the company's 2021 well inventory and that over 44,600 wells (68%) would remain unplugged. If these wells become orphaned, it could costs states an estimated $2.2 billion (in today's dollars) to P&A.

By 2056, only an estimated 20,390 wells, or 31 percent of Diversified's inventory, would be plugged and abandoned, leaving about 44,600 additional wells that will need to be decommissioned. Diversified could boost cash flow by acquiring more wells, but these new wells will also bring uncovered retirement obligations and could make the overall financial picture worse. Another strategy would be for Diversified to dedicate a portion of their revenues into an interest-bearing account and use these funds to cover their asset retirement obligations. However, this would likely require drastically lowering other expenses, which could lead to less production.

Diversified Wells to be Decommissioned

According to Diversified, the company owned an estimated 69,000 wells in 2021.[21] According to the *TCF Upstream* database, Diversified currently owns 66,288 wells in seven Appalachian states (Kentucky, New York, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia). Diversified also owns 3,000 operating wells in the Central Basin (Barnett and Cotton Valley/Haynesville Basins) in Oklahoma, Arkansas, Texas, and Louisiana.[22] Of the 66,288 in Appalachia, not all of them have been drilled and some are plugged. Approximately 2,603 are plugged, 1,269 are not drilled, and 169 are cancelled. It is unclear how many Central Basin wells are plugged, not drilled, or cancelled, so this analysis assumes the 3,000 "operated well" count published by Diversified means they are active drilled wells. Combining these figures reveals an estimate of at least 65,247 wells that will need to be P&Aed. We use a rounded figure of 65,000 wells that need to be decommissioned or P&Aed. This analysis does not include future acquisitions of wells or consider the higher cost to plug newer horizontal wells.

Diversified Well Decommissioning Schedule

Diversified's plan to P&A its well inventory has evolved as the company has acquired new wells. Their assumptions have also changed. In 2018, the company estimated it would P&A approximately 55,000 wells over 75 years and these wells would stop producing in 50 years or by 2048.[23] Diversified's "estimated plugging program" over the 75-year period assumed the following plugging schedule:

- Years 1-5: 70 wells plugged per year (2019-2023)
- Years 6-15: 100 wells plugged per year (2024-2033)
- Years 15-30: Linear increase in plugging until reaching 1,000 wells plugged per year (2034-2048)
- Years 31-75: 1,000 wells plugged per year (2049-2093)

Diversified estimated that by 2049, they would only have plugged 10,000 wells and that they would continue their plugging program until 2094. In a July 2019 investor report, Diversified modeled a similar 75-year plugging program for 60,000 wells using the following plugging schedule:[24]

- Years 1-5: 106 wells plugged per year (2019-2023)
- Years 6-15: 140 wells plugged per year (2024-2033)
- Years 15-30: Linear increase in plugging until reaching 1,100 well plugged per year (2034-2048)
- Years 31-75: 1,100 wells plugged per year (2049-2094)

This schedule slightly increased the number of wells plugged over the first 30 years of the program and increased the annual number of plugged wells from 1,000 to 1,100 from years 31 to 75 to reflect an increase of 5,000 additional wells in their inventory at that time. Included in the 2019, 2020, and 2021 investor reports and other financial reports in 2020 and 2021, was an 'illustrative run-off model of DGO's existing assets" over 75 years that projected cash flow and P&A expenditures. Most recently, in October 2021, Diversified included a "roll-off" plan of its proved developed and producing (PDP) wells, including the retirement of its wells (69,000) over 50 years instead of 75 years.[25] In January 2022, Diversified also stated that they plan to begin plugging 200 wells per year by 2023.

For the present analysis, we assume Diversified sticks to its 75-year plugging program for its well inventory, which we currently estimate at 65,000 wells to be decommissioned by 2095. Our projected plugging program schedule begins in 2021 and uses the following timeline:

- Years 1-2: 136 wells plugged in 2021 and 150 wells plugged in 2022
- Years 3-11: 200 wells plugged per year (2023-2033)
- Years 15-30: Linear increase in plugging until reaching 1,135 well plugged per year (2034-2048)
- Years 31-75: 1,135 wells plugged per year (2049-2094) and 344 in 2095

Plugging Costs on Decommissioning Wells

As noted previously, Diversified assumes (2021) it will cost, on average, $25,000 to plug each well in its inventory in 2021, but in their 2021 Annual Report they estimated a plugging cost of $22,500 per well.[26]

As noted in Appendix 1, the $22,500 P&A cost per well is less than half (on average) of what the best available data shows for plugging costs in states with Diversified wells. This analysis also does not take into consideration that as wells age, they can become more expensive to P&A. Nor does this analysis take into consideration new technology or other efficiencies that could lower future P&A costs. The P&A cost is in 2021 dollars.

Projecting Commodity Revenue for Current Well Inventory

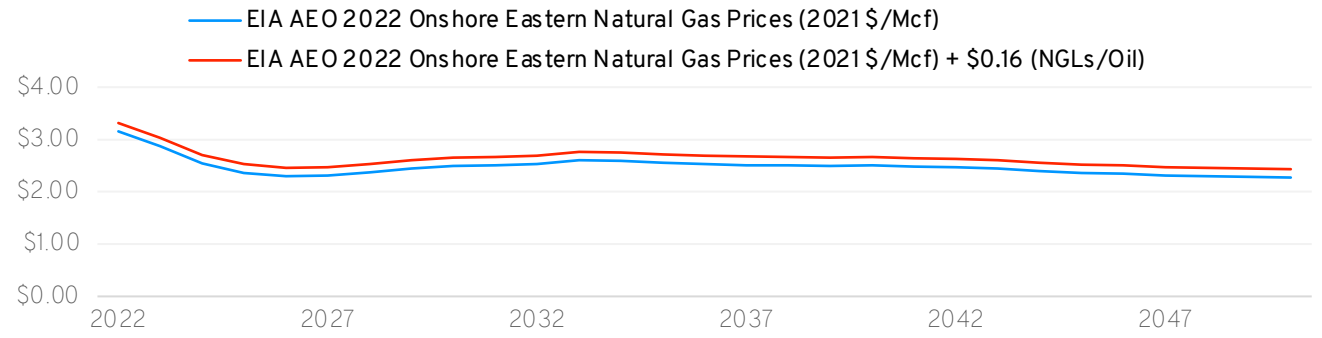
According to Diversified's 2021 Annual Report, the company produced 43,257,000 barrels of oil equivalent (BOE) in 2021.[27] This is equivalent to 259 billion cubic feet equivalent (Bcfe) or 259,543,000 Mcfe (thousand cubic feet equivalent) of natural gas. Total commodity revenue for Diversified was $973.1 million (excluding impact of derivatives), for an average price of $3.75 per Mcfe.[28] In 2021, commodity revenues comprised 97 percent of total revenues. (Mid-stream comprised 3 percent or $32 million in revenues in 2021, but also $60 million in operating expenses).

