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A strategic approach to selecting policy mechanisms for addressing coal mine methane emissions: A case study on Kazakhstan

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ABSTRACT

Coal production globally is projected to grow in the foreseeable future. Countries with heavy reliance on coal could reduce methane and other emissions through the capture and utilization of coal mine methane (CMM) in the short and medium term, while they pursue structural and long-term economic changes. Several countries have successfully implemented policies to promote CMM capture and utilization; however, some countries still struggle to implement projects. This paper outlines key factors to consider in adapting policies for CMM mitigation. The authors propose an approach for selecting adequate mechanisms for stimulating CMM mitigation that involves reviewing global best practices and categorizing them functionally either as mechanisms needed to improve the underlying conditions or as CMM-specific policies. It is important to understand local policy frameworks and to consider whether it is more feasible to improve underlying policy conditions or to provide targeted incentives as an interim measure.

Using Kazakhstan as a case study, the authors demonstrate how policymakers could assess the overall policy framework to find the most promising options to facilitate CMM projects. Kazakhstan's emissions from underground coal mines have been increasing both in total and per tonne of coal production, while overall production has been declining. CMM mitigation presents an opportunity for the country to reduce its greenhouse gas emissions in the near and medium term, while the government pursues sustainable development goals. Analysis shows that policymakers in Kazakhstan can leverage existing policies to stimulate utilization by extending feed-in tariffs to cover CMM and by developing working methodologies for companies to obtain emission reduction credits from CMM projects.

1. Introduction

Methane emissions from global coal production continued to grow through the last decade. Coal production might not have been growing as rapidly in recent years (IEA, 2015), but integrated assessment models project that global coal production, and associated methane emissions, will continue increasing into the foreseeable future. A study by Höök indicates that the average of model projections shows growth in coal production through 2050 for all emission scenarios, except in B1 scenarios ('local environmental sustainability'), in which coal production grows through 2040 (Höök, 2011). Developing countries, in particular, are expected to continue to rely on coal as a dominant fuel because of their need for a cheap and reliable energy source for social development (IPCC, 2014). In addition, countries are not likely to give up infrastructure in place, such as power plants, until the end of their lifespan, which may take decades. As nations are seeking to reduce reliance on fossil fuels, coal mine methane (CMM) mitigation projects can help reduce emissions from coal in the medium term.

Methane is a potent greenhouse gas, with a global warming potential of 28–36 over 100 years, yet it is the only pollutant that can be used as a source of fuel, making methane mitigation projects potentially cost-effective in coal-producing countries. Utilization of CMM has many benefits, such as reduced greenhouse gas emissions, improved energy intensity, improved mine safety, job creation, and others. CMM projects can help attain these benefits without compromising sustainable development goals, because countries will likely continue to rely on coal for several decades even with long-term plans for low-carbon economies. Methane mitigation will be particularly relevant since methane emissions per tonne are likely to increase as coal is mined deeper and deeper (IPCC, 2010; KazNIIEK, 2010). In an alternative scenario, if countries rapidly switch to renewables, the closing of mines will still require methane management of methane, as gassy mines will continue

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to release methane for some time.

Many policy instruments are available to support CMM projects in their capacity to meet environmental and social goals. Yet quick and effective adoption will require strategic selection of appropriate measures.

Kazakhstan is a member of the Global Methane Initiative (GMI), an international voluntary partnership that promotes the use of policy and industry best practices to reduce methane emissions in several industrial sectors. The GMI works in Kazakhstan to promote strong policies that encourage and enable CMM capture and utilization. Kazakhstan is the world's 10th largest coal producer and is a net coal exporter (EIA, 2015) but ranks as the 6th largest emitter of methane from the coal sector (EPA, 2012), indicating that Kazakhstan's mines are gassy. In this paper, the authors discuss a strategic approach to devising policies for incentivizing CMM mitigation in the country, which can, in turn, be applied in other countries.

2. Analytical framework and methodology

Many countries have experimented with various incentives and policies to encourage recovery and use of CMM. The most common policies and incentives include (adapted from Evans et al., 2009):

1. Institutional frameworks
2. Defined gas property/lease rights and licensing
3. Access to gas and power markets
4. Price of natural gas and electricity
5. Mine safety requirements, adequate technical regulations, and their implementation
6. Feed-in tariffs and obligations
7. Tax incentives
8. Environmental tax regulation and emission trading.

These mechanisms can be classified as either underlying economic/policy conditions or as CMM-specific policies. The underlying conditions are institutional framework, gas property/lease rights and licensing, access to gas and power markets, price of natural gas and electricity, mine safety requirements, and related technical regulation. Favorable underlying policy conditions might enable CMM projects without any CMM-specific policies. On the other hand, these policies can be harder to implement since they typically affect a broader sweep of policies, require involvement of more stakeholders, and need to be addressed in context. For example, providing access to natural gas and power markets requires review of such rights for all relevant industries, such as small electricity generation companies and all natural gas companies.

