U.S. Underground Coal Mine Ventilation Air Methane Exhaust Characterization 2011-2015

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2011-2015

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U.S. Underground Coal Mine Ventilation Air Methane Exhaust Characterization was originally published by the United States Environmental Protection Agency's Coalbed Methane Outreach Program (CMOP) in 2010. The original report presented aggregated Mine Safety & Health Administration (MSHA) mine ventilation shaft data from 2008-2009.

This 2017 update features data reported to the United States Environmental Protection Agency's Greenhouse Gas Reporting Program for the years 2011-2015. The update has been prepared by RTI International and Advanced Resources International, Inc. under contract EP-BPA-12-H-0023.

DISCLAIMER

This report was prepared for the U.S. Environmental Protection Agency (EPA). This analysis uses publicly available information in combination with information obtained through direct contact with mine personnel, equipment vendors, and project developers. EPA does not:

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INTRODUCTION

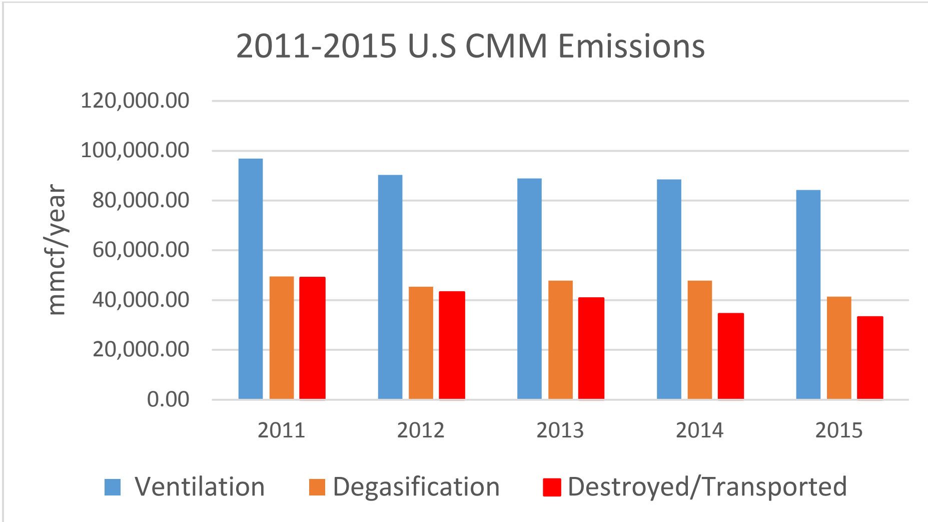
Recognizing that VAM emissions constitute a significant proportion of overall methane emissions, the U.S. Environmental Protection Agency's Coalbed Methane Outreach Program (CMOP) strives to highlight opportunities for implementing VAM abatement projects. Technology capable of oxidizing VAM is commercially available, and there are voluntary and compliance carbon markets that recognize the high quality of carbon emission reductions from VAM destruction. This document aims to encourage further VAM project development by identifying prospective mines and shafts based on publicly available shaft data.

BACKGROUND

Methane (CH_4) is a powerful greenhouse gas with a global warming potential 25 times that of carbon dioxide. Coal mines are the fourth largest emitting sector in the United States, accounting for 9% of anthropogenic methane emissions[1]; underground mines are the largest source of coal mine methane (CMM) emissions, releasing gas from mine ventilation shafts and degasification wells. In 2015 alone, 220 underground mines released 84.3 billion cubic feet (bcf) of methane from ventilation shafts, equating to 65 percent of all methane produced by active underground coal mines[2]. Figure 1 presents a summary of U.S. methane emissions from mine ventilation and degasification systems. In addition, the figure shows the quantity of CMM recovered and used. From 2011 to 2015 the data shows that both ventilation and degasification emissions have been decreasing year by year. Methane destroyed or transported has also experienced a steady year by year decrease. This is largely due to the restructuring of the coal industry that has occurred since 2010, resulting in increased mine closures and reduced gas emissions. Emissions, however, are not decreasing at the same rate as mine closures. Since 2008, the number of U.S. mines has decreased by over 47 percent, while VAM emissions have only experienced a 16 percent decline. [3] This is because the majority of mine closures are smaller room-and-pillar mines, while the principal contributors for the majority of CMM emissions are the large, high-production long-wall mines. With lower production costs, underground coal production will be dominated by these mines releasing large volumes of VAM emissions, presenting opportunities for VAM abatement projects.

[1] Environmental Protection Agency. (2017). *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2015* (EPA Publication No. 430-P-17-001). April 2017. Washington, DC: U.S. Environmental Protection Agency.
[2] EPA (2016)
[3] EPA (2016) and U.S. Energy Information Administration (2016). *Annual Coal Report 2015*. November 2016. Washington, DC: U.S. Department of Energy. In 2008 there were 583 operating underground mines; by year end 2015, there were 305 underground mines operating in the U.S.

Figure 1: CMM emissions from underground coal mines in the United States from 2011-2015



Source: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2015

This report is an update of EPA's 2010 publication, *U.S Underground Coal Mine Ventilation Air Methane Exhaust Characterization*[4]. This update can be used in conjunction with *Identifying Opportunities for Methane Recovery at U.S. Coal Mines: Profiles of Selected Gassy Underground Coal Mines* [5] to provide potential project developers with a comprehensive characterization of mine operations and methane production for the gassiest mines in the U.S.