Diversified has projected varying decline rates over the past three years in its financial fillings. These decline rates range from 5 percent in 2019, 7 percent in 2020, and mostly recently, 9 percent in 2021 and 2022.[29] This analysis uses a 9 percent annual production decline to estimate future production.

To estimate future commodity revenue from future production, this analysis uses onshore eastern United States natural gas price projections from the *2022 Annual Energy Outlook* published by the US Energy and Information Administration (EIA) from 2021 to 2050.[30] According to EIA's reference case, onshore eastern US natural gas prices will average $2.48 per Mcf from 2022 to 2050. This analysis assumes that natural gas prices between 2052 and 2095 are the same as year 2050, which is $2.27 per Mcf (Figure 2A3).

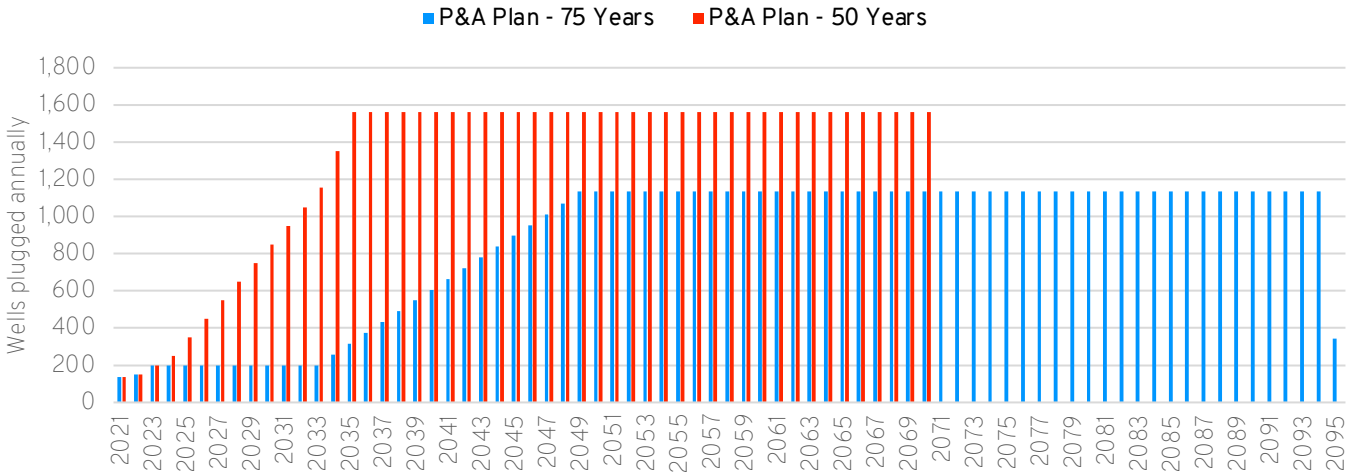
In addition to using forecasted EIA natural gas prices, this analysis includes an additional $0.16 per Mcf to adjust for the inclusion of oil and natural gas liquid production that is part of Diversified's commodity revenues. According to Diversified's annual reports from 2017 to 2021, natural gas comprised 90 percent of their production and 85 percent of their commodity revenue, on average.[31] Natural gas liquids made up 9.5 percent of commodity revenue and 9 percent of revenue while oil production comprised 2 percent of production and 5 percent of commodity revenue (rounded figures). Over these five years, the average Mcf price for only natural gas was $2.59 compared to the average price of $2.75 per Mcfe, which includes natural gas, oil, and natural gas liquids (rounded). To account for NGLs and oil, this analysis adds an additional $0.16 per Mcf to each projected price of natural gas from EIA projections.

Figure 2A3: Natural Gas Price Projections (2021 Dollars)



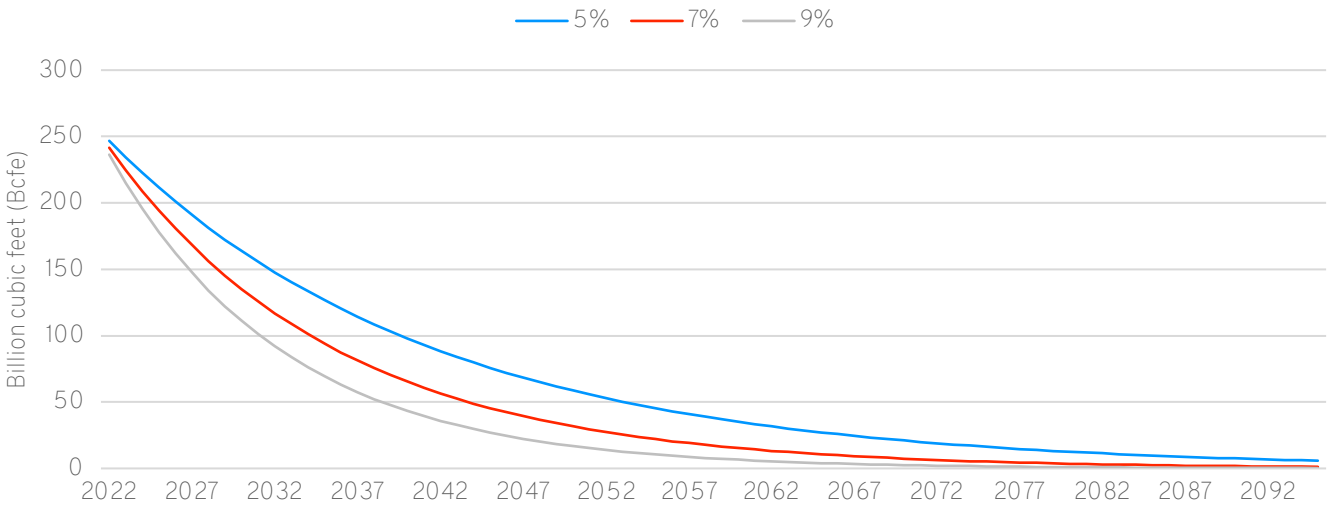
Source: EIA AEO 2022 and ORVI analysis of Diversified Energy Annual Reports (2017-2021)

Figure 3A3: Projected 75- and 50-year P&A Plan (n=65,000 wells)



Source: ORVI analysis of Diversified Energy financial reports

Figure 4A3: Projected Production by Decline Rate (2021 production = 259.5 Bcfe)