If the underlying conditions are not adequate to stimulate investment, policymakers can add additional incentives. CMM-specific policies can also be used to temporarily fill in gaps in underlying policy conditions. For example, China incentivized CMM to improve implementation of safety regulations. Policies, such as tax incentives, feed-in tariffs, and environmental regulation usually exist in countries in some form; building on the existing framework and aligning it to support methane mitigation might lead to easier adoption and faster capacity building. For example, a country with a well-functioning system of tax incentives might consider these incentives for stimulating CMM investment, whereas a country with strong environmental policy might consider expanding it for coal. Finally, to get a comprehensive policy one needs to consider implementation under the local conditions and consider how to enhance implementation of existing policies and whether the approach is feasible. Fig. 1 shows a sample policy framework for incentivizing CMM mitigation.

To propose strategic mechanisms for stimulating mitigation of CMM emissions in Kazakhstan, the authors relied on literature research to learn about Kazakhstan's policy and major stakeholders. The authors used statistical data from the International Energy Agency (IEA) and Kazakhstan's national inventory submissions to the United Nations Framework Convention on Climate Change (UNFCCC). In some instances, the authors used national statistics of Kazakhstan, reviewed laws and reports, and accessed local news articles. The authors supplemented this information with in-country meetings and interviews with representatives from government, companies, and non-governmental organizations. The authors assessed Kazakhstan's overall policy framework affecting CMM utilization to understand what practices are best suited for adoption locally. Information and data collection was conducted under the auspices of GMI coal mine sector activities.

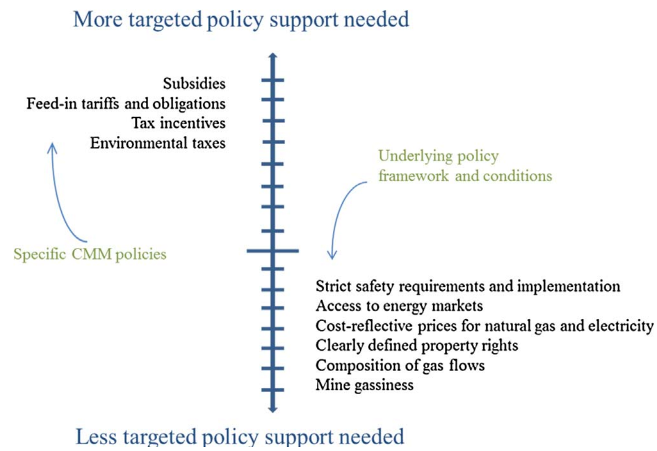

Fig. 1. Policy framework for incentivizing CMM mitigation.
Source: Roshchanka and Evans, 2014.

3. Background on Kazakhstan's coal sector and methane emissions

As in many coal-producing countries, Kazakhstan's coal sector represents a large share of domestic energy supply (see Fig. 2). Coal fuels over 80% of the country's electricity, and almost all of the heat supply comes from coal and coal products (IEA, 2015). Total production and export of coal and coal products in Kazakhstan have recently been shrinking, yet the country's domestic consumption has more than doubled over the past decade. Considering that the country is invested in coal production, coal-fired electricity, and district heating, Kazakhstan highlights an example of how countries with coal-fueled infrastructure are not likely to give up coal rapidly. For this reason, CMM mitigation is an important element of climate policy.

Kazakhstan's two major coal basins are Ekibastuz and Karaganda, which produce coal from opencast and underground mines, respectively. Opencast mines in the Ekibastuz region also produce about 90% of the country's coal, and thus, are a significant source of methane emissions. Underground coal mines in Kazakhstan are some of the most gassy in the world and prone to violent gas outbursts. The gas content of the coal averages between 12 and 53 cubic meters (m^3)/tonne, with the average value for sampled mines at 30 m^3/t (KazNIIEK, 2010). However, since Kazakhstan has been commercially extracting coal for over a century, the remaining coal lies deep, in most cases, at depths of over 500 m, and has low permeability. This and the complex geology make mines dangerous and degasification difficult and time-consuming (Baimukhametov et al., 2012). Kazakhstan's major coal producer from underground mines is Arcelor Mittal Temirtau Coal Division, a multinational company with headquarters in Luxembourg. The company operates eight underground mines in the Karaganda region that account for about 15% of the country's total coal output (including opencast mines). Government agencies in Kazakhstan also manage 13 closed mines, which also collect methane. Such mines also present an opportunity for methane utilization projects.