The VAM data included in this report consists of shaft-specific data from 2011-2015 for the gassiest mines in the U.S., based on reported 2015 emissions. The data are derived from annual reports submitted to EPA's Greenhouse Gas Reporting Program (GHGRP)[6]. The shafts presented in this report were selected based on volumetric airflow and methane concentration.

2015 VAM CHARACTERIZATION

Mines and shafts profiled in this report are listed in Table 1. The list of shafts is limited to those with methane concentrations of at least 0.4 percent methane. Lower-concentration VAM may be enriched with drained gas to increase the VAM concentration and produce a more consistent VAM flow. This can be especially beneficial for VAM-to-power projects. This report, however, does not consider VAM enrichment in reporting shaft CH_4 concentrations.

Data presented in this report were compiled from two sources: the *Inventory of U.S. Greenhouse Gas Emissions & Sinks*[7] and publically available facility level information reported to the EPA's Greenhouse Gas Reporting Program (GHGRP)[8]. EPA produces the *Inventory* on an annual basis as

[4] https://www.epa.gov/cmop/ventilation-air-methane-vam
[5] https://www.epa.gov/cmop/coal-mine-methane-sources#activeUndergroundMines
[6] https://www.epa.gov/ghgreporting
[7] *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2014* (EPA Publication No. 430-R-16-002)
[8] https://www.epa.gov/ghgreporting

part of its commitment to the United Nations Framework Convention on Climate Change (UNFCCC). The Inventory includes a summary of total U.S. CMM emissions, providing values for direct CH_4 emissions from underground mines and surface mines, post-mining emissions from underground and surface mines, methane utilization from underground mines and emissions from abandoned mines. The GHGRP collects GHG data from large emitting sectors in the U.S. economy including underground coal mines.[9] Since 2011, mines that liberate at least 36.5 million cubic feet per year of methane are required to report methane emissions from ventilation and degasification systems annually. Facilities must report quarterly data on volumetric air flow and CH_4 concentrations for each exhaust shaft. In 2015, 123 mines reported. The GHGRP data is public and instructions on how to access detailed facility level emissions data for underground coal mines can be found in Appendix B.

The GHGRP provides significantly more data than previously existed. When using the volumetric flow and CH_4 concentration data in this report, users should take note of the following:

- Volumetric air flow and CH_4 concentration measurements fluctuate substantially under actual operating conditions, especially methane concentrations. Account should be taken for some variability in the reported measurements.

- Different locations for taking measurements may impact the recorded CH_4 and volumetric air flow measurements. Through 2015, GHGRP reporters have used grab samples or MSHA reports to report ventilation data. These methods rely on measurements taken inside the mine in the approaches to exhaust shafts rather than at the exhaust fan on the surface. VAM project developers are likely to use continuous emissions monitoring systems (CEMS) on the surface for monitoring CH_4 destruction. Leakage and other inefficiencies may result in differences between the CH_4 concentrations and air flow volumes in the mine and at the surface.

- For measurements taken inside the mine, air flow velocity and methane concentration can vary depending on the physical location of the sampling event within the approach, and how the samples are taken, e.g., in the center, along the side, low near the floor, high near the ceiling.

Figure 2 shows the location of all mines in this report. These mines either had at least one shaft with an annual average CH_4 concentration greater than or equal to 0.4 percent or had at least one shaft with a CH_4 concentration greater than or equal to 0.4 percent in at least one quarter in 2015. Mines with an annual average CH_4 concentration greater than or equal to 0.4 percent are shown in black. Mines that had at least one shaft with a CH_4 concertation greater than or equal to 0.4 percent in at least one quarter are shown in red.

Mine shafts that have had an annual average CH_4 concentration equal to or greater than 0.4 percent anytime from 2011 through 2015 and remained active in 2015 are included in the detailed VAM characterization summary, which can be found in Appendix A.

Figure 2 shows that in 2015, 70 percent of underground coal mines with high CH_4 concentration shafts were located in the Central Appalachian Basin. These mines are heavily concentrated in the southwestern corner of Pennsylvania, northwest West Virginia (Northern Appalachian Basin), southern West Virginia and southwest Virginia (Central Appalachian Basin). The remaining 30 percent of mines with high CH_4 concentration shafts are located in the Illinois Basin and in Alabama's Warrior Basin. There is one high concentration mine located in the San Juan Basin of northwest New Mexico. The Central Appalachian Basin is the most prospective area for VAM projects given that it contains the vast majority

[9] 40 Code of Federal Regulations Part 98

of mines with high CH_4 concentration shafts. Several western mines also liberate significant volumes of gas; however, these mines employ methane drainage which decreases the VAM concentrations.