Source: ORVI analysis of Diversified Energy financial reports

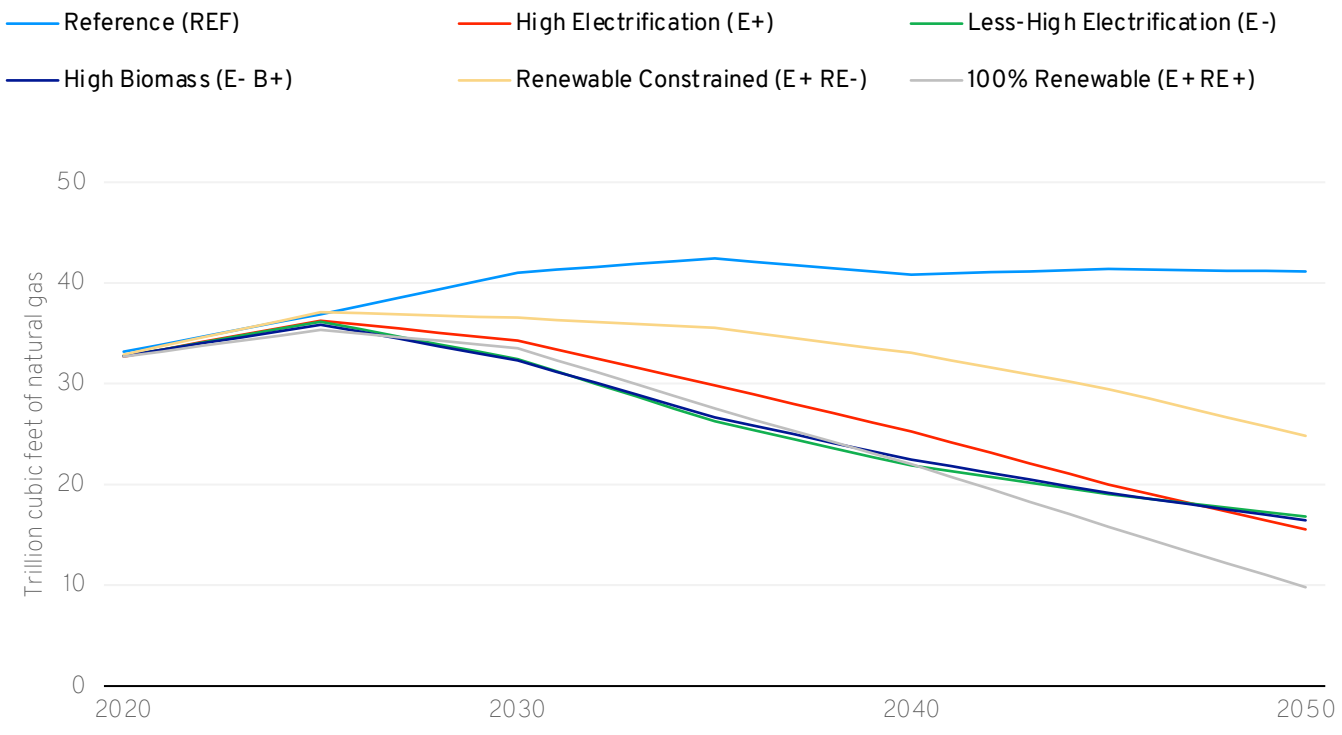
Impact of Carbon Reduction Goals on Natural Gas Production

On top of annual production declines from the exhaustion of natural gas reserves, the target of net-zero emissions of greenhouse gases by 2050 pledged by major corporations, municipalities, states, and national governments could lead to further declines in Diversified's natural gas production output over the next several years and decades. Net-Zero America, a project of Princeton University funded by BP and ExxonMobile, published a recent study modeling several pathways to achieve an economy-wide target of net-zero emissions.[32] Diversified has accelerated its own "net-zero emissions target" by 10 years, from 2050 to 2040, per its 2021 annual report.[33]

According to projections from Princeton's Net-Zero America project, meeting net-zero emissions by 2050 in the US will "require the earlier than planned closure of an estimated 0.5 million gas wells during the first decade of transition, requiring $25 billion for plugging and abandoning wells in addition to other remediation costs."[34] In 2019, there were approximately 969,136 active oil and gas wells in the US, including 538,968 that produced primarily natural gas.[35] Of these gas wells, approximately 31 percent (169,267) produced less than 1 BOED and 77 percent (418,859) were stripper wells (< 15BOED).

Net-Zero America modeled five distinct net-zero scenarios or pathways, along a reference case using projections from the U.S. Energy Information Administration's 2019 Annual Energy Outlook (Figure 5A3) (Figure 6A3). The five scenarios: Reference (REF), High Electrification (E+), Less-High Electrification (E-), High Biomass (E- B+), Resource-Constrained (E+ R-), and 100 percent Renewable (R+ E+). Based on this modeling, it found that "natural gas consumption declines between 50% (E+RE-) and 100% (E+RE+) across the suite of NZ scenarios, while the consumption stays relatively flat in the REF scenario." Including natural gas exports, NZ finds that natural gas production declines between 40% (E+RE-) and 75% (E+RE-) from 2020 to 2050. The "Renewable Constrained" scenario (E+RE-) includes "more CO2 storage to enable the option of more fossil fuel use" such as natural gas.[36]

Figure 5A3: Net-Zero Projections of US Natural Gas Production by Scenario (Including Exports)



Source: Erin Mayfield and Chris Greig, Andlinger Center for Energy and Environment, Princeton University, Net-Zero America: Annex N: Fossil Fuel Transitions, December 21, 2020

Figure 6A3: Net-Zero America Project's Net-Zero Scenario Descriptions

Scenario 1

E+
High Electrification

- Nearly full electrification of transport and buildings by 2050
- No land-use change for biomass supply allowed
- Few other constraints on energy supply options

Scenario 2

E-
Less-High Electrification

- Less-rapid electrification of transport and buildings
- No land-use change for biomass supply allowed
- Few other constraints on energy supply options

Scenario 3

E- B+
High Biomass

- Less-rapid electrification of transport and buildings
- Biomass supply requires converting some agricultural land from food to energy crops
- Few other constraints on energy supply options

Scenario 4

E+ RE-
Renewable Constrained

- Nearly full electrification of transport and buildings by 2050
- Solar and wind power annual capacity additions constrained to historical maximum
- No land-use change for biomass supply allowed
- Few other constraints on energy supply options

Scenario 5

E+ RE+
100% Renewable

- Nearly full electrification of transport and buildings by 2050
- No fossil fuel use allowed by 2050
- No land-use change for biomass supply allowed
- No new nuclear power construction allowed, existing plants retired
- No underground storage of CO2 allowed

Scenario 6

REF
Reference

- Based on US EIA, *Annual Energy Outlook 2019* (Reference case, no new policies)
- No greenhouse gas emission constraints imposed
- Same (low) projected oil and gas prices as for net-zero pathways

Source: Erin Mayfield and Chris Greig, Andlinger Center for Energy and Environment, Princeton University, Net-Zero America: Annex N: Fossil Fuel Transitions, December 21, 2020

Appendix 4: Additional Detail on Timeline of Diversified's Financial Assumptions and Accounting Practices[37]

2014

- Recorded "Gain on Bargain Purchase," an accounting practice that, to industry experts' knowledge, no other gas producer has used—even after buying companies out of bankruptcy. By booking a paper gain after acquiring other companies' wells, Diversified boosted its net income. In subsequent years, this was often the biggest source of income for the company. Generated two thirds (66%) of its operating profit from Gains on Bargain Purchase from 2014-2018.
- Recorded a ***Gain on Bargain Purchase on each of its 12 acquisitions*** from 2014-2018.

