

## Methodology for Estimating Unplugged Onshore Abandoned and Active Wells in the United States

The Capitol Forum *Upstream* database provides real-time production and well reporting data for the Appalachian Basin (Kentucky, New York, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia) and Louisiana. Altogether, there are about 1.2 million documented wells included in the database, of which there are 781,000 drilled wells that have an operational status of abandoned, inactive, orphan, other, plugged, shut-in, and unknown. The number of wells with an operational status of plugged is 450,000, representing approximately 57.6 percent of drilled non-producing wells in these eight states.

A 2021 peer reviewed article by James P. Williams, Amara Regehr, and Mary Kang in the journal *Environmental Science and Technology* estimates there “at least 4,000,000” abandoned wells in 36 states in the United States.<sup>1</sup> Williams et al. define an abandoned well as a well with no recent production that has a status of “suspended, idle, orphaned, plugged, dormant, deserted, inactive, junked, temporarily abandoned, and shut-in.”<sup>2</sup> Williams et al. find that of the estimated 4,047,809 abandoned oil and gas (AOG) wells, including 1,562,364 undocumented AOG wells, that 56.7 percent or 2,296,916 are unplugged AOG wells based on the “data-wide percentage of unplugged and plugged wells gathered from state/provincial/territorial datasets.”<sup>3</sup>

To estimate the number of unplugged AOG wells, this analysis uses Table S2 from Williams et. al. Supplemental Information that provides estimated AOG wells for 36 states.<sup>4</sup> Table 1A below lists the counts of AOG wells for each state provided by Williams et al. and estimates that 56.7 percent of these AOG wells have a status of unplugged, which is commensurate with the estimate from Upstream database. However, it is highly likely that many of the wells assigned as “plugged” are likely improperly plugged since cement plugging standards were not widely adopted until the 1950s.<sup>5</sup> For example, according to *Upstream*, Ohio has 113,826 plugged wells and approximately 88,141 contain a plugging date. Of the wells with plugging dates, 29 percent (24,066) were plugged prior to 1955.

**Table 1** below includes the estimated number of conventional and horizontal wells for the 36 states using 2022 data from the US Energy Information Administration (EIA) and several state oil and gas regulatory divisions when EIA data was unavailable. In total, there are an estimated 2.3 million unplugged orphaned and abandoned wells along with 941,000 active conventional and horizontal wells in the 36 states. While many states have “horizontal wells,” some of these wells are not hydraulic fractured horizontal shale wells that produce significant production. We estimate there are at least 171,400 active hydraulic fractured horizontal wells in 11 states using EIA production data for 2023.

