Legal and Regulatory Status of Abandoned Mine Methane in Selected Countries: Considerations for Decision Makers

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Legal and Regulatory Status of Abandoned Mine Methane in Selected Countries: Considerations for Decision Makers

In support of the Global Methane Initiative

Funded by the U.S. Environmental Protection Agency

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Executive Summary

Globally, the coal mining industry accounts for about 8% of total methane emissions (EPA, 2012). Coal mines capture methane mostly for safety reasons because methane can be dangerous for underground mining. However, after closure, underground coal mines continue to release methane into the atmosphere. This methane is known as abandoned mine methane (AMM). AMM is an important but often overlooked source of methane emissions.

There are a number of potential uses for recovery and utilization of AMM. Depending on the quality of the coal mine gas and other factors, options for commercial methane utilization include:

1. Electricity production;
2. Combined heat and power for industry and/or urban areas;
3. Supply to commercial natural gas market via existing pipelines;
4. Monetized benefits of reducing greenhouse gas emissions.

Because of the value of these assets, methane recovery and utilization from abandoned mines can boost local economic growth, create new jobs, reduce air and water pollution, and increase national energy supply. In addition, implementation of AMM projects also contributes to climate protection. AMM projects present interesting opportunities and challenges but enabling conditions have received less consideration for their part in making these projects successful.

Although methane utilization provides multiple economic and environmental benefits, AMM projects often face several implementation challenges. The policies that countries adopt can play an important role in overcoming technical and market barriers. For example, providing clear rules on ownership of AMM rights places AMM on equal footing with conventional gas projects. Likewise, some countries have developed incentives or tax policies to promote AMM utilization, recognizing the technical constraints that some projects face as well as the societal benefits of AMM utilization.

This report was funded by the U.S. Environmental Protection Agency (EPA) in support of the Global Methane Initiative (GMI). GMI is an international, public-private partnership that promotes cost-effective, near-term methane recovery and use. It works through partnerships between developed and developing countries, with participation from the private sector, development banks, and nongovernmental organizations.

Specifically, this report presents case studies on several countries that have successfully developed an enabling environment for AMM recovery and utilization. The experiences of Australia, Germany, the United Kingdom, and the United States can provide valuable lessons for other countries wishing to utilize the potential of AMM. Examples from these countries show

that supportive legal and regulatory framework can facilitate utilization of methane from abandoned coal mines.

Based on these case studies, some specific policies can help facilitate AMM capture and utilization projects:

1. Enacting clear procedures for obtaining AMM ownership rights for mines that are already abandoned/closed;
2. Allowing for the transfer of the methane rights from the mine to a third-party (gas developer);
3. Including AMM as a renewable energy resource in new legislation or by amending existing one;
4. Setting royalties at a level that encourages investment;
5. Offering reduced taxes or targeted financial and fiscal incentives to stimulate AMM projects.

Ownership rights are the most important and challenging issue in the regulatory framework. Clearly defined ownership rights can help companies mitigate risks in their contractual arrangements. For example, transferring ownership of AMM to a third-party that can monetize the emission reduction credits can diversify revenue and reduce the project's financial risk in certain situations. Countries with successful AMM projects have created an enabling environment by eliminating restrictions on transferring rights to the gas, regardless of whether it will be sold as gas or converted to electricity. Regulatory and fiscal incentives in the form of reduced royalties, feed-in-tariffs or supplier obligations, as well as an ability to monetize emission reductions can further improve the economic feasibility of AMM projects.

Countries with significant underground coal production today will face increasing AMM emissions in the future. Development and enforcement of a clear and favorable legal framework will not only maximize AMM utilization but can also provide an additional resource for the country's energy mix.

Contents

1. Introduction

The coal mining industry accounts for 8% of total methane emissions from human activities (EPA, 2012). Coal mine methane (CMM) is released during the process of coal mining. When underground mines cease operations and are abandoned, they still liberate methane for decades to come. This methane is known as abandoned mine methane (AMM) (EPA, 2008). Coal mines capture CMM mostly for safety reasons because high concentrations of methane can be dangerous for underground mining.

CMM and AMM are also valuable energy resources. Capturing and utilizing methane from active and abandoned mines can increase a country's energy supply. Many countries develop commercial projects to exploit CMM and AMM to supply gas, generate power and heat, or a combination of these. Since methane's global warming potential is 28-34 times stronger than that of CO_2 over a 100-year timeframe, its commercial utilization also contributes to climate protection efforts.

This report was funded by the US. Environmental Protection Agency in support of the Global Methane Initiative (GMI). GMI is an international, voluntary public-private partnership of more than 40 partner countries that aims to facilitate the development of methane recovery and utilization projects. This report focuses on opportunities in the coal mining sector, highlighting policy options for developing supportive regulatory environments for AMM recovery and utilization.

Regulatory Environment

The ten largest coal-producing countries account for more than 90% of world's coal production (Table 1). In most countries, industry lacks a uniform legal framework governing methane extraction and utilization from coal mines. Coal mines need the CMM rights to be part of the coal leases to safely and economically pursue CMM emission reduction projects. However, the costs associated with obtaining and maintaining a gas lease for a CMM/AMM project can be burdensome. Ownership regulation can create obstacles to recovery and utilization of AMM. Few countries clearly define AMM ownership rights by demarcating coal mine methane from other gas leases or coal leases. Outlining what AMM is from a legal standpoint can be critical, especially when this methane is considered a resource.

The Role of Geology and Technology

Although several countries have successfully developed and implemented projects to capture and utilize CMM/AMM, there are geographical and technical challenges to commercial recovery and utilization of methane. Options for commercial methane utilization include power generation or injection into existing pipeline infrastructure. If pipelines are close enough to the

site, and the quality and volume of methane are high enough to meet technical requirements, the developer can directly sell and supply CMM/AMM to the market via gas pipelines. Alternatively, the developer can generate electricity using mine gas even with a methane concentration of just 35%. In both cases, close proximity to existing gas pipelines and power lines improves the economic viability of the AMM projects (Ruby Canyon Engineering Inc, 2016).