2016

- Its ***$24 million Gain on Bargain Purchase*** was ***greater than Operating Profit*** of $22.5 million.

2017

- Gain on Bargain Purchase accounted for ***more than 90% of Operating Profit.*** In its restated 2017 financial results, Gain on Bargain Purchase for 2017 was further increased, from $11.60 million to $37.1 million. This increase allowed the company to restate its operating income, increasing it from $16.2 million to $41.2 million.
- Went public; listed on Alternative Investment Market, in London.

2018

- Extended the economic lives of its wells ***from 30 years to 73 years.*** No explanation was given for increasing the useful life from 2047 to 2093. The company's then-accounting firm, Crowe, did not raise this as a key audit concern.
- ***Reduced AROs by 90%*** on 11,000 wells purchased from CNX, a publicly traded gas producer in Appalachia. CNX had listed the ARO associated with these wells at $197 million.[38] Post-acquisition, Diversified recorded the ARO for the same wells at $14.4 million.[39] The ARO was an explicit part of the sale from CNX, which noted, "In connection with the sale, the buyer assumed approximately $196,514 of asset retirement obligations." The ARO reduction was not explained in Diversified's 2018 financial statements. Lowered ***Asset Retirement Obligation (ARO) liabilities***, which represent the future costs a company will incur to plug its wells, by hundreds of millions of dollars because of this change.
- Booked $173.5 million Gains on Bargain Purchases, representing 59 percent of operating profit that year.
- ***Omitted a $150,000 well plugging cost*** in an investor presentation, which would have called into question the $25,000 per well P&A cost assumption.[40]

2019

- Extended weighted average well clean-up costs to ***more than 50 years***. Asset Retirement Obligations (AROs) likely understated by hundreds of millions of dollars.
- Outside auditor, Crowe, considered ***"material misstatement and inconsistencies"*** were made for asset retirement obligations.[41] Though the issue was raised as an audit matter, AROs were not changed.
- ***Recorded no impairments/write-downs***, even as natural gas price drops to lowest price in decades. Outside auditor Crowe raises the issue as a key audit matter but agrees that no impairments are warranted.
- Estimated annual cost increases for well clean-up costs to ***less than 2.5% per year***. Other companies, such as EQT, maintained clean-up costs are expected to increase dramatically. [42]
- Used 6 percent as its well decline rate, despite ***similar wells decline rates that are 20 percent***.[43]

2020

- Received ***$80.4 million*** in federal marginal well tax credits, which can be carried forward 20 years. Though legal, this federal tax credit is at odds with the ***need to plug marginal wells***, especially ones that are idle or nearly so, many of which leak methane.
- Listed on London Stock Exchange.
- Recorded a $17.9 million Gain on Bargain Purchase from its $122.9 million acquisition of Carbon Energy.
- PwC, the company's new outside auditor, raises issue of ***lack of impairments*** as "key audit matter. PwC concluded that the company's decision not to impair any of its assets was "reasonable."[44]
- ***$25,000 average plugging costs*** assumed, far below industry estimates.
- ***Economic life of wells extended to 2095***, with weighted average plugging back-loaded to more than 50 years.

2021

- Recorded ***$173 million in marginal well tax credits***, in the first half of the year, which put a dent in the company's $305.7 million first half operating loss.
- Generated $85 million marginal well tax credits for the full year.
- ***Reported corporate-level decline rate of*** 9 percent, though outside analysis suggests base decline rates may be significantly higher, at 19 percent.[45]
- Recorded $58 million Gain on Bargain Purchases, making 2021 the 8th consecutive year the company has used this accounting practice. The company acknowledged in its financial filings, for the first time apparently, that the practice was "uncommon."[46]

Appendix 5: Additional Detail on Diversified's AROs, Including Revaluation of AROs Post-Acquisition and Assumptions Underlying AROs

The accounting for Diversified's Asset Retirement Obligations (AROs) is highly unusual. Its accounting practices include revaluing AROs post-acquisition and relying on assumptions that are far removed from industry norms. If Diversified valued its AROs based on assumptions that are in line with industry norms, its liabilities could potentially exceed its assets. At the end of 2020, Diversified had $2.29 billion in total assets.[47] The company's ARO liabilities would have been $1.89 billion, had it kept its net discount rate constant, but it used industry norms for P&A costs and timing, $50,000 per well and a 15-year average life for its remaining inventory. The restatement of its AROs would have increased its total liabilities to nearly $3 billion.

In 2021, Diversified Energy reported $3.49 billion in total assets.[48] If its AROs used industry norms of $50,000 per well and a 15-year average life for its remaining inventory, using the net discount rate in applied in 2021 of .029, its ARO would have been $2.1 billion. If it used a $75,000 per well P&A cost with a 15-year average life, its ARO liability would be $3.18 billion.

In addition to Diversified's revaluation of the AROs associated with its 11,000 wells acquired from CNX Resources in 2018 from $197 million to $14 million[49] as described in the body of the report, the company has also revalued wells post-acquisition numerous other times since 2016.

- In 2018, Diversified also purchased approximately 11,250 wells from EQT, the largest natural gas producer in the country. EQT's ARO associated with these wells was approximately $200 million.[50] Post-acquisition, the ARO was reduced on Diversified's books to $26.3 million, just 11.6% of the ARO amount pre-sale.

- A revaluation of this magnitude should be examined carefully by a company's outside auditors. The company's outside auditor, London-based Crowe Clark Whitehill (which was renamed Crowe LP in 2019), essentially gave the company a pass, noting: "After performing the testing above, we concluded that the valuation of oil and gas properties and other acquired assets and liabilities were within ranges we consider to be acceptable and appropriate for the relevant assets and liabilities."[51]

- Both CNX and EQT are publicly traded companies, whose financials are each audited by US-based auditor Ernst & Young. Ernst & Young has served as EQT's outside auditor since 1950 and CNX's outside auditor since 2008. It is likely EQT, CNX and their outside auditors carefully assess the value of an item on their balance sheets that represent $200 million.