Even though coal production from underground mines has declined,

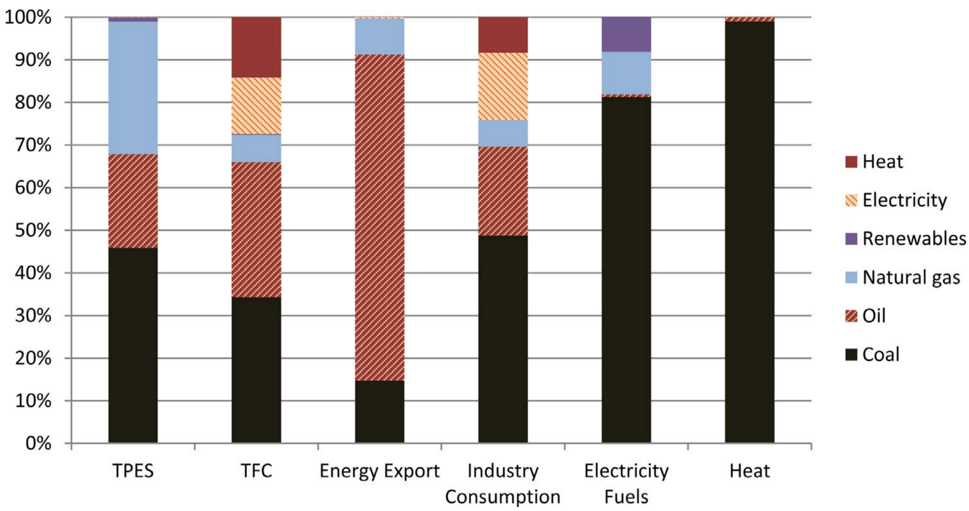

Fig. 2. Share of coal in Kazakhstan's total primary energy supply (TPES), total final consumption (TFC), energy export, and energy subsectors in 2013. Source: IEA, 2015.

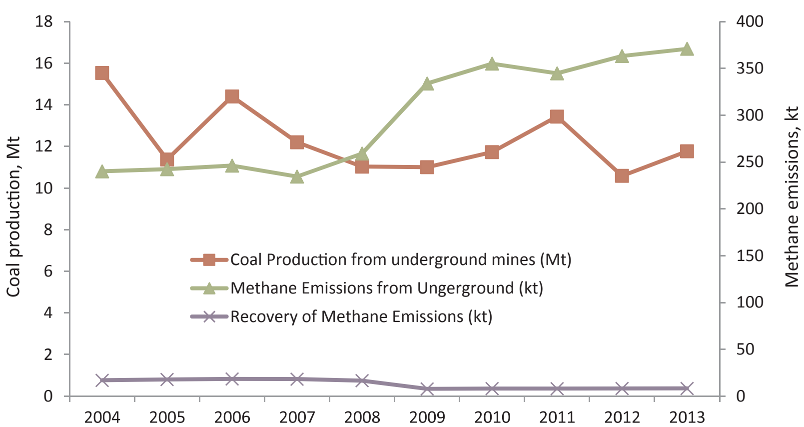

Fig. 3. Trends in coal production from underground mines and methane emissions from such mines.
Sources: UNFCCC, 2013; Government of Kazakhstan, 2015.

methane emissions increased from 240 kt to 370 kt over the past 10 years (Fig. 3). Kazakhstan's coal sector not only produces more methane emissions per tonne of produced coal than Australia, Russia, Poland, or the United States, but CMM capture and utilization/flaring rates are much lower compared to 10 years ago. According to the country's most recent submission to UNFCCC, the country captured only 2% of methane released from underground coal mines in 2013 (Government of Kazakhstan, 2015), whereas Russia utilized about 5%, Ukraine over 9%, and the United States 25% (UNFCCC, 2013; Government of Kazakhstan, 2015). A decade ago, in 2004, Kazakhstan recovered 7% of its methane emissions from underground coal mines (UNFCCC, 2013; Government of Kazakhstan, 2015; IEA, 2015). The share of coal produced in opencast mines increased from 83% in 2004 to 91% in 2014 (UNFCCC, 2013). With the development of opencast mines, the recovery rate decreases.

An important factor in coal production and CMM projects is energy prices. Domestic prices for coal, electricity and heating in Kazakhstan are some of the lowest in the region, reflecting the energy pricing policy of Kazakhstan aimed at keeping prices low. Kazakhstan residents paid on average just over $0.05 per kWh for electricity in 2015, and about $0.04 per cubic meter of natural gas (see Table 1). Prices for industrial consumers tend to be slightly higher in Kazakhstan, whereas they are typically lower in the EU and United States. For comparison, in Almaty industrial consumers pay for electricity according to a differentiated tariff: $0.08/kWh between 7 a.m. and 7 p.m., $0.16/kWh between 7 p.m. and 11 p.m., and $0.02/kWh after 11 p.m. (Energy Charter Secretariat, 2013). But even considering the fact that industrial consumers pay higher prices in Kazakhstan, energy prices in Kazakhstan are still low by standards of many countries.

Table 1
Natural gas and electricity prices in Kazakhstan, Russia, United States, and Europe. Average annual prices for residential consumers in 2015.
Sources: Statistics Agency of Republic of Kazakhstan, 2016; Russian Statistical Agency, 2015; EIA, 2016a,b; Eurostat, 2016.

Country	Natural gas, per m^3	Electricity, per kWh
Kazakhstan	$0.04	$0.05
Russia	$0.08	$0.05
United States	$0.37	$0.13
EU Average	$0.86	$0.24

The government of Kazakhstan has recently introduced a number of environmental policies as the country aims to transition to a "greener economy", including a cap-and-trade mechanism and feed-in tariffs for renewable sources of energy. Kazakhstan's 2050 Strategy sets a goal of 50% of its energy demand from renewable and alternative sources by 2050 (Kazakhstan Strategy 2050, 2015). As a result, installed renewable energy capacity has grown in recent years. CMM utilization projects have not been considered in implementing this strategy, yet data indicate that there are opportunities for methane mitigation in the Kazakhstan coal sector, which would help Kazakhstan move closer to achieving its goal of "greening" its economy.