Figure 2: Location of U.S. mines with high CH_4 concentration shafts

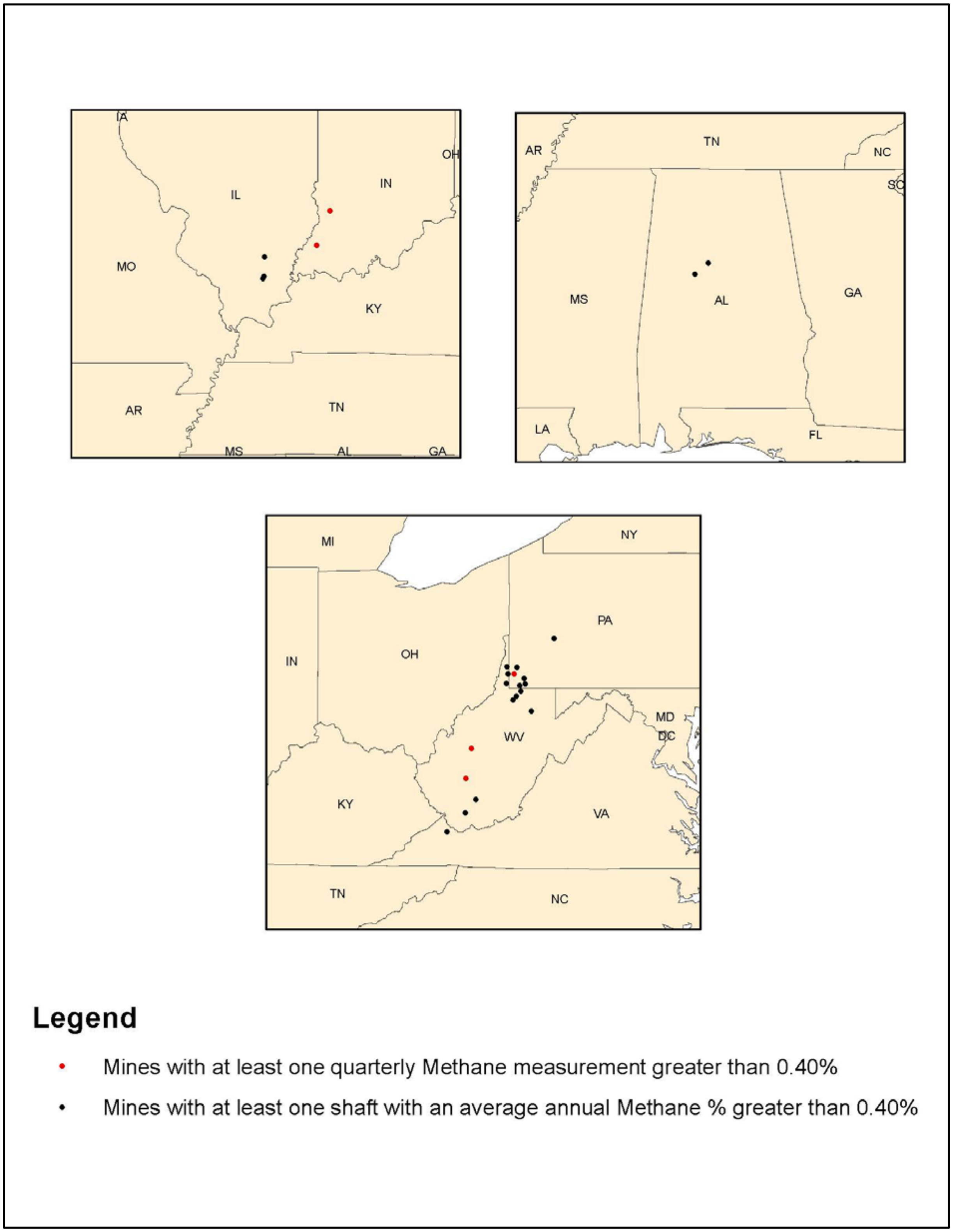


Figure 3 shows the number of shafts with average annual concentrations above 0.4 percent by concentration interval. Shafts with concentrations above 0.70 percent account for 37 percent of all prospective shafts with high average concentrations. Almost all of these shafts are bleeder shafts where concentrations can legally reach up to 2.0 percent methane. These shafts provide substantial volumes for emission reduction potential, but have shorter lives than main shafts. VAM project developers must account for the additional costs and logistics of moving the VAM abatement plant to a new location once the CH_4 concentration decreases to an unsustainable level.

Figure 3: High concentration shafts in the U.S. with an annual average concentration higher than 0.4 percent