- Ernst and Young, based on their long-term associations with two of the largest publicly traded Appalachian gas producers, have deep experience with conventional gas wells in Appalachia, including the likely costs to decommission them.

- The company's practice of "revaluing" ARO liabilities once it completes acquisitions dates back to 2016, based on an analysis by *Capitol Forum*.

Assumptions Underlying ARO Liabilities

The financial assumptions Diversified uses to calculate future decommissioning costs have lowered ARO liability, calling into question the company's financial wherewithal to fund the actual clean-up of its wells.The questionable assumptions outlined in this report include the following, some of which also appear in the main body of the report:

1. Low clean-up costs per well. In 2020, Diversified used a figure of $20,000 to $30,000 per well to decommission its wells, with an average of $25,000.[52] In 2021, the company plugged 136 wells at a reported $22,500 cost per well.[53] It used this lower amount, or something near that level, to calculate its ARO liability and to assure stakeholders—including debt and equity investors, regulators and credit rating agencies—it will have sufficient cash in the future to fund these costs. Diversified's plugging cost assumption is unrealistically low, based on a thorough comparison as detailed in Section 2.7.1 and in Appendix 2.

    - Industry experts estimate decommissioning conventional wells at a much higher level. See Appendix 2 for a detailed examination of P&A costs.
    - Unconventional wells (or fracked wells, which include horizontal drilling and hydraulic fracturing), which make up an increasing percentage of Diversified's wells with its recent acquisitions, are estimated to cost significantly more.
    - Some of Diversified's wells cost far more than the average to plug. The company does not disclose these in investor presentations, according to *Capitol Forum*, which revealed a 2018 clean-up expense of $150,000 for "a deep formation well."[54]
    - Diversified does not appear to incorporate the significantly higher decommissioning costs for its unconventional wells, maintaining an average of $22,500 to $23,500 for all its wells. Diversified currently has 1,680 fracked wells in its inventory, according to *Capitol Forum Upstream's* database.[55]
    - Diversified's own independent reserves engineer, Wright and Company (W&C), produced higher estimates for clean-up costs in September 2018. W&C calculated $29,862/well. Diversified ignored this during two subsequent 2018 investor statements.[56] Wright is no longer the company's reserve auditor.
    - To support its claim, Diversified has a variety of explanations, including citing specific actual costs from wells it has recently plugged. However, with roughly 65,000 wells to choose from, it may have "cherry picked" a set of relatively simple wells to clean up.
    - Diversified compares the cost of retiring a conventional well with the cost of retiring an offshore well, which could run into the hundreds of millions.[57] This is an irrelevant comparison.

2. Long economic lives of its wells. The company estimates some of its wells will be producing gas or oil through 2095. Even the most optimistic forecasts of the EIA, IEA, or the oil majors do not anticipate demand for natural gas remaining sufficiently robust to support this assumption.

3. Extensions of the useful life of its wells, more than doubling their economic lives from 30 to 75 years. By changing this key assumption in 2018, the company significantly reduced its ARO liabilities.

    - In its 2017 financial statements, Diversified calculated its ARO using clean-up costs "presently estimated through 2047, when the company expects its producing oil and gas properties to reach the end of their economic lives."[58] The following year, the economic lives of its wells had been extended and were "presently estimated through to 2093."[59] No explanation was given for the massive extension of its wells' economic lives. Again, in 2020, the company further extended its wells economic lives to 2095.[60]
    - Without making this change, the company's shareholder equity would have been greatly reduced in 2018, when it made the change.
    - The decision to extend the economic life of the wells appears to have no justification. No industry norms were used.
    - This change was not considered a key audit matter by the company's then-auditors, Crowe, or even noted as a significant change.[61]
    - Only in 2019, a year after the change was made, did Crowe raise the matter as a key audit matter.[62]

4. Long ramp-up timeline modeled to plug uneconomic wells. The company uses a weighted average of more than 50 years to retire its wells,[63] with most actual clean-up scheduled in the later years. In 2020, the company retired 92 of its 67,000 wells. At that rate, it would take over 700 years to retire all the wells. In 2021, the company retired 136 wells.

    - PwC, which became the company's outside auditor in fiscal year 2020, did not make the timing of plugging wells a key audit matter in 2020—despite the fact that Diversified's timeframe is so far outside industry norms.

5. Low annual cost inflation over the next 73 years (the date Diversified expects to its wells' economic lives to end). Diversified has used an inflation rate of 3 percent to calculate future clean-up costs from 2014 to 2017. It reduced this inflation rate assumption for clean-up costs to 2.2 percent for 2018 and 2.3 percent in 2019, and only 2.1 percent in 2020.[64] In its 2021 financial filings, the company used a 2.5 percent cost inflation rate.[65]

    - The 2021 net discount rate was 2.9 percent, which nets out a 5.4 percent discount rate with a. 2.5 percent cost inflation rate.[66]
    - The 2020 net discount rate was 3.7 percent, which nets out the discount rate of 5.8 percent and the cost inflation rate of 2.1 percent.[67]
    - The net discount rate for 2019 was 5 percent, which included 7.3 percent for a discount rate and 2.3 percent for an inflation rate.[68]
    - Other owners of gas wells have experienced higher costs and adjusted their AROS accordingly. EQT, for example, noted in its 2019 annual report: "During 2018 and 2017, the Company had changes in estimates for the plugging of conventional and horizontal wells, primarily related to increased cost assumptions of complying with existing regulatory requirements derived, in part, based on recent plugging experience and actual costs incurred. The Company operates in several states that have implemented enhanced requirements that resulted in the use of additional materials during the plugging process which has increased the estimated cost to plug these wells over recent years."[69]

6. Classification of nearly all wells as economically productive, when some are likely idle or no longer economically viable. As the largest owner of conventional wells in Appalachia, Diversified's wells likely mirror the larger set of conventional wells. An analysis of Diversified's wells in Appalachia indicates that, depending on how they are classified, most of Diversified's wells may not be economically viable. At best, most Diversified wells are financially distressed. See Section 1 for a complete description of Diversified's wells.[70]

7. The assumption that non-producing, or idle, wells can be brought back to production. By claiming that idle wells can become productive in the future, Diversified can delay plugging costs for additional wells that would be required to be immediately plugged based on the consent agreements. While the company has claimed to revitalize some wells each year, industry experts claim that the production burst from reopened wells might simply be the result of backlogged gas build-up, and that after a burst of production, it will rapidly decline after a few months. Diversified does not cite costs associated with reopening its wells.

8. Hard-to-verify claims about its ongoing asset retirement program. The company reports cost data about its ongoing plugging efforts and reports the results to investors. However, the company claims are, at present, impossible to verify. An industry expert who has followed the oil and gas sector for decades, Tom Loughrey, co-founder of FLOW, has called for the company to make its well data public, so that stakeholders can access Google Earth to verify its claims regarding its ongoing program.[71]

9. Shifting net discount rates assumptions, without sufficient explanation, that reduce the present value of its AROs well below a realistic level.