<b>Table A1: Estimated Abandoned and Active Onshore Oil and Gas Wells by State</b>
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<b>STATES (36)</b>	<b>AOG Wells (Williams 2021)</b>	<b>Unplugged AOG Wells (56.7%)</b>	<b>Active Conventional Wells (EIA 2023)</b>	<b>Active Horizontal Wells (EIA 2023)</b>	<b>Significant Hydraulic Fractured Horizontal Well Production (EIA 2024)</b>	<b>Total Unplugged Wells (Non-Hydraulic Fractured Horizontal Wells)</b>	<b>Total Unplugged Active Hydraulic Fractured Horizontal Wells</b>
Alabama	25,913	14,693	5,716	12	No	20,421	
Alaska	6,338	3,594	2,337	33	No	5,964	
Arizona	1,622	920	12	0	No	932	
Arkansas	13,696	7,766	5,482	5,492	Yes	13,248	5,492
California	204,769	116,104	46,439	2,189	No	164,732	
Colorado	91,075	51,640	35,688	10,126	Yes	87,328	10,126
Florida	1,331	755	65	0	No	820	
Idaho	25	14	0	0	No	14	
Illinois*	139,611	79,159	23,402	0	No	102,561	
Indiana*	67,159	38,079	6,984	0	No	45,063	
Iowa	334	189	0	0	No	189	
Kansas	426,142	241,623	67,788	71	No	309,482	
Kentucky	114,643	65,003	4,866	118	No	69,987	
Louisiana	232,917	132,064	25,309	5,436	Yes	157,373	5,436
Maryland	24	14	1	0	No	15	
Michigan	36,818	20,876	317	11,073	No	32,266	
Mississippi	30,286	17,172	2,671	266	No	20,109	
Missouri*	5,694	3,228	30	0	No	3,258	
Montana	50,086	28,399	7,694	1,723	No	37,816	
Nebraska	6,349	3,600	1,556	2	No	5,158	
Nevada	1,587	900	63	0	No	963	
New Mexico	68,229	38,686	47,634	12,099	Yes	86,320	12,099
New York	28,056	15,908	10,392	45	No	26,345	
North Dakota	30,341	17,203	2,057	17,455	Yes	19,260	17,455
Ohio	183,090	103,812	29,788	3,129	Yes	133,600	3,129
Oklahoma	280,034	158,779	54,137	16,878	Yes	212,916	16,878
Oregon*	968	549	8	0	No	557	
Pennsylvania	610,000	345,870	68,456	11,152	Yes	414,326	11,152
South Dakota	1,312	744	74	123	No	941	
Tennessee	15,066	8,542	1,844	20	No	10,406	
Texas	891,718	505,604	202,932	82,455	Yes	708,536	82,455
Utah	41,504	23,533	11,826	633	No	35,992	
Virginia	10,321	5,852	119	7,989	No	13,960	

Washington	1,295	734	0	0	No	734	
West Virginia	410,000	232,470	51,699	4,170	Yes	284,169	4,170
Wyoming	20,175	11,439	27,938	3,040	Yes	39,377	3,040
TOTAL	4,048,528	2,295,515	745,324	195,729		3,065,136	171,432

Source: Williams et al. (2021) and U.S. Energy Information Administration, “The Distribution of U.S. Oil and Natural Gas Wells by Production Rate with data through 2022,” December 2023. \*The US EIA does not list any active wells for Illinois and Missouri. The Illinois Department of Natural Resources Oil and Gas list 23,402 oil and gas production wells. The Missouri Department of Natural Resources lists (August 30, 2024) 30 active wells. The Indiana Department of Natural Resources list 6,974 active oil and gas wells. The Oregon Mine Land Regulation and Reclamation Division list 8 producing wells for December 2023. Links: <https://dnr.illinois.gov/oilandgas/aboutoilandgasinillinois.html> and <https://dnr.mo.gov/sites/dnr/files/media/file/2024/09/Oil%20and%20Gas%20Well%20List%20Updated%20August%2030%202024.xlsx> and <https://experience.arcgis.com/experience/57b23396b9204be9a621783ecc4605d8/> and [https://www.oregon.gov/dogami/mlrr/mist/2023\\_Production\\_Figures\\_MistGasField.xlsx](https://www.oregon.gov/dogami/mlrr/mist/2023_Production_Figures_MistGasField.xlsx)

To determine the decommissioning cost for abandoned and active conventional wells, this analysis uses orphan well plugging cost data from the Interstate Oil and Gas Compact Commission and notice of intent data submitted to the U.S. Department of the Interior (DOI) for an application to receive formula grants to decommission orphaned wells as part of the Infrastructure Investment and Jobs Act (IIJA) of 2021. To determine the average per-well decommissioning cost for each state, the IOGCC data for state and federal well plugging expenditures was relied upon when a larger sample was included in the data; otherwise, the DOI data was utilized. When state decommissioning costs data for a state was unavailable, the national average of all states (except Alaska) was used.