4. Policy analysis and discussion

CMM capture and utilization is not a new topic in Kazakhstan. The country's first CMM projects began in the Karaganda region in the 1950s. A number of projects operated in the 1990s but were closed with the restructuring of the sector; however, some projects are in operation

Table 2
Recent and current CMM utilization projects in Kazakhstan.
Sources: (1) Khamimolda, 2014; (2) GMI, 2010; (3) Khamimolda, 2014; (4) Abramenkov, 1996; (5) Arcelor Mittal Kazakhstan, 2011; (6) Glushich et al., 2011; (7) Abramenkov, 1996; (8) Arcelor Mittal Kazakhstan, 2011; (9) Abramenkov, 1996; (10) Arcelor Mittal Kazakhstan, 2010.

Mine Name	CMM Project Type and Approx. Date Active	Operator/Owner	Utilization Technology	Other Notes
Abayskaya	Underground, active mine (2010–current)	ArcelorMittal Temirtau	1 boiler	Operation status unknown.
Karaganda Coal[1] Mine	Underground, closed mine (2000s)	ArcelorMittal Temirtau	1 boiler	Formerly, Mine Named after 50th Anniversary of October Revolution.
Kazakhstanskaya[2]	Underground, active mine (2010)	ArcelorMittal Temirtau	Boilers	
Kirovskaya[3,4]	Underground, active mine (mid-1990s–2000s)	"Gefest" Association	2 boilers	The project was developed but not installed.
Mine Named After Kostenko[5]	Underground, active mine (2000s–current)	ArcelorMittal Temirtau	Boilers	Not in continuous use.
Mine Named After Lenin[6]	Underground, active mine (2000s and 2011–current)	ArcelorMittal Temirtau	2 boilers, 1 gas engine with total out-put of 1.4 MW	The mine utilized CMM in boilers for heat onsite. In 2011, ArcelorMittal Temirtau installed GE Energy Jenbacher to generate electricity. This unit was later moved to Kazakhstanstaya due to drop in gas flow.
Saranskaya[7]	Underground, active mine (1990s–current)	ArcelorMittal Temirtau	1 boiler	Not in continuous use, because of low gas flow.
Shakhtinskaya [8]	Underground, active mine (2000s–current)	ArcelorMittal Temirtau	2 boilers	Operation status unknown.
Stakhanovskaya[9]	Underground, reorganized mine (1990s)	ArcelorMittal Temirtau	3 boilers	Now part of Mine Named after Kostenko.[10]

today. Using online research and company information, the authors compiled information on recently closed and operating CMM projects in the country (Table 2).

Such previous experience with CMM in Kazakhstan is likely to contribute to favorable underlying conditions, since the country has maintained some of the institutional framework and has laws and policies that are essential for CMM projects to function. Below is an analysis of underlying policy conditions related to CMM in Kazakhstan.

4.1. Institutional framework

A country's institutional framework is key to reducing transaction costs and other barriers for CMM projects. A dedicated agency, program, or institute can facilitate interaction among stakeholders, identify policy measures and technical barriers, disseminate information, approve projects for leasing land, issue licenses and permits, and perform other functions.

Several countries offer examples of how such coordinating agencies provide information to CMM stakeholders and support policymaking. One example of such an entity is the China Coalbed Methane Clearinghouse (http://www.nios.com.cn/coalbed.html) within the China Coal Information Institute (CCII). This government-supported clearinghouse has improved awareness of decision-makers and developed policy recommendations to encourage foreign investment and joint ventures. The Clearinghouse also provides information and identifies investment opportunities for Chinese and foreign companies. India offers another example. Its (http://cmmclearinghouse.cmpdi.co.in/) is operated by the Central Mine Planning and Design Institute (CMPDI). The Indian CMM/CBM Clearinghouse is a non-government organization that operates under the aegis of the Ministry of Coal and serves in an advisory role, while supporting policymaking, such as on CMM ownership and other legal issues. It regularly hosts seminars and technical workshops, disseminates information and builds capacity of government agencies and policymakers to promote the development of CMM projects in India (India CMM/CBM Clearinghouse, 2015). Both of these clearinghouses were established and partially funded by the United States Environmental Protection Agency (EPA), under the auspices of the GMI; they provide examples of how a similar center could facilitate CMM recovery and use in Kazakhstan.