10. Failure to incorporate far higher costs to P&A a leaking well than a non-leaker.

Appendix 6: Additional Information on Diversified's Use of Gain on Bargain Purchase

Gain on Bargain Purchase Not Used by Other Producers

Diversified has used Gains on Bargain Purchases each year since at least 2014,[72] when it accelerated its acquisition strategy. It is difficult to overstate how uncommon an accounting practice this is, but a comparison with other companies in the oil and gas space is illuminating.

In contrast to Diversified's use of Gain on Bargain Purchase to boost income and asset values, other gas producers in Appalachia, based on our research, have not used this accounting practice. Gas producers in Appalachia have been *in extremis* since at least 2010, with gas prices dropping from more than $12/MMBtu in 2008 to less than $2.00/MMBtu in 2020. More than 15 gas producers in Appalachia have filed for bankruptcy, including Magnum Hunter (2015); Warren Resources, Penn Virginia, Stone Energy, and Ultra Petroleum (2016); Rex Energy, EV Energy Partners, and EXCO (2018); EdgeMarc and Arsenal Resources (2019); Chesapeake, Gulfport Energy, BJ Services, and FTS (2020); Rockdale Marcellus and Abarta Energy (2021), and Tilden Marcellus in 2022

When these bankrupt companies' assets have been acquired by publicly traded companies, the acquiring companies have not recorded Gains on Bargain Purchases.

Table 1A6 lists the producers in Appalachia that have filed for bankruptcy since 2015, and Figure 2A6 the acquirers.

Table 1A6: Appalachian Gas Producers' Bankruptcy Fillings, 2015-2021

Year	Bankruptcy Filings
2015	Magnum Hunter (2015);
2016	Warren Resources, Penn Virginia, Stone Energy, Ultra Petroleum
2018	Rex Energy, EV Energy Partners, EXCO
2019	EdgeMarc, Arsenal Resources
2020	Chesapeake, Gulfport Energy, BJ Services, FTS
2021	Rockdale Marcellus; Abarta Energy

Source: ORVI analysis

Table 2A6: Acquirers of the Assets from Appalachian Gas Producers, Post-Bankruptcy, Partial List

	Acquirer	Bankrupt Acquiree	Year
1	Eclipse Resources	Magnum Hunter Resources	2018
	Blue Ridge	Magnum Hunter Resources	2018
2	GSO Capital	Warren Resources	2016
	Claren Road Asset Management	Warren Resources	2016
3	Denbury Resources	Penn Virginia	2019
4	EQT	Stone Energy	2017
5	Alta Resources	Ultra Petroleum	2016
6	PennEnergy Resources	Rex Energy	2018
7	LOLA Energy	Edge Marc	2021

Source: ORVI analysis

Gain on Bargain Purchase Counter to Principle of Conservatism

This unusual accounting practice is at odds with the fundamental principle of conservatism, which holds that accountants should "be in the direction of understatement rather than overstatement of net income and net assets."[73] The textbook definition of conservatism "generally means in a situation where revenue and costs are questionable, less income is recorded, and more expenses are recorded" under Generally Accepted Accounting Principles (GAAP).

The International Financial Reporting Standards (IFRS), which governs Diversified's accounting practices since it is listed on a foreign stock exchange, has different rules surrounding expenses, revenue, and income—including how an entity would realize a Gain on Bargain Purchase.

For decades, the Financial Accounting Standards Board (FASB), applying GAAP,[74] has codified the meaning and understanding of conservatism. Currently, nearly all reputable accountants adhere to the fundamental principle that the value of assets is not increased above their purchase price, and that income is not overstated.

Numerous academic journals have suggested the practice of reporting Gain on Bargain Purchase is highly irregular and to be used in extremely rare circumstances.

The Conduct Committee of the Financial Reporting Council (FRC) requested information on Diversified's 2018 Annual reports. FRC's focus of the inquiry included Diversified's use of Gain on Bargain Purchase.[75] The FRC purview was to "consider compliance with reporting requirements and [to] stimulate improvements in the quality of corporate reporting" and did *not* provide assurance that the material in Diversified's 2018 Annual report was materially correct.[76]

One of the major issues auditor PwC focused on when it began its 2020 audit of Diversified's financials focused on its use of Gain on Bargain Purchase. PwC became the external auditor for the company's financials in 2020, after the company was listed on the London Stock Exchange in 2020. Prior to PwC, outside auditors were Crowe Clark Whitehill, LLP in 2016, since renamed Crowe.

In its 2021 Annual Report, PwC made Gains on Bargain Purchases, a key audit matter when analyzing the company's acquisitions in 2021. PwC concluded that "Based on our audit procedures performed, we consider the accounting for all four acquisitions and the related valuation of gas and oil properties and other assets acquired, and liabilities assumed, to be reasonable."[77]

Appendix 7: Federal Marginal Oil & Gas Well Production Credit

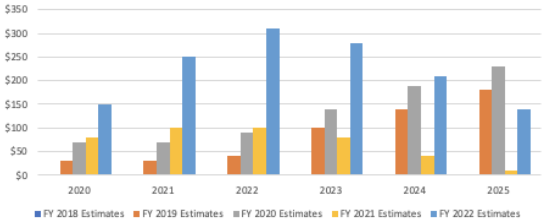
By 2016, gas prices were sufficiently low that the gas producers could begin claiming the credit. The amount of credit was $.66/1,000 cubic feet (Mcf) in 2020 for a marginal gas well, defined as a well that produces less than 90 Mcf/day. Gas producers who own and operate qualified stripper wells could receive as much as $4,336.20 in tax savings per qualified well, according to Schneider Downs, an accounting firm.[78]

To qualify for a marginal well tax credit, a well must produce fewer than 15 barrels of oil equivalents (BOE) per day, or roughly 90 Mcf of gas/day. The maximum production on which a credit can be claimed is 1,095 barrels or BOE per year, per well, according to Deloitte.[79] Tax credits are based on the average price for the prior year. There is no limit on the number of qualified wells that a taxpayer, such as Diversified, can claim. Unused marginal well tax credits can be carried back five years or forward 20 years.

The rationale for the marginal well tax credit, when it was enacted in 2004, was to provide an incentive for oil and gas producers to keep their wells producing when prices were low, by offering a safety net— presumably for small producers. It was meant as a countercyclical measure to protect small producers when prices fell too low.