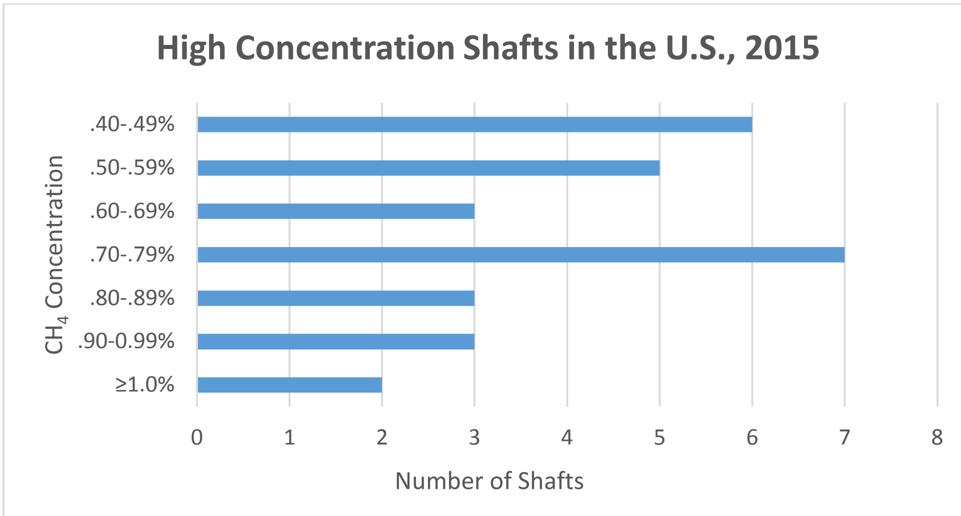
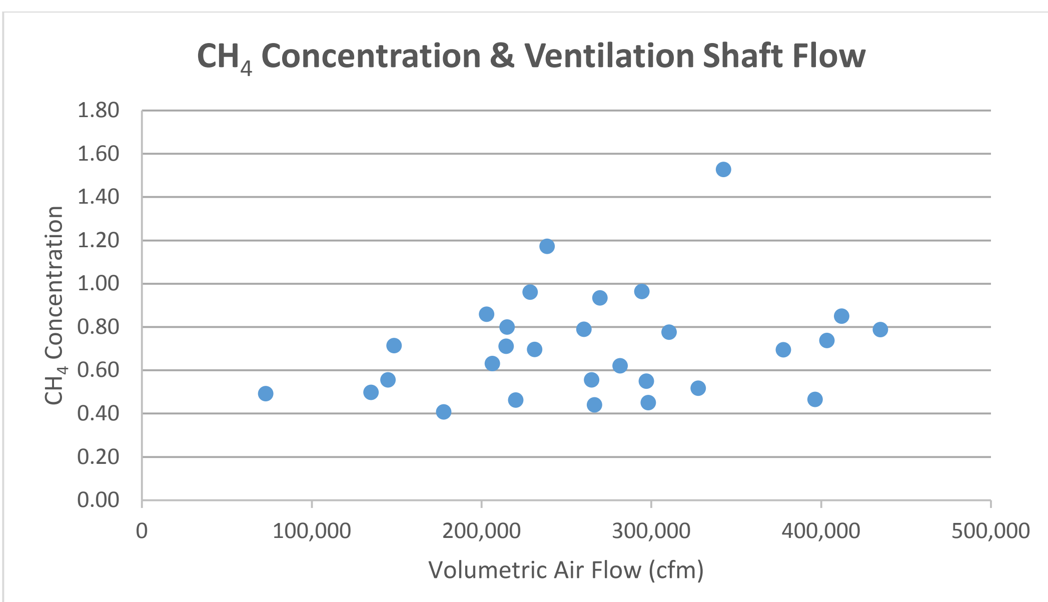


Figure 4 is scatter plot showing the combination of shaft flow and CH_4 concentration for each shaft having an annual average concentration greater than 0.4 percent. The majority of high CH_4 concentration shafts, including all of those with CH_4 concentrations of 0.7 percent and greater, have volumetric airflows between 150,000 cfm and 300,000 cfm. Volumetric flow can vary over time due to several factors and VAM project developers should account for the possibility of varying volumetric flow when designing new projects.

Figure 4: Distribution of CH_4 concentration by volumetric airflow for mine ventilation shafts in 2015



*Note: Only shafts with an annual average CH_4 concentration greater than or equal to 0.4 percent are plotted

Table 1 includes all U.S ventilation shafts that have an annual CH_4 concentration greater than 0.4 percent or had a CH_4 concentration greater than 0.4 percent in at least one quarter.

Table 1: 2015 VAM shaft characterization

2015 VAM Shaft Characterization						
MSHA ID	MSHA Name	Mine Shaft	State	Annual Average Flow Rate (acfm)	Annual Max. CH_4%	Annual Weighted Average CH_4%
4605437	American Eagle Mine	2210-FAN #6	WV	403,761	0.40	0.35
3607230	Bailey Mine	4J BLEEDER SHAFT	PA	281,812	0.68	0.62
		1L BLEEDER		214,559	0.90	0.71
4404856	Buchanan Mine #1	VENT SHAFT 12	VA	412,233	1.02	0.85
3605018	Cumberland Mine	#7 BLEEDER SHAFT	PA	228,798	0.99	0.96
3605466	Emerald Mine No. 1	#8 BLEEDER SHAFT	PA	266,670	0.54	0.44
3607416	Enlow Fork Mine	E-22 BLEEDER SHAFT	PA	297,163	0.65	0.55
		F-23 BLEEDER SHAFT		310,684	0.87	0.78
4601456	Federal No 2	0755-DAYBROOK #10	WV	298,243	0.62	0.45
1202423	Freelandville West Underground	RETURN PORTAL	IN	90,608	0.46	0.25
1202388	Gibson South Mine	GIBSON SOUTH	IN	383,262	0.41	0.36
4608829	Gravefork No. 1 Mine	RETURN ENTRY 2	WV	50,930	0.41	0.35
4601318	Harrison County Mine	18A BLEEDER FAN	WV	203,132	1.64	0.86
		10A BLEEDER FAN		248,999	0.43	0.27
		DENTS RUN BLEEDER SHAFT		148,645	0.87	0.71
3610045	Harvey Mine	7 NORTH #1 SHAFT	PA	507,078	0.57	0.27
		1A BLEEDER		416,892	0.61	0.27
4605252	Beckley Pocahontas Mine	RETURN SHAFT	WV	177,896	0.46	0.41