In Kazakhstan, many agencies cover various aspects of CMM ownership, recovery, utilization, and regulatory compliance. The Committee on Geology plays a key role in defining ownership and leasing procedures. The government of Kazakhstan appointed the Department for Coal Industry Development within the Ministry of Energy to take a leadership role in promoting CMM capture and utilization in Kazakhstan. Another institute, the Karaganda Institute for Scientific Research on Industrial Safety and the Ministry of Energy, historically oversaw degasification and utilization of methane in mines in the region. The institute piloted degasification and utilization of methane in a boiler in 1956 and, between 1955 and 2000, developed degasification schemes for 24 mines (Novikov, 2012). The existence of these institutions is a positive factor, as these agencies can help develop adequate legislation, contribute to the research agenda, and align incentives and policies to stimulate recovery and use of CMM. If these agencies continue to build their capacity and offer resources to stakeholders, promote dialogue and coordination, and identify key barriers and potential policy solutions, they can play a critical role in increasing investments in CMM. Increasing the visibility and online presence of these agencies can also improve their effectiveness. Selecting one agency to be a 'one-stop shop' for issues related to CMM could reduce the need for coordination and increase efficiency. At the same time, adjusting the institutional framework requires political will and might take years, and thus, has to be part of a longer-term strategy.

4.2. Defining gas property rights and licensing procedures

Many countries lack clear rules on ownership and licensing terms related to the use and sale of CMM. The legal definition of CMM as a natural resource could determine how it is treated in tax law and whether companies can own, sell, or transfer rights to the gas. CMM property rights are tied to other property rights and often have to be reviewed in context with other natural resource property laws.

By default, the government of Kazakhstan is the primary owner of all mineral resources in accordance with the Constitution of the Republic of Kazakhstan and the Law on Mineral Resources and Their Use. However, Kazakhstan's legislation does not classify CMM as a commercial resource and does not offer a defined legal approach to obtaining or transferring rights to CMM. Rather, the resource is allocated on a case-by-case basis. In the case of Arcelor Mittal, the company obtained their license to coal and associated gas and, thus, can manage CMM as a 'waste' resource. This might imply that selling CMM-sourced energy might trigger royalties and other taxes applicable to commercial resources, such as natural gas. Another disadvantage to this approach is that there are no procedures defined for transferring rights to CMM or obtaining rights to AMM resources in closed mines nearby are not defined. At the same time, combining CMM and AMM projects can be attractive for improving project economics and risk management.

Recently, the Government of Kazakhstan has been working to revise laws pertaining to mineral resources using Australia's model. There is potential for the government to clarify CMM ownership under this revision. In Australia, state (or provincial) governments own the mineral resources and lease them out to coal companies under permits and mining leases. Coal mines can extract CMM as part of their coal mining operations; however, production of CMM requires a production license and off-site use or sale require a petroleum lease. In Queensland, flaring and venting are prohibited and, if mines cannot use all of their CMM resources on-site, petroleum lease holders may apply to utilize it. In New South Wales, companies do not pay royalty payments on CMM, even for off-site use (GMI, 2014). This model could clarify CMM in Kazakhstan and increase attractiveness of CMM investments.

As these cases show, Kazakhstan currently does not have systematic rules defining CMM rights. This could create costly legal due diligence and negotiations each time a mine or related company wants to utilize CMM, which creates a strong barrier to CMM use. On the other hand, lawmakers' attention to mineral regulations could be an opportunity for clarifying procedures for obtaining and transferring CMM ownership.

4.3. Accessing natural gas and power markets

Access to natural gas and power markets, in principle, allows for CMM to be sold off-site, and thus, could be an incentive for companies to recover and utilize CMM. In Kazakhstan, the law guarantees access to major pipelines as long as the supplier has the authorization to sell, meets technical requirements and is connected to the infrastructure.

When it comes to accessing natural gas infrastructure, major coal basins in Kazakhstan are far from major existing natural gas pipelines. Thus, in practice, companies utilizing CMM would not find it feasible to sell CMM-based natural gas to pipelines without costly infrastructure investments. The Karaganda basin also has substantial resources of CBM, and the government envisions building natural gas pipelines, but it may take years before the infrastructure is developed.

Kazakhstan's electricity transmission system consists of a national transmission grid and regional low-voltage grids, operated by 21 regional transmission companies (Energy Charter Secretariat, 2013). Kazakhstan Electricity Grid Operating Company (KEGOC) is the national transmission grid operator, which provides connection between Kazakhstan's regions, links to the power grids of neighboring countries and transmits electricity from power plants to wholesale consumers. Independent electricity producers, such as companies specialized in recovering CMM, can participate in the wholesale electricity market, if they are able to sell at least 1 MW on average per day. To access the market, a company has to obtain a license, meet technical requirements, build electric lines to the transmission grid, and sign service and other agreements with the appropriate transmission company (national or regional). Companies that have a supply capacity of over 10 MW must coordinate with KEGOC on technical conditions and plans. For technical capacities of 1 to 10 MW, KEGOC simply requires notification of the intentions to supply electricity.

Kazakhstan's law allows for access to the power grid in principle, but because of low energy prices and the requirement to construct connecting power lines, selling off-site might not be feasible at this time.