The US Treasury projects federal tax expenditures that include the marginal well tax credit beginning in FY 2018. Figure 1A7 shows the projections from 2018 to 2022 (the fiscal year ends in June 2021). As the graph illustrates, the latest projections show a large increase over prior years for 2020 to 2023. Diversified is either receiving the lion's share of the credit or the Treasury is underestimating the amount of the tax expenditure. The Joint Committee on Taxation (JCT) also publishes tax expenditure estimates for the United States Congress. That group maintains the marginal well tax credit will be below $50 million per year for FY 2020-2024, so the amounts are not disclosed.[80]

Figure 1A7: Estimates of Marginal Well Tax Credit Expenditures



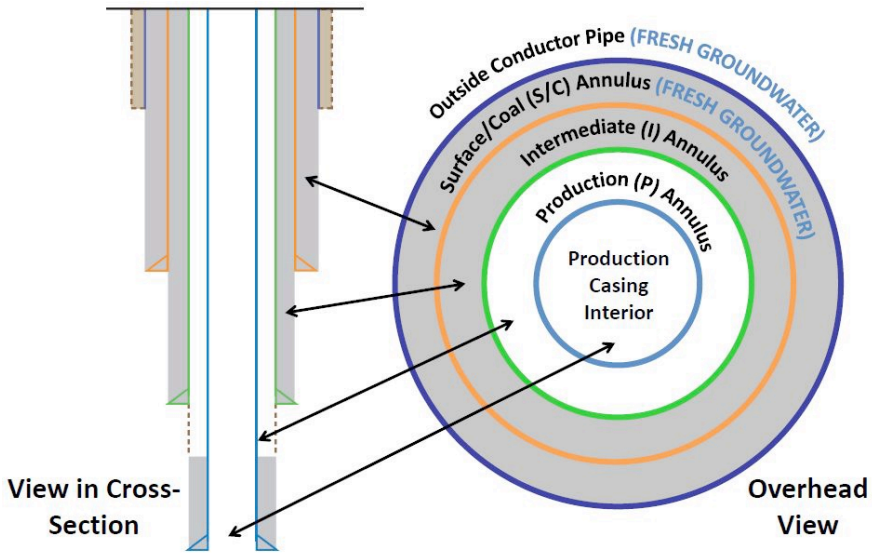
Source: ORVI analysis

Appendix 8: Investigating Diversified's Company-Reported Methane Emissions Data Post-Acquisitions

The PADEP's Mechanical Integrity Assessment Program

Recognizing the risks of methane emissions from leaking wells, the Pennsylvania Department of Environmental Protection (PADEP) created the Mechanical Integrity Assessment Program (MIT Program) in 2011.[81] The Program created a well-monitoring requirement that applies to all oil and gas operators of both active wells and abandoned wells that have not yet been plugged. The MIT Program requires quarterly inspections at wells to identify and to measure, if possible, the well head pressure or water level, open gas flow readings or shut-in pressures associated with the well's production annulus, gas escaping from other annuli, and signs of progressive corrosion (Figure 1A8.)

Figure 1A8: Schematic of Casing/Cement Arrangement for a Aell with All Required and Optional Casings[82]



Source: Pennsylvania Department of Environmental Protection Mechanical Integrity Assessment Program

Note: Grayed areas indicate required cement sheaths.

Operators of unconventional wells are required to report results quarterly; other operators must report at least once a year. Pennsylvania is currently the only state requiring quarterly mechanical integrity inspections of all active and unplugged abandoned wells.

In this appendix we present details of an analysis of this data beginning with the first Program reporting year, 2014, and ending with the data reported in 2020 with particular attention to the reports produced by Diversified.

Overview of Reported Emissions, 2014-2020

Table 1A8 on the following page presents the history of natural gas emissions in cubic feet per day (cpfd) from all wells reporting to the MIT Program by location of gas flow from the well; the number of operators reporting each year; the number of wells for which there was at least one report, and the share of each reported by Diversified. Note that, contrary to the requirements of the Program, not all operators file reports on each of their wells each year. Ingraffea *et al.* (2020)[83] analyzed all Program data from 2014 to 2018 and found the response rate to be highly variable among operators. Therefore, the emissions noted in Table 1A8 are reported, not actual, emissions and are lower bounds on actual emissions.

Among the 638 operators, including Diversified, reporting to the Program in 2020, Diversified was responsible for about 17 percent of total reported emissions from leaking wells in the state. The data shown in Table 1A8 actually dilute the influence of Diversified on natural gas emissions.[84] Since almost all of Diversified wells (Diversified acquired 140 coalbed methane wells in 2019 and reported no emissions from any of them) fall into two types, gas and combined gas and oil, what appears to be a complete and clearer picture emerges in Table 2A8.[85] It shows that by 2020, among 561 operators, Diversified operated about a third of the wells but claimed responsibility for less than a quarter of emissions from wells of these two types.

Table 1A8: Time History of Natural Gas Emissions from All Wells, Diversified Wells by Emissions Location[86]

	Well count	Production annulus flow (cfpd)	Vent flow (cfpd)	Freshwater annulus flow (cfpd)	Intermediate annulus flow (cfpd)	Total emissions (cfpd)
2014						
Diversified	1,159	52,309	-	-	-	52,309
1,154 operators	90,505	2,791,944	343,085	2,272	6,322	3,143,622
Percentage	1	2	-	-	-	2
2015						
Diversified	2,550	57,950	-	-	-	57,950
1,026 operators	89,178	2,408,752	3,661,945	16	12,336	6,083,048
Percentage	2	2	-	-	-	1
2016						
Diversified	8,775	273,107	-	-	-	273,107
774 operators	85,162	754,489	78,988	326	215	834,018
Percentage	10	36	-	-	-	33
2017						
Diversified	13,928	314,241	-	-	-	314,241
702 operators	83,856	762,607	2,582,703	52	1,251	3,346,613
Percentage	17	41	-	-	-	9
2018						
Diversified	19,074	267,501	-	-	-	267,501
635 operators	84,141	1,245,995	2,027,954	6	1,585	3,275,541
Percentage	23	21	-	-	-	8
2019						
Diversified	22,109	177,568	-	-	-	177,568
661 operators	87,544	609,040	1,369,307	511	2,817	1,981,675
Percentage	25	29	-	-	-	9
2020						
Diversified	22,178	139,261	766	-	-	140,027
638 operators	84,983	620,022	183,249	17	2,676	805,964
Percentage	25	22	-	-	-	17

Source: Pennsylvania Department of Environmental Protection Mechanical Integrity Assessment Program

Table 2A8: Time History of Natural Gas Emissions from All Gas and Combined Oil & Gas Wells by Location of Emissions[87]