After ceasing operation, coal mines usually become flooded with water. Once this happens, emissions from a mine, or the flooded portion of the mine, typically stop. The rate of the AMM emissions from an abandoned mine is highest immediately after the mine closure. The emission rate of AMM decreases to a significantly lower level over a period of 8-10 years. Thus, AMM capture and utilization are most effective with respect to economic and environmental concerns immediately following the closure of mines. UNECE (2017) and Ruby Canyon Engineering Inc (2016) provide additional information on technical constraints that affect deployment of CMM/AMM projects.

Policies and Markets

Factors important for successful deployment of AMM projects include mine safety regulations, the licensing process, ownership rights, environmental regulations, taxation, and fiscal regulations. For example, without clear rights to the methane, investors will not develop the projects; complicated licensing procedures can also make investors wary.

Domestic energy prices likewise play an important role. For example, low electricity prices can make power generation run on AMM less attractive, while relatively high natural gas prices can encourage AMM recovery and supply to the natural gas market. In addition, any form of energy subsidies can hinder the economic performance of AMM projects.

Creating a supportive policy environment increases project feasibility and expands potential markets for AMM. A clear legal status and procedures for obtaining rights to the methane are essential for commercializing methane production. Tax incentives, royalty relief, and other fiscal instruments improve project economics and can facilitate development of AMM projects. Feed-in-tariffs and utility obligations can further boost investments in AMM utilization and recovery projects. Thus, understanding and adapting to local circumstances are crucial to create an enabling environment for AMM projects.

Case Studies and Analysis Methodology

This report provides an overview of AMM regulations in key coal-producing countries and recommendations on ownership and royalties for countries that want to implement AMM utilization projects. The report aims to provide guidance to countries and jurisdictions that want to clarify their regulations regarding AMM in order to better capture and utilize it. Through

work in Kazakhstan and other countries, GMI saw the importance of clear information on policy best practices regarding AMM ownership and promotion in support of new policies and legislation.

This report contains case studies from four countries – Australia, Germany, the United Kingdom, and the United States. Using the latest available data, it provides an overview of AMM emissions. In addition, this report focuses particular attention on policies in each country that affect AMM projects, including rules on property rights and royalties.

While there are many technical constraints that can hinder development of AMM projects, this report focuses only on policy aspects. Specifically, the report summarizes the existing policy framework in each country and draws conclusions regarding two policy assessment criteria that might be of interest to countries with coal resources:

- Ability to produce AMM as a resource (e.g., what policy factors and/or market features encourage or hinder AMM production?);
- Administrative ease (e.g., how easy is it to assign ownership or rights to AMM?).

Several factors are used to evaluate each country's progress. For example, several policies can impact a country's ability to produce AMM as a resource, including: 1) clarity of ownership rights and licensing process; 2) existence of any financial, fiscal, or regulatory incentives; 3) whether AMM is defined as a renewable resource for incentives; 4) presence of any other regulations, e.g., safety requirements, which encourage AMM production. A similar approach has been used in assessing the criteria "Administrative ease". An assessment of this criterion also accounts for ownership and leasing rights, meaning how easy it is to transfer and/or obtain AMM methane rights after the coal mine closure. This report also provides data on the percentage of AMM emissions that each country utilizes[1].

While this report focuses on the policy environment and policy choices, it is important to recognize that geology also plays an important role in defining how policies work in this area. Geological conditions in the United States and Australia are significantly different from those in Germany and the United Kingdom. Because of these differences, coal mines in Australia and the United States have higher gas quality and lower production costs compared to Germany and the United Kingdom. In the majority of cases, there is no royalty fee on methane captured for

[1] To calculate the percentage of AMM utilization rate, we first sum aggregate fugitive GHG emissions from abandoned underground mines that each country reported to the UNFCCC (http://di.unfccc.int/detailed_data_by_party) together with annual avoided GHG emissions from abandoned mines that countries reported to the International CMM Database. This is a database that the U.S. Environmental Protection Agency developed (https://www.globalmethane.org/coal-mines/cmm/index.aspx). In case there is more recent and reliable source for avoided emissions and deployed AMM projects, we use this source instead of the Database. We then divided avoided GHG emissions (only from active AMM projects) by the sum of avoided and aggregate fugitive GHG emissions reported to the UNFCCC.

safety reasons. For commercial projects where safety is not an issue, royalties are usually required. The amount of such royalty fees can define whether AMM projects will be profitable or not. Hence, many jurisdictions choose to levy small royalty fees or offer rebates on them for AMM to encourage project development.

2. Australia

Overview

Australia is the world's fifth largest coal producer and second largest coal exporter. The majority of coal mines in Australia are surface mines. As of 2015, there were 123 operating coal mines, 78 of which are surface mines, while the remaining 45 were underground mines (Australian Government, 2017). There are, however, thousands of abandoned underground mine sites in the country. Coal and gas licenses and applications cover about 37% of Australia's land.

Queensland and New South Wales (NSW) account for 97% of Australia's total coal production. As Australia does not have a national legislative framework regarding ownership and licensing of CMM and AMM, each state sets its own regulations (Global Methane Initiative, 2015).

Australia's abandoned mine methane emissions deceased by more than 50%, from 0.969 Mt CO_2e in 2000 to 0.420 Mt CO_2e in 2015 (Figure 1). Total AMM emissions are expected to increase through at least 2020 due to an overall increase in underground coal mining (Australian Government, 2016).