MSHA ID	MSHA Name	Mine Shaft	State	Annual Average Flow Rate (acfm)	Annual Max. CH_4%	Annual Weighted Average CH_4%
4609192	Leer Mine	MILLER BLEEDER SHAFT	WV	135,023	0.66	0.50
		SHARP BLEEDER SHAFT		396,633	0.88	0.46
5601433	Marion County Mine	18D BLEEDER	WV	342,682	1.55	1.53
4601437	Marshall County Mine	1B BLEEDER FAN	WV	265,005	0.64	0.55
		MP-1 SALLY'S BACKBONE		220,282	0.54	0.46
		12 EAST BLEEDER SHAFT		215,230	1.27	0.80
		GLENN EASTON BLEEDER SHAFT		269,908	1.01	0.93
4601968	Monongalia County Mine	13 W BLEEDER SHAFT	WV	152,708	0.68	0.35
		16 BLEEDER SHAFT		238,692	1.50	1.17
1102752	The American Coal Company New Era Mine	LW BLEEDER SHAFT #26 FAN	IL	260,355	1.02	0.79
		#2 MAIN FAN		585,133	0.46	0.32
1103232	New Future Mine	#23 BLEEDER FAN	IL	294,522	1.05	0.96
100851	Oak Grove Mine	FAN #6	AL	377,849	0.88	0.69
4601436	Ohio County Mine	1D BLEEDER FAN	WV	303,520	0.61	0.35
		EAST BLEEDER FAN		144,946	0.69	0.56
4601816	Pinnacle Mine	ASCO FAN	WV	403,643	0.90	0.74
2902170	San Juan Mine No. 1	ULE	NM	908,203	0.48	0.35
3608603	Tracy Lynn Mine	WEST SHAFT	PA	73,024	0.65	0.49
4608864	Tunnel Ridge Mine	MILLER SHAFT	WV	206,464	0.80	0.63
1103203	White Oak Mine No. 1	BLEEDER SHAFT	IL	231,316	0.74	0.70
0101401 / 0101247	No 7 Mine/ No 4 Mine (Walter Energy Inc.)	MINE 7 EAST 7-16	AL	951,923	0.44	0.36
		MINE 7 BLEEDER 7-13		435,014	0.91	0.79
		MINE 7 BLEEDER 7-14		327,842	0.61	0.52

U.S. VAM OXIDATION PROJECTS

There is currently one operating VAM project in the United States. In addition, one commercial scale demonstration project operated on a bleeder shaft at an operating mine in the United States from 2009 through 2013, and a commercial-scale project was tested on varying ventilation flows at an abandoned mine from 2007 through 2008. All U.S. projects have used regenerative thermal oxidation (RTO) technology and have been destruction-only technologies, meaning that they do not recover energy for heating, electricity or other use. Below is a brief description of each project. Additional information may be found on EPA's Coalbed Methane Outreach Program website at https://www.epa.gov/cmop/ventilation-air-methane-vam.

Marshall County Mine - Verdeo McElroy VAM Abatement Project (West Virginia, USA)

The project, announced in June 2010, was commissioned at Murray Energy's Marshall County Mine (formerly CONSOL Energy's McElroy Mine) in May 2012. Sindicatum Sustainable Resources (SSR) is the project financier and developer, and the RTOs are manufactured by DURR Systems. The project consists of 3 RTOs, each with a capacity of 53,330 cfm for a total throughput capacity of 160,000 cfm. The project is located at the 5 North 11-A Bleeder Fan. The VAM project is designed to take up to 80 percent of the shaft flow. The RTOs are capable of operating at CH_4 concentrations ranging from 0.30 percent to 1.2 percent, and the average shaft concentration during operation has been 1.03 percent. The project has thus far generated 700,000 carbon credits through 2015.[10]

Blue Creek No. 4 Mine – Biothermica Project (Alabama, USA)

The Blue Creek Mine No. 4, owned by Walter Energy, was the first active mine in the United States to host a VAM project. Biothermica, a Canadian company, was the financier, developer and manufacturer of the VAMOX® RTO process used at the project site. The project was announced in May 2008, and the unit was installed on the Bleeder Shaft 4-9 fan in January 2009. The nominal capacity of the RTO was 30,000 cubic feet per minute (cfm) or 14 Normal cubic meters per second (Nm^3/s). The unit has operated more than 27,000 hours from 2009 to 2013 with an average availability of 93 percent, generating 80,766 carbon credits. The credits, initially registered under the CMM Climate Action Reserve (CAR) Protocol, were then converted in 2015 to Air Resources Board Offset Credits (ARBOCs) and sold.

[10] Based on verification reports listed on the American Carbon Registry (http://americancarbonregistry.org/) and the Climate Action Reserve registry (http://www.climateactionreserve.org/).

The success of the demonstration project has led to the design of a much larger VAMOX® process capable of handling 140,000 cfm (66 Nm^3/s) over CH_4 concentration ranging from 0.30 percent to 1.2 percent[1] as well as to generate electric power. Future VAMOX® Projects are presently being developed in the United States, Canada and China. [11]

CONSOL Energy VAM Demonstration Project at the Abandoned Windsor Mine (West Virginia, USA)

CONSOL Energy conducted the first field demonstration of a VAM oxidation project in the U.S. using MEGTEC Systems' RTO— the VOCSIDIZER™—at their abandoned Windsor Mine in West Liberty, West Virginia. The U.S. Department of Energy and the U.S. Environmental Protection Agency co-funded the demonstration project with CONSOL. Because it was sited at an abandoned mine, the Windsor project simulated a typical VAM flow by diluting methane drained from the closed mining area. The project operated from February 2007 through October 2008, employing a single VOCSIDIZER™ unit to process 30,000 cubic feet per minute (cfm) of simulated VAM at a concentration of 0.6 percent methane. This project provided hands-on experience in operating a VAM oxidizer and verified (1) VAM destruction efficiency, (2) system operational safety, and (3) reliable operation of the system under U.S. field conditions.