To estimate the cost of decommissioning horizontal shale wells, this analysis uses asset retirement obligation (AROs) information from Security Exchange Commission (SEC) 2023 10-K Annual Reports from EQT Corporation and Range Resources along with drilled well counts from the Upstream database.<sup>6</sup> Altogether, EQT and Range Resources listed \$2.8 billion in undiscounted AROs for their gross well inventory of 6,749 wells for an average per-well decommissioning cost of \$415,000. Using additional data from the Upstream database that shows these two shale operators have 10,724 drilled unplugged wells decreases this cost to approximately \$261,000 per well.

STATES (36)	Per Well Decommissioning Cost (USDOI, 2021)	Per Well Decommissioning Cost (IOGCC, 2024)	Applied Per Conventional Well Decommissioning Cost
Alabama	\$46,484	\$2,179,000	\$46,484
Alaska	\$3,551,354	n/a	\$3,551,354
Arizona	\$52,936	n/a	\$52,936
Arkansas	\$15,000	\$33,704	\$33,704
California	\$182,029	\$51,606	\$182,029
Colorado	\$75,750	\$80,711	\$80,711

Florida	n/a	n/a	\$66,640
Idaho	n/a	n/a	\$66,640
Illinois*	\$37,000	\$47,988	\$47,988
Indiana*	\$53,248	\$64,341	\$64,341
Iowa	n/a	n/a	\$66,640
Kansas	\$6,530	\$10,634	\$10,634
Kentucky	\$20,040	\$36,508	\$36,508
Louisiana	\$87,232	\$73,551	\$73,551
Maryland	n/a	n/a	\$66,640
Michigan	\$72,577	\$63,338	\$63,338
Mississippi	\$80,000	\$156,250	\$80,000
Missouri*	\$6,000	\$5,200	\$5,200
Montana	\$51,090	\$75,678	\$75,678
Nebraska	\$41,000	\$28,486	\$41,000
Nevada	n/a	n/a	\$66,640
New Mexico	\$166,922	\$144,246	\$144,246
New York	\$50,656	\$172,047	\$50,656
North Dakota	\$208,376	\$62,141	\$208,376
Ohio	\$78,774	\$125,285	\$125,285
Oklahoma	\$28,093	\$21,203	\$21,203
Oregon*	n/a	n/a	\$66,640
Pennsylvania	\$68,068	\$85,291	\$85,291
South Dakota	n/a	n/a	\$66,640
Tennessee	n/a	\$3,474	\$3,474
Texas	\$65,143	\$33,117	\$33,117
Utah	\$37,435	n/a	\$37,435
Virginia	n/a	n/a	\$66,640
Washington	n/a	n/a	\$66,640
West Virginia	\$157,077	\$117,490	\$117,490
Wyoming	\$15,200	\$11,955	\$11,955

**Source:** Interstate Oil and Gas Compact Commission, “Idle and Orphan Oil and Gas Sells: State and Provincial Regulatory Strategies, Supplemental Information on Orphan Well Plugging and Site Restoration,” 2024, p.17-21. U.S. Department of the Interior, “Bipartisan Infrastructure Law Section 40601 Orphaned Well Program, Phase 1 (Fiscal Year 2023) State Formula Grant Guidance,” p.19-20.

Altogether, these results show that the total present-day cost to decommission the estimated 3.2 million unplugged wells is approximately \$271 billion. Using the highest available decommissioning cost per well for conventional wells in each state, the total decommissioning cost rises to above \$316 billion. Using the lowest decommissioning cost per well estimate reveals a total decommissioning liability of \$232 billion. These estimates are likely conservative since many of the nation’s plugged wells will need to be re-plugged and that the data fails to

capture the cost to decommission the number of unplugged abandoned shale horizontal wells. Furthermore, the undocumented abandoned and orphaned well inventory in each state likely consists primarily of unplugged or improperly plugged wells.