4.4. Price of natural gas and electricity

Energy prices are a key underlying condition, as they define the economic feasibility of CMM projects. Energy prices in Kazakhstan have been growing: since 2000, electricity prices more than doubled and natural gas prices increased as well (Statistics Agency of Republic of Kazakhstan, 2016). However, energy prices are still substantially lower than in most other industrialized countries. Kazakhstan residents paid on average about \$0.05 per kWh for electricity in 2012, and about \$0.04 per cubic meter of natural gas (Table 2).[2] Central and regional authorities in Kazakhstan regulate energy tariffs, keeping energy prices low for social stability. Such low energy prices create obstacles for CMM as CMM has to compete with cheap sources of energy.

Despite energy prices being an insufficient stimulus for CMM investment in Kazakhstan, coal mining companies might be interested in investing in on-site electricity generation to avoid power purchase, to improve security of supply, and to reduce exposure to volatile electricity prices. The sector infrastructure is also in need of significant investment, signaling potential future increases in electricity prices (Energy Charter Secretariat, 2013). This makes electricity production a promising investment when it comes to utilizing CMM.

4.5. Mine safety requirements, adequate technical regulation, and their implementation

Enforcement and implementation of mining safety regulations has a positive impact on the feasibility of CMM projects, since mines are more likely to capture methane and in larger quantities. Countries must also have adequate technical regulations that correspond to industry best practices and are performance-oriented. A number of countries with a good track record in labor safety, such the United Kingdom, Australia, and the United States, have integrated regulations that require or encourage a process-based assessment of risks and focus on performance. Strong, risk-based regulation can have a major impact on regulating worker fatalities as well as costly work stoppages due to unsafe methane concentrations.

Recent data show that fatalities in Kazakhstan's coal mines have decreased (see Fig. 4), although non-lethal accidents are still regular. The major reasons for accidents are methane accumulation due to poor degasification, ventilation, equipment failure, and non-compliance with existing safety standards.

In Kazakhstan, safety regulations are prescriptive and include detailed standards, norms, rules, methodologies, and instructions to ensure that companies know what the government expects. The regulations are approved at the national level through a centralized process that aims to ensure that they are written by expert committees that

[2] It should be noted that Table 2 gives average electricity prices, which might differ from those faced by coal companies. For example, in the United States electricity prices vary by region and are usually much cheaper in coal producing regions. In the Appalachian region electricity, prices can be as low as \$0.04 per kWh; project developers use such prices for benchmarking and evaluating CMM projects (Talkington, 2015). Thus, Kazakhstan's context might not be unique.

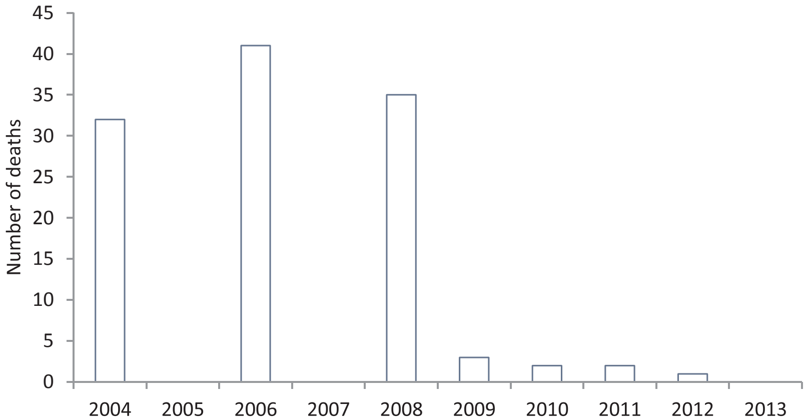

Fig. 4. Annual deaths at coal mines in Kazakhstan, 2004–2013.
Sources: Ecomuseum, 2008; Regnum, 2008; Newsru.com, 2009; Kazakhstan Portal NUR KZ, 2010; Arcelor Mittal Termirtau, 2011; Veber, 2012.

involve stakeholders from government agencies, quasi-government research institutions, industry, and others. Based on in-country meetings, the general opinion in the Kazakhstan government is that technical regulations are necessary to stimulate the economy, improve competitiveness, manage environmental issues, and guarantee the well-being of citizens. However, in practice, it is difficult for such technical committees to cover all sectors of Kazakhstan's economy and keep up with all industrial processes in the country, particularly when such committees might not have continuous sources of funding. Thus, technical regulation in Kazakhstan has fallen behind in many sectors, and regulations are often outdated and difficult to comply with. For example, degasification instructions present complex formulas for calculating angle, depth, and spacing for drilling headings, while not referencing the use of computers and software that can improve accuracy and ease of compliance. Greater engagement of industry stakeholders in development of technical regulations and better alignment with industrial processes and practices, particularly, when companies already rely on internal procedures for risk assessment and management, could improve the quality and relevance of technical regulations and bring them in line with best available practices. In addition, policymakers could reframe safety enforcement from being a costly burden of compliance with complex regulations to being a source of revenue from CMM utilization that drives safety.

The problems with prescriptive solutions to safety problems have been acknowledged and discussed on an international level. The United Nations Economic Commission for Europe and the Global Methane Initiative (formerly the Methane to Markets Partnership) published the *Best Practice Guidance for Effective Methane Drainage and Use in Coal Mines* (UN, 2010). The report describes the benefits of promulgating principles-based regulations that could be helpful for Kazakhstan. The guidance document was recently updated in 2016 (https://www.unece.org/energy/se/cmm.html).