[11] Conversation with Dominque Kay, Biothermica Technologies Inc., July 2017

APPENDIX A: 2011-2015 VAM SHAFT CHARACTERIZATION

Appendix A: 2011-2015 VAM Shaft Characterization

The table below includes all U.S ventilation mine shafts that have had an annual average CH_4 concentration greater than 0.4 percent in at least one year from 2011 through 2015, excluding shafts that were no longer active for 2014 and 2015.

				2011			2012			2013			2014			2015		
MSHA ID	MSHA Name	Mine Shaft	State	Annual Average Flow Rate (acfm)	Annual Max. CH_4%	Annual Weighted Average CH_4%	Annual Average Flow Rate (acfm)	Annual Max. CH_4%	Annual Weighted Average CH_4%	Annual Average Flow Rate (acfm)	Annual Max. CH_4%	Annual Weighted Average CH_4%	Annual Average Flow Rate (acfm)	Annual Max. CH_4%	Annual Weighted Average CH_4%	Annual Average Flow Rate (acfm)	Annual Max. CH_4%	Annual Weighted Average CH_4%
4605437	American Eagle Mine	2210-FAN #6	WV	233,485	0.50	0.39	233,485	0.49	0.41	313,130	0.54	0.46	365,066	0.54	0.46	403,761	0.40	0.35
3607230	Bailey Mine	9I BLEEDER SHAFT	PA	280,655	1.09	0.78	179,906	0.98	0.88	173,419	1.06	0.97	176,212	0.58	0.43	-	-	-
		4J BLEEDER SHAFT		331,103	0.76	0.44	229,404	0.30	0.19	317,765	0.22	0.11	192,544	0.73	0.60	281,812	0.68	0.62
		12H BLEEDER SHAFT		121,883	1.59	1.06	125,830	1.38	0.92	334,410	1.07	1.04	160,275	1.03	0.81	-	-	-
		15-I BLEEDER FAN SOUTH LEG		84,078	0.78	0.41	63,828	0.58	0.48	79,527	0.96	0.79	103,239	0.66	0.37	-	-	-
		R-North/WEST		-	-	-	-	-	-	157,840	0.41	0.41	-	-	-	-	-	-
		6H BLEEDER FAN - SURFACE		194,222	0.76	0.69	181,233	0.44	0.37	185,318	0.29	0.25	194,325	0.29	0.19	-	-	-
		SURFACE 91 RETURN SHAFT		-	-	-	-	-	-	162,975	0.79	0.79	-	-	-	-	-	-
4404856	Buchanan Mine #1	VENT SHAFT 12	VA	375,588	1.11	0.97	430,147	0.87	0.67	463,851	0.99	0.90	445,095	0.86	0.64	412,233	1.02	0.85
1202349	Carlisle Mine	NORTH RETURN	IN	274,756	0.43	0.26	249,320	0.44	0.29	198,890	0.64	0.54	224,101	0.25	0.21	100,656	0.21	0.18
		MAIN RETURN		189,502	0.39	0.35	193,930	0.27	0.22	195,629	0.43	0.43	187,914	0.25	0.15	74,578	0.31	0.21
4608194	Pleasant Hill Mine	#1 RETURN	WV	-	-	-	-	-	-	-	-	-	112,333	0.49	0.40	77,132	0.25	0.19
3605018	Cumberland Mine	#6 BLEEDER SHAFT	PA	519,251	0.51	0.49	255,196	1.47	1.25	175,530	1.24	0.95	125,047	0.44	0.40	117,618	0.35	0.26
		#7 BLEEDER SHAFT		-	-	-	-	-	-	215,640	0.89	0.89	232,394	0.97	0.78	228,798	0.99	0.96
		#8 BLEEDER SHAFT		-	-	-	-	-	-	-	-	-	221,968	0.59	0.59	-	-	-
3605466	Emerald Mine No. 1	#8 BLEEDER SHAFT	PA	-	-	-	-	-	-	-	-	-	221,968	0.64	0.59	266,670	0.54	0.44
3607416	Enlow Fork Mine	E-15 BLEEDER SHAFT	PA	380,964	1.12	0.89	283,869	0.67	0.50	129,700	0.41	0.35	311,167	0.24	0.23	-	-	-
		E-22 BLEEDER SHAFT		-	-	-	127,636	0.84	0.79	209,476	0.90	0.66	225,403	0.90	0.71	297,163	0.65	0.55
		E-9 BLEEDER SHAFT		104,275	0.46	0.35	62,521	0.46	0.32	68,945	0.45	0.45	44,597	0.46	0.23	-	-	-
		F-14 BLEEDER FAN		199,520	0.49	0.44	171,549	0.87	0.54	107,850	1.82	0.51	0	0.00	0.00	-	-	-
		F-20 BLEEDER FAN		82,132	1.11	0.85	66,872	0.77	0.78	107,850	0.60	0.49	290,837	1.13	0.94	-	-	-
		F-23 BLEEDER FAN		-	-	-	122,488	1.10	0.56	207,339	1.11	0.90	0	0.00	0.00	310,684	0.87	0.78
		F-22 LW		-	-	-	-	-	-	-	1.12	1.12	-	-	-	-	-	-
4601456	Federal No 2	0755-11 LEFT #11	WV	174,577	0.76	0.53	220,819	0.72	0.43	94,940	1.04	0.82	239,807	0.41	0.37	298,243	0.62	0.45
4601318	Harrison County Mine	10A BLEEDER FAN	WV	256,993	1.01	0.84	253,991	0.54	0.49	167,476	0.49	0.46	238,599	0.33	0.27	248,999	0.43	0.27
		DENTS RUN BLEEDER SHAFT		-	-	-	-	-	-	-	-	-	-	-	-	148,645	0.87	0.71
		18A BLEEDER FAN		138,759	0.69	0.56	212,073	0.88	0.80	229,339	0.91	0.90	210,033	1.12	0.93	203,132	1.64	0.86