<b>Table 3A: Estimated Decommissioning Costs by State (in billions)</b>				
STATES (36)	Estimated Unplugged Wells	Low	Reference	High
Alabama	20,421	\$0.95	\$0.95	\$1.14
Alaska	5,964	\$21.18	\$21.18	\$21.18
Arizona	932	\$0.05	\$0.05	\$0.05
Arkansas	18,740	\$1.63	\$1.88	\$2.34
California	164,732	\$10.57	\$29.99	\$29.99
Colorado	97,454	\$9.26	\$9.69	\$11.27
Florida*	820	\$0.04	\$0.05	\$0.07
Idaho*	14	\$0.00	\$0.00	\$0.00
Illinois	102,561	\$3.79	\$4.92	\$4.34
Indiana	45,063	\$2.40	\$2.90	\$2.90
Iowa*	189	\$0.01	\$0.01	\$0.02
Kansas	309,482	\$2.02	\$3.29	\$3.29
Kentucky	69,987	\$1.40	\$2.56	\$2.56
Louisiana	162,809	\$12.99	\$12.99	\$15.15
Maryland*	15	\$0.00	\$0.00	\$0.00
Michigan	32,266	\$2.04	\$2.04	\$2.34
Mississippi	20,109	\$1.61	\$1.61	\$3.14
Missouri	3,258	\$0.02	\$0.02	\$0.02
Montana	37,816	\$1.93	\$2.86	\$2.86
Nebraska	5,158	\$0.15	\$0.21	\$0.21
Nevada*	963	\$0.05	\$0.06	\$0.08
New Mexico	98,419	\$17.57	\$15.61	\$15.61
New York	26,345	\$1.33	\$1.33	\$4.53
North Dakota	36,715	\$5.75	\$8.57	\$8.57
Ohio	136,729	\$11.34	\$17.55	\$17.55
Oklahoma	229,794	\$8.88	\$8.92	\$10.39
Oregon*	557	\$0.03	\$0.04	\$0.05
Pennsylvania	425,478	\$31.11	\$38.25	\$38.25
South Dakota*	941	\$0.05	\$0.06	\$0.08
Tennessee*	10,406	\$0.56	\$0.04	\$0.84
Texas	790,991	\$44.99	\$44.99	\$67.68
Utah	35,992	\$1.35	\$1.35	\$1.35
Virginia*	13,960	\$0.75	\$0.93	\$1.13

Washington*	734	\$0.04	\$0.05	\$0.06
West Virginia	288,339	\$34.48	\$34.48	\$45.72
Wyoming	42,417	\$1.26	\$1.26	\$1.39
TOTAL	3,236,568	\$231.59	\$270.70	\$316.13

\*For these states, the average decommissioning cost of all states (excluding Alaska) was used. The low was \$53,653 and the high was \$81,032. For the reference case, the state average of \$66,640 was used to approximate decommissioning costs.

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<sup>1</sup> James P. Williams, Amara Regehr, and Mary Kang, “Methane Emissions from Abandoned Oil and Gas Wells in Canada and the United States,” Environmental Science & Technology, 2021, Vol.55, 563-570. Accessed on October 28, 2024: <https://pubs.acs.org/doi/10.1021/acs.est.0c04265>

<sup>2</sup> Ibid, p.B

<sup>3</sup> Ibid

<sup>4</sup> William et al., Methane Emissions from Abandoned Oil and Gas Wells in Canada and the United States,” Supplement Information, S16. Accessed on October 28, 2024: <https://ndownloader.figstatic.com/files/25926079>

<sup>5</sup> Jacqueline Ho et al.,” Plugging the Gaps in Inactive Well Policy,” Resources for the Future, May 2016. Accessed on October 28, 2024: <https://media.rff.org/documents/RFF-Rpt-PluggingInactiveWells.pdf>

<sup>6</sup> EQT 2023 Annual Report SEC 10-K report, <https://d18rn0p25nwr6d.cloudfront.net/CIK-0000033213/190f9550-ada7-4bb1-b983-9ea52f4a4ed1.pdf> and 2023 Range Resources Annual Report SEC 10-K report, <https://ir.rangeresources.com/sec-filings/sec-filing/10-k/0000950170-24-018046>