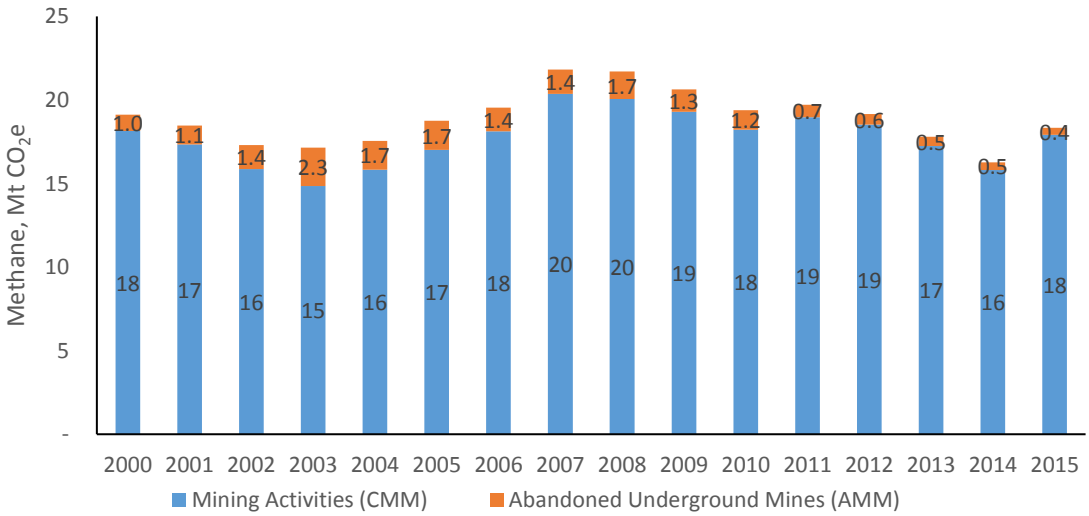

Figure 1. Australia's reported methane emissions from active and abandoned coal mines by year, Mt CO2e
Source: UNFCCC (2017).

According to the International Coal Mine Methane Projects Database, developed by the U.S. Environmental Protection Agency's Coalbed Methane Outreach Program, as of October 2017, there have been five AMM projects in Australia. Two are currently operational and both are located in New South Wales. Together they reduce methane emissions by 0.187 Mt CO_2e (Global Methane Initiative, 2017). This constitutes 31% of total AMM emissions in Australia.

Ownership/Property Rights

The federal and state governments in Australia consider AMM as a petroleum product; they grant rights or licenses, called petroleum titles, to explore for or produce petroleum (Allnutt and Yoon, 2015).

In New South Wales, the land surface belongs to landholders, while the State of New South Wales owns subsurface resources (NSW Government, 2017a). The Mining Act 1992 is the primary regulation for coal mining and methane extracted during mining (NSW Government, 1992). AMM is considered a petroleum product and therefore falls under the regulation of the Petroleum (Onshore) Act 1991 (NSW Government, 1991). When a coal mine ceases operations, a company interested in capturing and utilizing the AMM should apply for a petroleum title.

In Queensland, a coal mining lease does not provide rights for commercial utilization of the methane contained in the strata. The Mineral Resources Act 1989 allows a company to capture methane only for safety reasons and utilize it on site. Once a coal mine ceases operation, a company interested in extracting and utilizing AMM should apply for a license under the Petroleum and Gas (Production and Safety) Act 2004 (EPA, 2014), which can overlap with the coal mining lease, regulated separately by the Mineral Resource Act 1989. The Mineral Resource Act prohibits the holder of a mining lease from flaring or venting coal mine methane unless specific conditions are met. Specifically, a mine lease holder must utilize the gas unless that is not economically or technically feasible, or utilizing the gas would create safety risks (Queensland, 1989).

Incentives

Currently, Australia has no incentives for AMM production. However, some of Australia's states had incentive programs in the past that provide useful lessons learned.

Queensland is Australia's largest state in terms of coal production. In order to diversify the state's energy production mix and decrease emissions, the Government of Queensland enacted the Gas Electricity Certificate (GEC) scheme. The scheme commenced in 2005 and was active until the end of 2013. It aimed to establish a mature gas industry by encouraging gas-fired electricity production (Queensland Parliament, 2013). The program required electricity suppliers to produce some of their power from gas, including abandoned mine methane, and

the GECs certify the source of the power (Queensland Parliament, 2013). To encourage compliance, the Electricity Act also introduced penalties for suppliers, who fail to meet targets. The share of gas-fired generation reached 20% by the end of 2013, exceeding the program's initial target of 18% by 2019. Once producers met the GEC targets, the Government of Queensland withdrew the requirements to certify the source of production. Another argument to repeal the scheme was that it duplicated the expected impact of the Carbon Pricing Mechanism, introduced by the Australian Government in 2012 (Ashurst, 2013), though this mechanism was soon after cancelled. Overall, due to the Gas Electricity Certificate scheme, the share of gas-fired electricity generation increased from 2.4% in 2005 to 20% in 2013-2014 (Australian Government, 2015)[2].

Royalties

The royalty rate is 10% of the gross value of the petroleum at the wellhead (NSW Government, 2017b). The wellhead value is calculated based on the revenue from the sale of the petroleum minus certain deductible costs incurred downstream (NSW Parliament, 2012). The New South Wales Government also provides a 5-year exemption for stand-alone coal seam gas operations (Global Methane Initiative, 2015).

Table 1. Business Environment for AMM in Australia

Criteria	Description
Ability to produce AMM as a resource	- Active AMM projects utilize 31% of total AMM emissions; - AMM is not defined as a resource in the national and state regulatory framework; - Some states have restrictions on flaring and venting AMM.
Administrative ease	No uniform national legislative framework on AMM ownership. Each state sets its own arrangements. However, in New South Wales and Queensland, companies interested in capturing AMM should apply for petroleum licenses once a coal mine ceases operations.

[2] It should be noted that the share of gas-fired generation in Queensland decreased from 22% in 2014 to just 12% in 2016. Several factors contributed to that decline, but the primary reason was an increase of gas prices due to rising demand from the LNG industry Australian Energy Regulator, 2017. State of the energy market, Australian Competition and Consumer Commission 2017. Melbourne, Victoria. Available at https://www.aer.gov.au/system/files/AER%20State%20of%20the%20energy%20market%202017%20-%20A4.pdf.. Other factors include repeal of the Gas Electricity Certificate in the end of 2013 and phase-out of the fixed carbon pricing, introduced under the Carbon Pricing Mechanism in 2012.