	Well count	Production annulus flow (cfpd)	Vent flow (cfpd)	Freshwater annulus flow (cfpd)	Intermediate annulus flow (cfpd)	Total emissions (cfpd)
2014						
Diversified	1,159	52,309	-	-	-	52,309
989 operators	66,622	2,539,536	178,649	2,272	6,312	2,726,768
Percent	1	2	-	-	-	2
2015						
Diversified	2,550	57,950	-	-	-	57,950
892 operators	65,496	2,200,836	422,633	6	12,336	2,635,810
Percent	3	3	-	-	-	2
2016						
Diversified	8,775	273,107	-	-	-	273,107
674 operators	64,023	542,455	76,351	326	215	619,347
Percent	13	50	-	-	-	44
2017						
Diversified	14,481	314,241	-	-	-	314,241
613 operators	63,327	574,205	381,022	52	1,251	956,530
Percent	22	55	-	-	-	33
2018						
Diversified	19,074	267,501	-	-	-	267,501
560 operators	64,145	1,028,886	255,116	6	1,585	1,285,594
Percent	29	26	-	-	-	21
2019						
Diversified	21,969	177,568	-	-	-	177,568
581 operators	65,669	440,579	208,765	511	2,817	652,672
Percent	32	40	-	-	-	27
2020						
Diversified	22,038	139,261	766	-	-	140,027
561 operators	65,464	438,150	133,748	17	2,676	574,591
Percent	32	32	1	-	-	24

Source: Pennsylvania Department of Environmental Protection Mechanical Integrity Assessment Program

Note: Table includes a small number of unconventional gas wells in 2019 and 2020.

Accuracy of Emissions Reported by Diversified

One would expect that as Diversified acquired more wells, all of them aging,[88] their emissions total would increase, unless they are detecting and repairing the leaking wells as they are acquired. No information is given by Diversified within the reporting protocols of the Program to indicate that leak repair was being done on any well. Figure 18 shows the trend in the number of Diversified's gas and combined oil and gas wells reporting to the MIT Program and the reported emissions from these wells.[89] Data from 2014 to 2017 follow the expected trend; data from 2018 to 2020 are a marked departure from the trend.

Table 3A8 gives insight into this departure.[90] The 2018 emissions bar in Figure 18 is questionable because, despite the fact that over 100 more leaking wells were detected, over 4,000 wells were reported as not having a reliable measurement.[91] However, in that same year, Diversified reported being able to make a leak detection as low as one cpfd day on over 20 other wells. The 2019 emissions bar is questionable because it includes over 9,000 wells reporting that testing on them was not applicable; in 2018 and 2020 testing in only 81 and 35 Diversified wells was reported not applicable, respectively; and in 2019 only 297 wells were tested for leakage.[92] The 2020 emissions bar is questionable because it includes a decrease to only 261 wells with reported leakage.[93] The average leaking well rate for conventional wells in 2014 to 2018 for all operators was 3.4 percent.[94] The leaking well rate for Diversified wells was about 4 percent in 2014 when it owned relatively few wells but that rate continuously declined to about 1.2 percent in 2020, when it owned over 20,000. The 2020 data bar also includes over 9,600 wells reporting no reliable measurement and over 6,300 wells with reported annular shut-in pressure but no emissions.[95] The surface plumbing that accesses the production annulus can be opened for emissions testing, or closed for pressure testing: if closed, leakage can still occur through migration outside the well, but this would not be measured or reported.

Table 3A8: Post-2016 Trends in Data Reported to the MIT Program, including Distribution of Reporting Categories[96]

	2017	2018	2019	2020
Total reporting wells	13,914	19,050	22,079	21,433
Wells tested for gas leakage	3,462	3,765	297	3,919
Wells with leakage	176	285	297	261
Reported emissions (cfpd)	314,241	267,612	177,568	139,997
Wells reported not inspectable	1,806	1,881	1,640	2,314
Wells reported no reliable measurement	5,501	9,791	10,290	9,623
Well measurement reported not applicable	29	81	9506	90
Wells reporting pressure reading but no emissions	3,778	4,382	1,117	6,324

Source: Pennsylvania Department of Environmental Protection Mechanical Integrity Assessment Program

Aberrant Year-to-Year Reports for Highest Emitting Diversified Wells

Table 4A8 on the following page shows year-to-year reporting classifications, and leak rates, for Diversified's biggest leakers.[97] Here are a few of the aberrant reporting histories shown in this figure. In Table 4A8(a), Well #25994 shows a very high emission rate in 2014 quickly declining then changing to a pressure reading (psig). Well #23769 goes from a high emission rate, to no reliable report (NRM), to a zero reading, to a NA status, and finally back to a zero emission reading. *In Table 4A8(b), Well #34278 goes from a high emission rate to a high pressure reading, and finally to the I status!* In Table 4A8(d), Well #23651 goes from a high emission rate to a very high pressure. Well #21409 first reports a very high emission rate, to within 1 cfpd, then fails to report, and finally reports an emission rate about a third of its initial report value.[98]

Table 4A8: History of Emissions (cfpd) or Annual Pressure (psig) for Highest Emitting Diversified Wells in their First Year of Reporting[99]

TABLE 4A8(a)							
Well API #	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
005-25994	10000	800	1000	1000	1000	30 psig	30 psig
033-23769	5000	5000	5000	NRM	0	NA	0

TABLE 4A8(b)							
Well API #	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
063-34278		6000	1000	1000	1000	225 psig	I
033-23769	5000	5000	0	NRM	0	NA	0

TABLE 4A8(c)						
Well API #	**2016**	**2017**	**2018**	**2019**	**2020**
129-23340	45000	40000	30000	NA	2 psig
129-22706	15000	15000	13000	NA	NRM
129-22564	10000	13000	15000	NA	NRM
003-20996	6000	6000	0	NRM	NRM
065-26213	6000	NRM	NRM	NRM	NRM
063-35118	5000	5	5	5	5
065-21698	5000	0	0	NA	NR
065-26434	5000	NRM	NRM	NR	NR

TABLE 4A8(d)						
Well API #	**2016**	**2017**	**2018**	**2019**	**2020**
129-23340	45000	40000	30000	NA	2 psig
031-23651		33000	25000 psig	25000 psig	25000 psig
063-21409		15861	10689	NR	5385
063-33562		15020	13061	15016	0
129-22706	15000	15000	13000	NA	NRM
129-22564		13000	15000	NA	NRM
063-21408		8922	5948	83 psig	130 psig
063-20008		6130	1187	250	0 psig
003-20996		6000	0	NRM	NRM

Source: Pennsylvania Department of Environmental Protection Mechanical Integrity Assessment Program

Note: Apparently aberrant series of measurements shown in red.
NA = not applicable, I = inaccessible, NRM = no reliable measurement, NR = no report.

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88. The median age of Diversified gas and combined oil and gas wells in Pennsylvania with known spud dates, 22,189 wells, is 17 years. The oldest well is 121 years old, the youngest is eight. There are an additional 2,985 wells with unknown spud dates and inclusion of these wells would certainly increase the median age.
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