MSHA ID	MSHA Name	Mine Shaft	State	Annual Average Flow Rate (acfm)	Annual Max. CH_4%	Annual Weighted Average CH_4%	Annual Average Flow Rate (acfm)	Annual Max. CH_4%	Annual Weighted Average CH_4%	Annual Average Flow Rate (acfm)	Annual Max. CH_4%	Annual Weighted Average CH_4%	Annual Average Flow Rate (acfm)	Annual Max. CH_4%	Annual Weighted Average CH_4%	Annual Average Flow Rate (acfm)	Annual Max. CH_4%	Annual Weighted Average CH_4%
4601433	Marion County Mine	18D BLEEDER	WV	143,880	0.50	0.45	251,650	1.16	1.12	328,663	1.16	1.39	345,017	1.48	1.43	342,682	1.55	1.53
		HARVEY RUN RETURN FAN		-	-	-	199,007	0.26	0.18	87,875	0.40	0.40	195,226	0.11	0.09	-	-	-
4609192	Leer Mine	MILLER BLEEDER SHAFT	WV	-	-	-	-	-	-	-	-	-	-	-	-	135,023	0.66	0.50
		BLEEDER SHAFT 1		-	-	-	-	-	-	-	-	-	244,792	0.83	0.56	-	-	-
		SHARP BLEEDER SHAFT		-	-	-	-	-	-	-	-	-	-	-	-	396,633	0.88	0.46
4605252	Beckley Pocahontas Mine	RETURN SHAFT	WV	-	-	-	-	-	-	-	-	-	-	-	-	177,896	0.46	0.41
4601437	Marshall County Mine	1B BLEEDER FAN	WV	220,236	1.49	1.04	207,832	1.29	1.01	180,865	1.38	1.27	188,682	1.51	1.06	265,005	0.64	0.55
		NAUVOO RETURN SHAFT		-	-	-	229,916	0.31	0.18	180,865	0.58	0.47	312,541	0.39	0.29	324,350	0.18	0.12
		BIG TRIBBLE RETURN AIR SHAFT		287,358	0.61	0.31	273,680	0.20	0.13	180,865	0.51	0.46	319,730	0.28	0.21	274,661	0.17	0.14
		EP303 AT REIDS RUN BLEEDER SHAFT		-	-	-	-	-	-	91,637	1.32	1.72	-	-	-	-	-	-
		12 EAST BLEEDER SHAFT		-	-	-	-	-	-	-	-	-	108,000	0.45	0.41	215,230	1.27	0.80
		MP-1 SALLY'S BACKBONE		301,152	1.43	0.88	276,615	0.64	0.56	-	-	-	349,313	0.57	0.51	220,282	0.54	0.46
		1 LEFT-5 SOUTH BLEEDER FAN-MP-1		255,497	0.53	0.42	230,322	0.48	0.46	294,649	0.60	0.48	-	-	-	-	-	-
		GLENN EASTON BLEEDER SHAFT		135,360	1.34	0.95	149,715	1.60	1.36	219,166	1.27	0.99	234,917	1.11	1.00	269,908	1.01	0.93
4601968	Monongalia County Mine	16 BLEEDER SHAFT	WV	155,590	1.73	1.52	187,249	1.42	1.23	195,172	1.69	1.55	221,011	2.00	1.67	238,692	1.50	1.17
1102752	The American Coal Company New Era Mine	#18 BLDR FAN	IL	-	-	-	485,000	0.35	0.20	254,606	0.50	0.43	479,851	0.27	0.14	-	-	-
		LW BLEEDER SHAFT #26 FAN		-	-	-	-	-	-	-	-	-	289,980	0.71	0.56	260,355	1.02	0.79
		#21 BLDR FAN		-	-	-	191,319	0.77	0.55	377,650	1.37	0.99	295,587	1.22	0.95	-	-	-
1103232	New Future Mine	#23 BLEEDER FAN	IL	-	-	-	-	-	-	202,677	1.03	0.97	295,587	1.22	0.95	294,522	1.05	0.96
		#20 BLDR FAN NORTH APPROACH		-	-	-	-	-	-	73,440	0.47	0.47	-	-	-	-	-	-
100851	Oak Grove Mine	FAN #6	AL	253,285	1.07	0.88	230,557	1.11	0.65	202,677	1.23	0.81	313,804	1.05	0.86	377,849	0.88	0.69
4601436	Ohio County Mine	MILLER HILL SHAFT-MP49-#1	WV	284,341	0.63	0.46	131,726	0.44	0.24	146,152	0.41	0.36	285,815	0.22	0.19	282,121	0.17	0.15
		ENTRY MAJORSVILLE		-	-	-	304,732	0.15	0.15	161,920	0.46	0.46	275,115	0.25	0.20	160,128	0.12	0.10
		1D BLEEDER FAN		-	-	-	-	-	-	206,040	0.23	0.25	262,692	0.56	0.49	303,520	0.61	0.35
		EAST BLEEDER FAN		-	-	-	-	-	-	-	-	-	-	-	-	144,946	0.69	0.56