3. Germany

Overview

In 1982, the German government reviewed the legislative framework for mining, developing a single, unified Federal Mining Act (German Environment Agency, 2014). In 2007, the federal government, in close cooperation with regional authorities and unions, decided to phase out subsidies for coal production by the end of 2018 (BMWi, 2017b).

The Federal Mining Act provides a legal framework for ownership issues that defines rules and procedures for all parties (U.S. EPA, 2009). The former coal mine operator has the right of first refusal on the rights to AMM.

German's Renewable Energy Sources Act provides a feed-in-tariff for previously authorized projects to generate electricity using CMM or AMM. Power grid operators are also obliged to provide priority dispatch to sources run on CMM or AMM (EPA, 2014). The feed-in-tariff for methane-based power generation has been a primary factor driving active development of CMM and AMM recovery and utilization projects (UNECE, 2017). Recently, this program has moved from a feed-in-tariff to a market support mechanism for AMM.

AMM emissions in Germany had been increasing from 1990 and peaked in 2000. Since then there had been a decrease in methane emissions from 5 Mt CO_2e in 2000 to just 18,000 t CO_2e in 2015 (Figure 2).

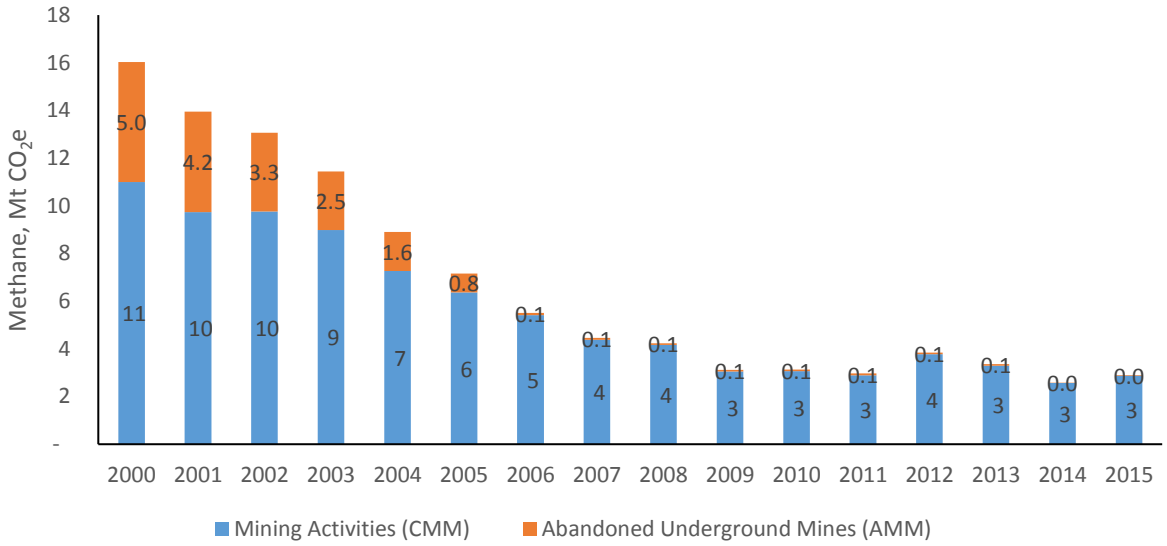

Figure 2. Germany's reported methane emissions from active and abandoned coal mines by year, Mt CO_2e.
Source: UNFCCC (2017).

According to the International Coal Mine Methane Projects Database, Germany has deployed more than 35 AMM projects and all of them involve electricity generation or combined heat and power (Global Methane Initiative, 2017). As of 2016, there were 94 AMM-fired CHP units (one project usually involves several CHP units) with a combined installed capacity 120 MWe (Figure 3).

Figure 3. Number of power generation and CHP units in Germany
Source: Clemens Backhaus (2017).

These AMM projects generate more than 500 MWh of electricity and 75 MWh of heat annually, while avoiding 2.3 Mt of CO_2e emissions (Figure 4).

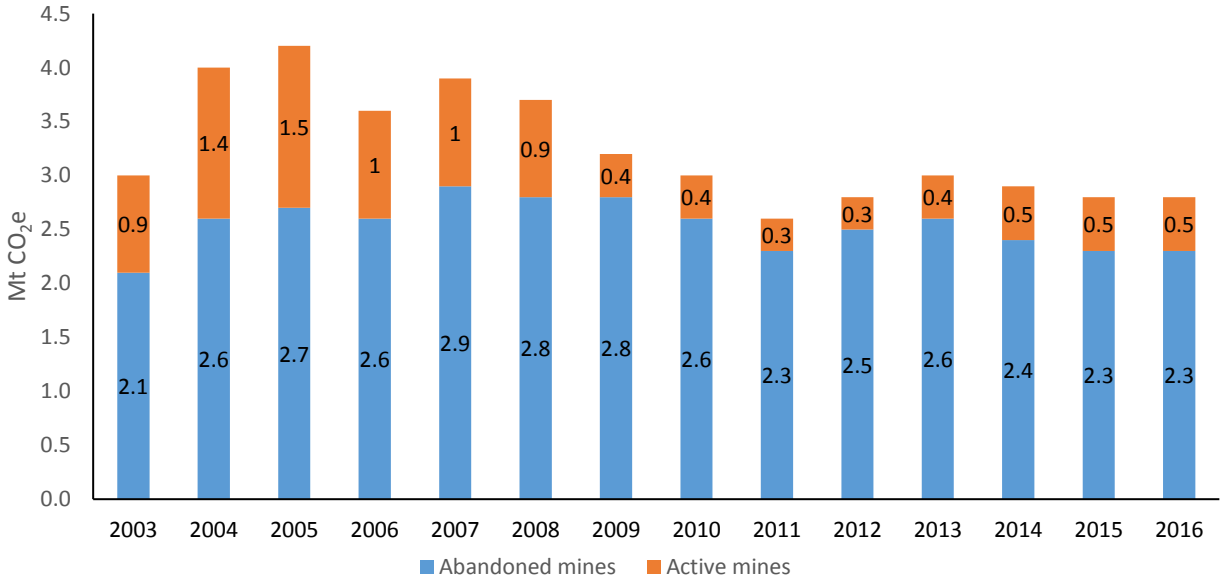

Figure 4. Avoided CO_2 emissions due to CMM/AMM utilization projects.
Source: Clemens Backhaus (2017).