The Government of Kazakhstan is currently updating existing mining safety rules, but it is unclear whether the revised regulations have a process approach that is results-oriented. A review of latest best practices can offer new approaches for estimating CMM emissions, such as the use of software and models that evaluate methane emissions and control options; technologies that can improve the economics of CMM capture and utilization, such as methane purifying technologies or engines that utilize methane; or improved understanding of safety practices and processes companies much undertake to evaluate risks and achieve zero-accident goals. CMM utilization could be a powerful tool in achieving such goals.

4.6. Feed-in tariffs and obligations

To help CMM-based electricity enter the market, a government can establish feed-in tariffs that increase and guarantee prices for alternative electricity, and obligations that require utility companies to purchase a certain percentage of electricity from renewable/alternative sources. These are CMM-specific policies, and several countries rely on feed-in tariffs and/or obligations. For example, the German Renewable Law guarantees CMM-based power at a price of about €0.07/kWh ($0.05/kWh). In Poland, utilities are obliged to purchase up to 2.3% of electricity from highly efficient cogeneration, like CMM. In China, companies can receive a feed-in tariff of 0.25 yuan/kWh ($0.04/kWh), although implementation of this law has not been universally applied (Evans and Roshchanka, 2013; GMI, 2014).

In some states of the United States, CMM-based energy is eligible to fulfill mandated requirements for alternative energy supply (EPA, 2016). This mechanism is similar to a feed-in tariff, but instead of setting the price of a tariff and obliging utilities to purchase alternative energy at that price, a renewable portfolio standard (RPS) sets volume requirements for utilities and lets the market establish the price for the alternative fuel. To ensure that the alternative fuel is in line with the environmental agenda, some states, such as Colorado, require the CMM project to demonstrate carbon neutrality.

CMM does not enjoy any feed-in tariff benefits in Kazakhstan. However, Kazakhstan does have green tariffs to support renewable energy. The tariff covers solar, wind, hydro, geothermal, biomass, biogas, and bio feedstock, so it might be possible to add CMM to the existing system. The government has set tariffs for the next 15 years starting at 23 KZT/kWh ($0.07) for wind energy to 32 KZT/kWh ($0.09) for biogas. The European Bank for Reconstruction and Development worked with the government of Kazakhstan to develop the legal framework and calculation methodologies for feed-in tariffs. However, the methodologies do not cover CMM-based electricity. An important advantage of CMM is that it can provide a steady supply for power throughout the day, and as such could help balance more intermittent sources of power such as solar and wind. Methodologies for calculating a feed-in tariff for CMM could be linked to that of biogas, since the technologies and principles for projects are very similar.

Most countries with feed-in tariffs also allow net metering and will provide the feed-in tariff for power from eligible sources, even if it is consumed onsite. Energy-generating consumers would simply get a credit on their bill, based on the installed meter for alternative electricity generated onsite. Kazakhstan is striving to develop such legislation, which will support all types of renewable and alternative energy.

In summary, Kazakhstan already provides "green" feed-in tariffs and utility obligations for power generated from solar, wind, hydro, geothermal, biomass, biogas, and bio feedstocks. Extending these tariffs to cover CMM-based energy appears to be one of the most feasible policy options for stimulating CMM projects. This is an example of how Kazakhstan could leverage existing CMM policy.

4.7. Tax incentives

Exemptions from or deductions on royalty payments, production taxes, value-added taxes (VAT), import duties, or from other taxes on capital purchases may provide incentives to develop CMM projects.

Such policies are in place in Poland, where CMM-based electricity is exempt from excise taxes. China provides exemptions from VAT on CMM project equipment, exemptions and discounts on royalties for exploration rights and mining rights, exemptions from import duties for CMM equipment, as well as a tax deduction for financing CMM capital purchases (Evans and Roshchanka, 2013; GMI, 2014; Liu, 2016).

Recovered CMM is not taxed in Kazakhstan if coal mines use the gas onsite; this is potentially an incentive for onsite generation. Policymakers in Kazakhstan can offer further incentives to improve the economics of CMM projects; however, taxation legislation is harder to introduce than other types of incentives because of the wider implications of taxes.

4.8. Environmental tax regulation and emission trading

Environmental taxation and regulations can potentially provide a strong stimulus for CMM projects. Governments can reduce environmental taxes if coal companies mitigate their methane emissions through CMM projects. In the UK, electricity produced from CMM was exempted from the Climate Change Levy, but it was insufficient on its own to support CMM development (IEA, 2009).

Kazakhstan's legislation requires that coal companies obtain emissions permits from an authorized government agency for any regulated emissions. The Ministry of Energy issues emission permits for emission levels within government norms. This Ministry also sets emission limits for individual enterprises. Companies need to pay a base fee per tonne of permitted emissions and higher level fines for each tonne that exceeds that facility limit. Coal mining companies do not need to apply for new emission permits if they pursue CMM projects.