MSHA ID	MSHA Name	Mine Shaft	State	Annual Average Flow Rate (acfm)	Annual Max. CH_4%	Annual Weighted Average CH_4%	Annual Average Flow Rate (acfm)	Annual Max. CH_4%	Annual Weighted Average CH_4%	Annual Average Flow Rate (acfm)	Annual Max. CH4%	Annual Weighted Average CH_4%	Annual Average Flow Rate (acfm)	Annual Max. CH4%	Annual Weight ed Average CH_4%	Annual Average Flow Rate (acfm)	Annual Max. CH4%	Annual Weighted Average CH_4%
504674	Elk Creek Mine	ELK CREEK FAN	CO	577,877	0.47	0.41	543,622	0.31	0.26	596,112	0.14	0.07	205,253	0.06	0.04	350,628	0.00	0.00
4601816	Pinnacle Mine	ASCO FAN	WV	239,355	0.01	0.01	341,769	0.01	0.01	338,746	0.01	0.01	446,062	1.13	1.04	403,643	0.90	0.74
4608715	Pond Creek Mine No. 1	LWD2 BLEEDER SHAFT N EP	IL	231,791	0.40	0.38	210,156	0.43	0.31	243,528	0.62	0.54	271,815	0.58	0.52	418,809	0.37	0.36
1202249	Prosperity Mine	REGULATOR MW2 RETURN	IN	-	-	-	-	-	-	-	-	-	12,530	0.42	0.42	-	-	-
2902170	San Juan Mine 1	KFC	NM	77,970	1.02	0.86	90,443	1.00	0.78	385,706	0.40	0.35	-	-	-	-	-	-
102901	Shoal Creek Mine	#2 FAN SHAFT	AL	384,033	1.55	0.61	377,566	0.36	0.19	413,124	0.09	0.09	-	-	-	-	-	-
3608603	Tracy Lynn Mine	WEST SHAFT	PA	-	-	-	-	-	-	-	-	-	76,832	0.35	0.28	73,024	0.65	0.49
4608864	Tunnel Ridge Mine	MILLER SHAFT	WV	-	-	-	-	-	-	-	-	-	155,160	0.89	0.68	206,464	0.80	0.63
1103203	White Oak Mine No. 1	BLEEDER SHAFT	IL	-	-	-	-	-	-	74,196	0.04	0.04	260,080	0.12	0.06	231,316	0.74	0.70
0101401/ 0101247	No 7 Mine/ No 4 Mine	MINE 4 BLEEDER 4-9	AL	387,937	0.75	0.48	739,619	0.42	0.18	365,458	0.38	0.35	976,530	0.43	0.37	411,954	0.22	0.19
		MINE 7 BLEEDER 7-13		358,236	1.25	0.96	346,847	1.11	0.90	351,878	1.02	0.82	418,227	0.91	0.60	435,014	0.91	0.79
		MINE 7 BLEEDER 7-14		689,739	1.21	0.95	946,225	0.79	0.71	681,577	1.06	0.90	761,717	0.86	0.70	327,842	0.61	0.52
4202233	West Ridge Mine	MAIN RETURN	UT	692,028	0.77	0.72	593,121	0.47	0.27	-	-	-	713,250	0.15	0.09	732,364	0.38	0.16
1103058	Pattiki	PATTIKI	IL	257,699	0.28	0.26	639,768	0.27	0.27	316,512	0.44	0.44	0	0.00	0.00	83,188	0.33	0.27

APPENDIX B: EPA PUBLIC DATA RESOURCES FOR UNDERGROUND COAL MINES

All ventilation emissions data used for this analysis is available publically through the Greenhouse Gas Reporting Program (GHGRP). The GHGRP has two main resources for accessing emissions data, the EPA Facility Level Information on Greenhouse Gases Tool (FLIGHT)[12] and Envirofacts[13], EPA's one-stop portal for all environmental information managed by EPA.

The FLIGHT database is specific to the data collected by the GHGRP. FLIGHT provides basic information about reporters at the facility level, the locations of facilities on a map of the United States, access to a facilities' emissions reports, and a time-series graph showing annual emissions. FLIGHT is most beneficial when seeking a geographical representation of reporting mines or a list of reporting mines, or when viewing the annual reports for individual mines.

Envirofacts can be used to download large data sets of publically available environmental information. For example, users interested in underground coal mines can download all reported ventilation data for all reporting mines in one query. In comparison, using FLIGHT would require calling up annual reports for each facility and compiling the data manually. To access emissions data for underground coal mines, the best method is to complete a Customized Search under "Greenhouse Gas" specific to underground coal mines (https://www.epa.gov/enviro/greenhouse-gas-customized-search). There you will go through a series of steps where you can select which data tables you want to include in your data download, the rows to be included in the data table, and the columns to be included in the data download.

Both of these resources provide facility level information on underground coal mines including weekly and quarterly data from each of the facilities monitoring points.

[12] EPA Flight Database- https://ghgdata.epa.gov/ghgp/main.do
[13] EPA Envirofacts Database- https://www3.epa.gov/enviro/