Most of the AMM projects commenced in the early 2000s, which coincides with an update in the country's renewable energy policy, creating a special feed-in-tariff for AMM and CMM-fired power. At the same time, annual reported greenhouse gas (GHG) emission from abandoned mines dropped from 5 Mt CO_2e in 2000 to just 18,000 t CO_2e in 2015 (UNFCCC, 2017). Using these data, we estimate that active AMM projects utilized 99% of total methane emissions from abandoned mines in Germany in 2015.

Drawing on the information above, there appear to be two main reasons for the decline in AMM emissions: increased utilization and decreased coal mining (which over time has limited the number of new abandoned mines).

Ownership/Property Rights

The legal framework set by the Federal Mining Act provides rules for the licensing process, transfer of ownership, and royalties. Specifically, the Federal Mining Authority oversees issues related to exploration, extraction, and utilization of the methane. As a result, no endemic disputes over methane rights have been recorded and Germany is a world's leader in CMM/AMM utilization (U.S. EPA, 2009). The Federal Mining Act treats mine gas as a freely mineable mineral resource (BMWi, 2016).

To explore and extract mineable resources, including methane, companies have to apply for exploration and extraction licenses, respectively. An extraction license grants exclusive rights to extract and acquire ownership to the resources, specified in the license (BMWi, 2016). The law does not have separate rules for AMM or CMM licenses; companies simply follow the regular processes for petroleum licenses. When a coal mine operator obtains a coal license, it automatically includes a license to the gas. Once a mine is abandoned, the former mine operator must re-apply for an AMM license. The former operator does get the first right of refusal in case multiple companies are interested in the AMM license.

The Federal Mining Law provides details on license application procedures as well reasons for rejecting license applications. The maximum initial duration of exploration licenses is five years while extraction licenses can exceed 50 years (BMWi, 2016).

Germany has developed a regulatory framework and favorable economic incentives that enable exploration, extraction, and utilization of coal mine methane. Well-defined property rights, which include the ability to transfer those rights, minimize legal disputes over ownership of coal mine methane (U.S. EPA, 2009).

Incentives

As noted, the number of AMM projects in Germany grew significantly in 2004, when the Renewable Energy Sources Act (hereinafter reffered to as EEG based on the German acronym[3]) was revised to provide feed-in-tariffs for AMM and CMM-fired power. The special tariff was guaranteed for 20 years from the date when a new source applied. The EEG also gives priority dispatch to all renewable sources. However, in 2016 Germany revised the EEG again. According to the new regulation, the Federal Network Agency will pay a market premium for AMM and CMM generated power. The market premium is the difference between the fluctuating market price and fixed reference values (see below) (BMWi, 2017a). The updated EEG establishes the following reference values for electricity from CMM and AMM projects:

- 6.54 € ¢/kWh for installed capacity up to 1 MW;
- 4.17 € ¢/kWh for installed capacity 1 - 5 MW;
- 3.69 € ¢/kWh for installed capacity above 5 MW (BMWi, 2017c).

The updated EEG specifies that starting in January 1, 2018 the reference value for electricity generated from CMM and AMM will decrease annually by 1.5% from the values in the preceding calendar year. The EEG also requires plant operators to sell electricity directly to customers to receive the market premium (BMWi, 2017c).

Royalties

The Federal Mining Act regulates royalty payments. There is a small field royalty on exploration, ranging from 5 to 25€ per km^2 of licensed area per year (Federal Law Gazette, 2016).

In addition, an extraction license holder must pay a mining royalty of 10% of the average market value of extracted resources (BMWi, 2016; OECD, 2013). All forms of commercial energy, including electricity and gas sales are subject to a value-added tax of 19% (OECD, 2013).

Table 2. Business Environment for AMM in Germany

Criteria	**Description**
Ability to produce AMM as a resource	- Active AMM projects utilize 99% of total AMM emissions; - Clearly defined gas property rights; - Existing AMM projects eligible for feed-in-tariff, but new projects are not; - Safety regulations require mine sealing; - Priority dispatch for power plants run on AMM/CMM.
Administrative ease	Regulatory framework provides clear guidance for licensing process, property rights, and transfer of ownership.

[3] In German, the title of the Renewable Energy Source Act is Erneuerbare Energien Gesetz or EEG.

4. United Kingdom

Overview

The United Kingdom (UK) has a long history of developing CMM mitigation projects, and the first AMM project was developed in the 1950's. The UK Government owns the methane associated with coal, and it regulates rights to this methane through its licensing process. Since the UK Government considers methane from coal mines as a petroleum product, it is regulated not by the Coal Authority, but by the Petroleum Act of 1998 (U.S. EPA, 2009). However, any activities and access to the coal reserves require the consent of the Coal Authority.

Abandoned mine methane emissions in the United Kingdom decreased from 1.4 Mt CO_2e in 2000 to 0.441 Mt CO_2e in 2015 (Figure 5).