Base charges for methane emissions from stationary sources are 0.01 of Monthly Calculation Index (MCI)/t,[3] or $0.10/t. For associated petroleum gas, the base charge for methane emissions is higher: $0.40/t. In addition to the base charges, the Ministry of Energy applies coefficients in accordance with various factors. For example, energy producers face additional multipliers; for emissions above established limits, the charge is 10 times higher. Individual regions have the right to set higher charges. In Severo-Kazakhstanskiy region in northern Kazakhstan, the base charge for methane emissions is 0.014 MCI/t ($0.14/t). Emissions without permits are considered to be above limits and, thus, charges are multiplied by 10. However, companies typically apply for extra emission allowances (e.g., facility limits) to avoid paying the higher fines. Pollution fines would present a stronger incentive for companies to invest in CMM if implementation was stricter or the price signal was stronger. At present, this policy option does not provide a strong incentive to invest in CMM.

Many countries, such as the United States and China, have regional or national emission trading schemes, which can be designed in a way that allow CMM projects to generate offset credits. This also required creating adequate methodologies and procedures for valuating emission reductions. In California, CMM projects are eligible for offsets in the emission trading scheme and the state has a detailed methodology for certifying emission reductions.

Kazakhstan could also stimulate CMM through its national emission trading system (ETS) in 2010. The Government of Kazakhstan amended the Environmental Code to include a chapter on greenhouse gas emission regulations and adopted other laws to support implementation of the carbon cap-and-trade scheme. In 2012, the government made the first quota allocation for 2013, but postponed implementation and fines until 2018. According to the National GHG Allocation Plan for 2014–2015, the cap covered over 180 facilities, each of which emitted at least 20,000 t of CO_2 in 2012, at 23,401,215 t of CO_2 with the base year as 2011–2012. Companies also have to report their CO_2, CH_4, and N_2O emissions. However, only CO_2 emissions are capped.

[3] 1MCI = 1852 tenge = $10.

The national ETS does not yet stimulate investment in CMM use, but has the potential to do so if it is enforced and provides sufficient price signal. The legislation already allows for methane mitigation projects to be used as emission reduction credits in Kazakhstan's ETS. Agencies accredited by the Ministry of Energy can verify emission reduction credits; however, the methodology for calculating such credits still needs to be developed. Without operational methodologies, companies are not likely to invest time and resources into applying for emission reduction credits for CMM projects. Given the experience of other countries in developing such methodologies, ensuring that CMM projects can easily obtain emission reduction credits is one of the more feasible options for stimulating CMM project development.

5. Conclusions

Coal mines continue to emit methane, which is a valuable fuel source and commodity, as well as a potent greenhouse gas. Given that countries will likely mine coal and, thereby, emit methane for decades to come, policymakers should consider policy instruments for stimulating mitigation of CMM. International experience shows that a number of policy options are available for supporting CMM projects; however, adoption of best practices requires applying them to local conditions.

Looking at Kazakhstan conditions as a case study, a strategic approach is proposed for devising mechanisms to support CMM mitigation that involves examining global best practices, categorizing them functionally, and reviewing them in the local context. Given low fossil fuel prices and falling production from underground mines, CMM projects might find it hard to attract investments without policy stimuli, such as those offered to renewable energy fuels.

Many economic, geological, and policy conditions affect the success of recovery and use of methane at coal mines. Examples include existing infrastructure, energy prices, composition of gas flow, mine gassiness, regulatory processes, investment, and institutions. When these conditions are favorable, CMM projects can be economic even without CMM-specific support from policymakers. However, less supportive enabling conditions require more policy support for CMM projects to make them feasible. Policymakers might not be able to easily change the underlying geological or economic conditions to make them more enabling, but they still have many options to facilitate CMM recovery and use.

Kazakhstan has significant CMM resources, which create large opportunities for using methane as a valuable commodity. The Kazakhstan government has stated goals of transitioning to a "greener" economy, yet recovery and use of CMM from coal mines has not been an inherent part of the country's strategy, and opportunities exist for greenhouse gas mitigation from the sector. In light of this, the government will be closer to attaining its environmental and social goals if it expands its existing levers to encourage utilization of CMM resources. Kazakhstan's coal mines have launched new investments in CMM utilization projects recently, but the number of projects could grow in parallel with the trend in the sector's methane emissions.

Based on analysis and international experience, Kazakhstan has several options to increase the attractiveness of CMM projects. The easiest options are to leverage existing policies by expanding feed-in tariffs to include CMM and ensuring that methodologies for obtaining emission reduction credits are detailed, solid, and operational for companies to use in Kazakhstan's ETS. Other strategies might be amending taxation legislation to offer taxation benefits for CMM projects or increasing pollution taxes. Policymakers need to ensure that ownership and leasing rights for CMM are clear and companies have access to natural gas and power markets. Finally, institutions that can offer education and capacity building, like the GMI, play an important role in creating basic understanding and expertise in CMM recovery and utilization as well as getting required stakeholders to support CMM projects. Kazakhstan's government agencies and academic organization, such as Karaganda Institute for Scientific Research on Industrial

Safety, and Karaganda State Technical University, already provide a number of CMM-related trainings.

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