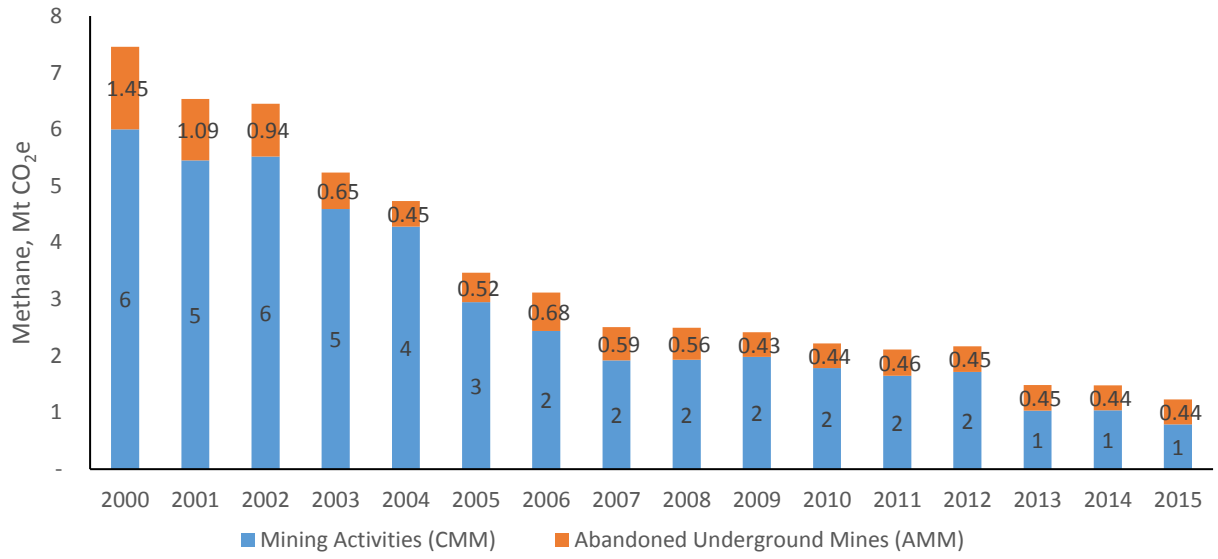

Figure 5. Reported methane emissions from active and abandoned coal mines in the United Kingdom by year, Mt CO_2e
Source: UNFCCC (2017).

An increase in methane recovery and utilization, as well as an overall decline in coal production, are the main reasons for this sharp decline in methane emissions (Thakur et al., 2014).

As of October 2017, there are 23 AMM projects, 13 of which are operating. Twelve of these produce power (with a total installed capacity of 78 MWe) and one project involves pipeline injection. Together these projects avoid emissions of 0.606 Mt CO_2e annually (Global Methane Initiative, 2017). Active AMM projects in the UK utilize about 58% of total methane emissions from abandoned mines. There are more than 900 deep abandoned coal mines, which provide vast opportunities for commercial AMM capture and utilization.

Ownership/Property Rights

The UK regulatory environment for AMM ownership is straightforward with clear definitions for methane during the active period of coal production and after a mine's abandonment (Global Methane Initiative, 2015).

The UK Government owns the methane associated with coal mines and regulates the rights to it in accordance with the Petroleum Act of 1998. The UK Oil and Gas Authority (the successor to the Department of Energy and Climate Change) auctions rights to methane recovery during the "Licensing Round." However, before any production activities, the developer should acquire the consent of the UK Coal Authority.

There are two main types of licenses for capturing and utilizing coal mine methane: 1) Methane Drainage Licenses (MDLs) and 2) Petroleum Exploration and Development Licences (PEDLs).

MDLs apply during the coal production period; they grant the right to capture and utilize methane for safety reasons. In practice, this means that any gas extracted for the safety of the mine may be either vented or utilized.

Unlike MDLs, PEDLs are used for commercial production of oil and gas resources, including abandoned mine methane. Companies do not usually use PEDLs to extract gas in the same strata of mining operations due to safety reasons.

When a mine ceases production, the holder of the MDL must apply for a PEDL to maintain access to the gas. In addition, a company should seek approval from the UK Coal Authority before any production activities.

The UK Coal Authority maintains the Abandoned Mines Catalogue[4], a search tool to determine the relevant abandonment plans. It contains coal and other mineral abandonment plans, covering both surface and deep mining operations (UK Coal Authority, 2014).

Incentives

The license fees are relatively low, and no gas royalty fee per unit volume produced is levied, mainly because in the UK the costs and risks involved in AMM exploitation are relatively high. A royalty would disincentivize exploitation of the resource. Since there are no royalties, the government derives its revenue primarily through energy taxes. The government applies the standard national value-added tax rate of 17.5% to the sale of AMM-related electricity and gas. CMM and AMM projects are subject to an exemption from the Climate Change Levy. When

[4] Coal mining data: abandoned mines catalogue. Available at: https://www.gov.uk/government/publications/coal-mining-data-abandoned-mines-catalogue.

methane is used as a fuel for power generation, this fiscal instrument provides an incentive of £4.41 per MWe (Global Methane Initiative, 2015).

Royalties

The United Kingdom does not charge royalties for extracting AMM. The UK Oil and Gas Authority auctions PEDL licenses to developers who want to win the gas rights. Subsequently, the government levies a nominal annual license (or rental) fee upon the PEDL owner, where the PEDL owner is required to submit an annual report to demonstrate that the resource is in the process of being exploited. When the license owner fails to exploit the resource within a set period, the owner should return the PEDL to the government. License fees increase each year on each square kilometer licensed; this incentivizes developers to increase exploitation of retained acreage (Thomson Reuters, 2016).

Table 3. Business Environment for AMM in the United Kingdom

Criteria	Description
Ability to produce AMM as a resource	- Active AMM projects utilize 58% of total AMM emissions; - Clearly defined ownership rights; - Tax exemptions for power generation from CMM/AMM as fiscal incentives; - AMM requires petroleum license and consent of the UK Coal Authority.
Administrative ease	The Coal Act of 1994 and Petroleum Act of 1998 clarified the gas ownership issues.

5. United States

Overview

The United States is the world's third largest coal producer after China and India. U.S. coal production concentrated in three coal basins: the Appalachian Basins of the Eastern United States, the Rocky Mountain Basins in the Western United States, and Arkoma Basins of the South/Southeast (Global Methane Initiative, 2015).

In the United States, there are about 7,500 abandoned mines, 524 of which are "gassy"[5] (Table 4).

Table 4. Number of abandoned "gassy" mines grouped by class in the United States as of 2015

Class	Sealed	Vented	Flooded	Total Known	Unknown	Total Mines
Total	148	54	100	302	222	524

Source: EPA (2017).

[5] A coal mine is considered as "gassy" if it releases more than 2,830 cubic meters of methane every day.

Abandoned mine methane emissions decreased from 8.8 Mt CO_2e in 2000 to 6.4 in 2015 (EPA, 2017). Eighteen AMM recovery and utilization projects at 40 mines contributed to the reduction in emissions over this period.

The vast majority of AMM projects in the United States involve injection into gas pipelines (Table 5).

Table 5. Summary of CMM and AMM projects in the United States

Type of mine	Number of mines with projects	Number of projects	End Uses					
			Pipeline	Power generation	Heater	Boiler /Dryer	Flare	VAM
Active underground	15	20	13	1	2	1	2	1
Abandoned underground	40	18	15	2	0	0	1	0

Source: EPA (2018a).

In 2015, 2.6 Mt CO_2e emissions at abandoned mines were recovered and utilized, which resulted in 6.4 Mt CO_2e of net AMM emissions (EPA, 2017). Hence, AMM recovery and utilization projects avoided almost 29% of the methane emissions from abandoned mines.

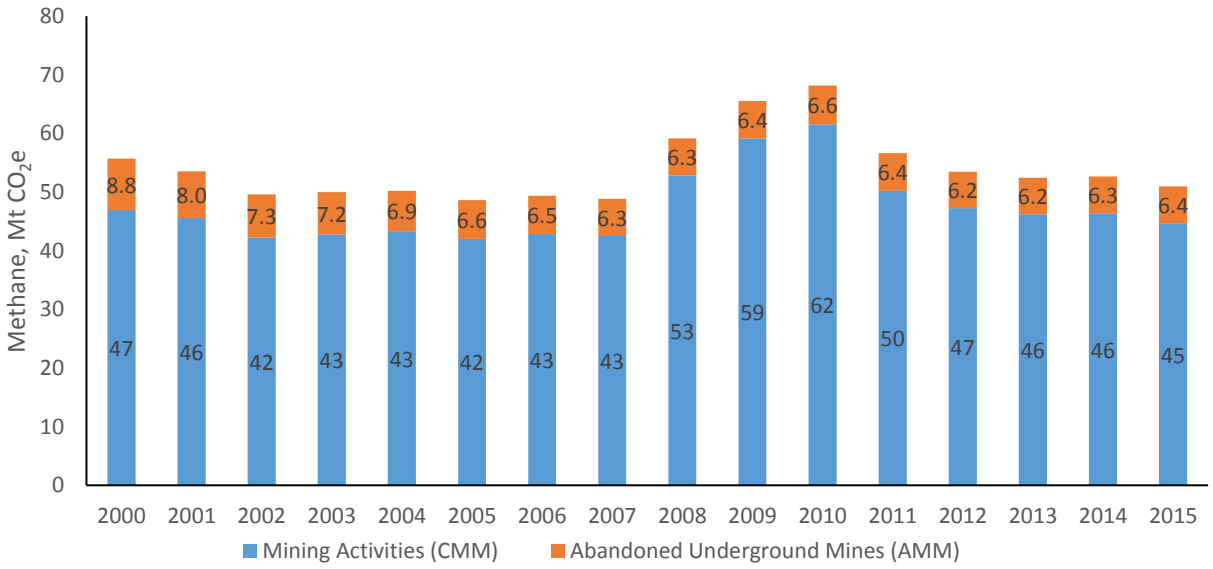

Figure 6. Reported emissions from active and abandoned coal mines in the United States, Mt CO_2e
Source: UNFCCC (2017).

Ownership/Property Rights

The legal framework governing AMM ownership varies across the United States and depends on the regulatory framework in each state, as well as whether or not coal mines are located on

Federal lands. In the Western U.S. states, where many of the coal mines occur on Federal lands, the Federal Government and states usually issue coal leases without automatically granting rights to the associated methane. Conflicts may arise where there are multiple lease holders in the same area (for example, covering resources at different depths, such as AMM, coalbed methane, and natural gas). To encourage the capture of methane released during and after coal production, the U.S. Bureau of Land Management (BLM) can renegotiate coal leases and allow the capture and destruction of methane (BLM, 2017).

On Federal lands, AMM developers typically follow the procedures for a conventional natural gas lease. Because of potential conflicts between the AMM lease holders and other resource lessees, AMM projects on federal lands can be legally expensive to develop, which reduces investments (Ruby Canyon Engineering Inc, 2016).

On private lands, the coal owner has the right to capture gas from abandoned mines once the appropriate environmental permits are secured. This is the case in Illinois, where the majority of U.S. AMM projects are located. Once a lease expires, the methane rights also expire in most cases. Environmental permitting can also differ by state and land ownership.

Deployment of AMM projects has been especially prominent in states where coal lease holders have the right to capture and utilize AMM. For example, 9 out of 26 total AMM projects registered in Illinois. One AMM project, located in Southern Illinois, captures and utilizes AMM from 14 abandoned mines (EPA, 2018a). Figure 7 shows a regional distribution of AMM projects in the United States.

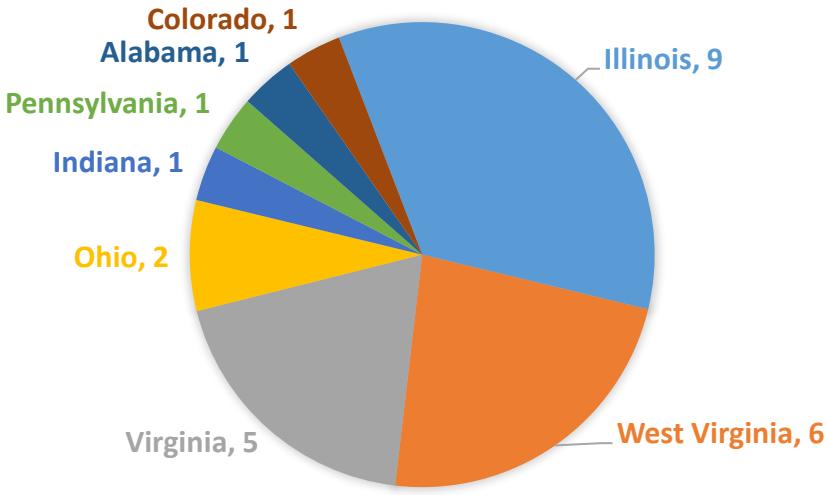

Figure 7. Operational AMM projects in the United States as of 2017.
Source: Global Methane Initiative (2017).

Incentives

Currently, there are no federal incentives to promote AMM usage or utilization. However, several states define methane from abandoned mines as a renewable (or alternative) energy source. This qualifies electricity produced from AMM for state Renewable Portfolio Standards, which then gives utilities a strong incentive to invest in AMM. As of 2016, three out of six states with significant coal production included AMM in their Renewable Portfolio Standards. These states are Pennsylvania, Ohio, and Utah. Some states also provide royalty relief. In addition, several carbon markets in the U.S. provide opportunities to for CMM and AMM utilization projects (EPA, 2018a). For example, California introduced a greenhouse gas cap-and-trade program that includes abandoned mine methane projects as a source of emissions offsets (California ARB, 2014).

Royalties

On Federal lands, if a mining company uses the leased gas for power production or sells it to another company, it must pay royalties to the U.S. BLM. Royalty rates for gas leases on Federal lands are typically 12.5% of the value of resource at the wellhead (GAO, 2017). To encourage capturing and utilizing CMM, agencies that administer Federal and state lands can provide regulatory incentives to the lessee in a form of a royalty reduction (EPA, 2016a). On private lands, royalties are also usually about 12.5% (EPA, 2016a). In addition to royalty payments, private property owners may also receive signing bonuses and annual lease payments. Mines that remove methane to ensure worker safety and meet safety standards, do not generally pay royalties on methane. A 2018 rule stipulates that the BLM incentivize the beneficial use of gas by making gas used for operations and production purposes royalty-free (BLM, 2018).

Table 6. Business Environment for AMM in the United States

Criteria	**Description**
Ability to produce AMM as a resource	- Active AMM projects utilize 29% of total AMM emissions; - No uniform AMM ownership legislation; - Widespread access to gas pipelines; - Royalty relief in some states; - In some states, AMM included in Renewable Portfolio Standards and eligible for GHG offsets.
Administrative ease	Varies depending on the location and land ownership, but often hard to work. Where AMM ownership rights rest with coal estate, it is easy to work on AMM.

6. Conclusions

Many countries have developed and implemented effective AMM regulations and several policy factors play an important role in making AMM projects a success. Table 7 below summarizes key AMM regulation and policies in the four countries analyzed.

Table 7. Comparison of AMM regulation and policies in selected countries

Country	Royalties	Ownership	Ability to produce AMM/Summary of AMM policy	Administrative ease
Germany	10% of the market value	Federally owned	- Active AMM projects utilize 99% of total AMM emissions; - Clearly defined gas property rights; - AMM is a renewable resource, eligible for market premium; - Safety regulation requires mine sealing; - Priority dispatch for power plants run on AMM/CMM.	Regulatory framework provides clear guidance for licensing process, property rights, and transfer of ownership.
United Kingdom	No royalties, but fairly high taxes; Licenses auctioned	Central Government	- Active AMM projects utilize 58% of total AMM emissions; - Clearly defined ownership rights; - AMM and CMM exempted from Climate Change Levy; - AMM requires petroleum license and consent of the UK Coal Authority.	The Coal Act of 1994 and Petroleum Act of 1998 clarified the gas ownership issues.
Australia	10 of the value at the wellhead minus certain downstream costs	State Government	- Active AMM projects utilize 31% of total AMM emissions; - AMM is not clearly defined as a resource; Flaring is prohibited; - In New South Wales, CMM is exempt from royalties; - In New South Wales, venting is prohibited.	No uniform national legislative framework on the AMM ownership. Each state sets its own arrangements.
United States	12.5% of the value of the resource on federal lands, at or near 12.5% on private lands	Private (East); Mostly federal (West)	- Active AMM projects utilize 29% of total AMM emissions; - AMM ownership rules vary by state and ownership of the resources; - Widespread access to gas pipelines; - Royalty relief in some states; - In some states, AMM included in Renewable Portfolio Standards and eligible for GHG offsets.	Difficult to work on federal land where resource rights may be divided among multiple lessees. Where AMM and CMM ownership rights rest with coal estate, easy to work on AMM.

Examples from these countries shows that the proper legal and regulatory framework, combined with financial or fiscal incentives can facilitate utilization of methane from abandoned coal mines for the natural gas market (as in the United States), power generation (mainly in the UK and Australia), and combined heat and power (as in Germany).

While geology plays an important role in setting the limits to AMM utilization, ownership rights are the most important and challenging issue in the regulatory framework. Countries with successful AMM projects have market rules that make it easy to sell gas or gas-fired power to third parties and allow for the easy transfer of rights to the gas.

Royalties also play an important role in the economic feasibility of a project. High royalty rates can discourage developers from pursuing AMM projects. Royalty payments usually vary from 5 to 13% percent depending on the country's specific circumstances, regulatory environment, gas field location, and wellhead value of the gas. High royalty payments can discourage AMM developers in countries with high AMM production costs. To incentivize unconventional gas development, regulators can offer special terms such as discounting royalty rates for such projects.

Examples of policies that countries and local jurisdictions have used to promote AMM utilization include:

1. Enacting clear procedures for obtaining the AMM ownership rights for mines that are already abandoned;
2. Developing rules that make it easy to transfer gas rights to AMM project developers both when mines close and at other stages in an AMM project;
3. Defining AMM as a renewable resource so that it is eligible for renewable incentives;
4. Setting royalties at a low level to encourage investment, especially in areas with difficult geological conditions;
5. Requiring proper sealing of the mine after closure.

Development and enforcement of a clear and favorable legal framework will not only maximize AMM utilization but also can provide an additional energy resource for country's energy mix.

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