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Action agenda for the Economic Commission for Europe:
International decade of methane management

Effective actions to reduce methane emissions

Note by Raymond Pilcher, Chair, Group of Experts on Coal Mine Methane

I. Background

1. Methane is an important greenhouse gas whose atmospheric concentrations have been rising. It is also a precursor for ozone, a local air pollutant in urban settings and is expected to play an important role in the future in transport, power generation, space heating, and industrial applications. Methane is delivered through an existing natural gas infrastructure that could serve as the backbone for a hydrogen economy, however, it also poses a risk for coal mining operations as accumulations in mines creates risks of explosions. Emissions of methane from coal mines can also be used or at least abated, but most of the methane liberated by mining activities are released to the atmosphere. Methane emissions are controllable and important near-term opportunities exist to monitor and remediate emissions of methane from the coal, oil, and gas sectors but finance for these activities are problematic.

2. Global emissions of methane from the oil and gas industry is estimated by the United States Environmental Protection Agency to amount to 91 Mt in 2020,[1] or about 2,300 Mt of CO2e.[2] Global methane emissions from active and closed coal mines are estimated by International Energy Agency (2019) to be 1,200 Mt CO2e,[3] while Kholod, et al, (2020), estimated 1,742 Mt CO2e.[4].

3. In February 2020, ECE member States officially designated Promoting circular economy and sustainable use of natural resources in the United Nations Economic Commission for Europe (ECE) region as the cross-cutting theme for the high-level segment

[1] USEPA, 2019, Global Methane Emissions and Mitigation Opportunities fact sheet, https://www.globalmethane.org/documents/gmi-mitigation-factsheet.pdf, accessed June 2020.

[2] The notation, CO2e, is used to represent the mass equivalent of CO_2 derived by multiplying the GHG emitted by its GWP for the appropriate time horizon.

[3] IEA (International Energy Agency), 2019, World Energy Outlook-2019, IEA

[4] Kholod, N.; Evans, M.; Pilcher, R.C.; Roshchanka, V.; Ruiz, F.; Coté, M.; Collings, R., 2020, Global methane emissions from coal mining to continue growing even with declining coal production. J. Clean. Prod, pp 1-12., https://doi.org/10.1016/j.jclepro.2020.120489

of the sixty-ninth session of the ECE. This segment will take place on 20 April 2021. The Committee has an opportunity to report to the parent body on its ongoing work and to suggest actions that could be proposed as draft decisions for consideration by the ECE.

4. One of the most powerful ways that the ECE can broaden the adoption of best practice to reducing emissions is to create a thematic approach to tackling this enormous problem. The suggestion is to build on ECE's convening power to raise awareness and develop actionable steps toward methane reduction.

5. The Committee is invited to agree on such decisions about methane management. The Committee is requested to mobilize the ECE to call on its member States to:

(a) Commit to monitoring methane emissions, reporting annually, and managing them;

(b) Support calls for the United Nations General Assembly to declare an International Decade for Methane Management;

(c) Commit to exploring investing in infrastructure in support of a hydrogen economy;

(d) Consider developing capacity for carbon capture and storage commensurate with requirements to achieve 2ºC.

6. The Committee is further requested to:

(a) Support the development of needed normative instruments in light of expected increased use of natural gas in line with the 2030 Agenda for Sustainable Development;

(b) Endorse the deployment of normative instruments, including a protocol, for monitoring, reporting, and remediating anthropogenic methane emissions and derivative compounds contributing to local air pollution;

(c) Work with multi-lateral development banks to create funding mechanisms directed at capture use and/or abatement of methane emissions from coal mines and oil and gas operations;

(d) Call on countries to financially support the International Decade for Methane Management.

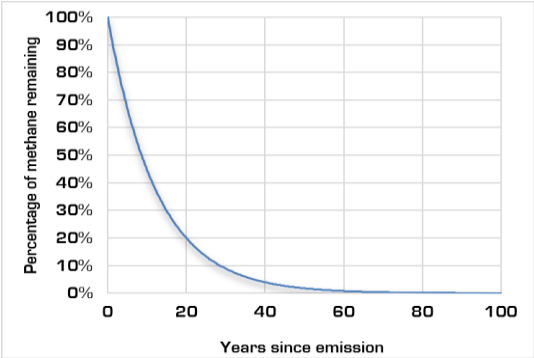
II. Methane is a global problem — and a solution

7. Methane is the major constituent of natural gas and when produced and transported under safe conditions, it becomes an important fuel source which continues to grow in importance in many regions. It can be a transition fuel and a destination fuel depending on its economic and environmental suitability when compared to other forms of energy in the regional marketplace. However, when methane mixes with air and is diluted to a range lying between five and fifteen percent, it becomes explosive and has caused many coal mine[5] and oilfield disasters.[6] When released to the atmosphere methane is a potent greenhouse gas which in the past, has received less attention than carbon dioxide in climate policy, but now it is widely acknowledged that emissions of anthropogenic methane must be reduced in order slow and diminish global warming.

[5] Macleod, F. and Richardson S. (2018),, Piper Alpha, The Disaster in Detail, in The Chemical Engineer: https://www.thechemicalengineer.com/features/piper-alpha-the-disaster-in-detail/ accessed August 2020

[6] A closer look at eight of the worst coal mining disasters in history, 2019, NS Energy, https://www.nsenergybusiness.com/features/worst-coal-mining-disasters/, accessed August 2020.

Figure I
Decline of methane concentration in the atmosphere after initial emission to the atmosphere



8. Methane emissions from different sources are second only to carbon dioxide (CO_2) emissions as a cause of global warming---even though it remains in the atmosphere for only about 12.4 years. The global warming potential (GWP) of a gas is estimated based on a theoretical emission of gas for selected time horizons. The relative potency of the gas as an agent of global warming is most often reported at the 100-year time horizon, however, estimates of GWP for the 20-year time horizon are especially useful in understanding the impact of short-lived climate forcers in the atmosphere. The 100-year and the 20-year time horizons are chosen by convention to illustrate the relative impact that a gas will have upon its release to the atmosphere and act as the basis for policy development and monitoring the success of limiting these greenhouse gases (GHGs). However, as molecules of methane are destroyed in the atmosphere, other GHGs are formed including CO_2, water vapor and tropospheric ozone which increase the heat retained in the atmosphere that results from a single emission of methane. To account for this indirect effect on global warming the GWP is increased, but depending on the application, different values may be used.[7]

9. The GWP for methane in the year of its release is 120, with an average of 86, including indirect effects for the 20-year time horizon.[8.]This value represents the average of its GWP from years 0 through 20. Similarly, for the 100-year time horizon, the average GWP, including indirect effects for years 0 through 100 is 34. This means that after 20 years, only about 20 percent of the initial mass of methane emission will remain in the atmosphere and by the time that the 100-year time horizon is reached, only 0.03 percent of the original mass of the methane emission will remain (Figure I). Clearly, most of the damage to the climate will occur during the first twenty years a methane emission is present in the atmosphere. Reducing methane emissions at its sources are therefore an important and available solution to current climate efforts.

A. Methane and fossil fuel extraction

10. While most natural gas that is produced worldwide is transported and used, in 2018 approximately 145 billion cubic meters of gas was flared, contributing 350 million tons (Mt) of CO_2 to the atmosphere. The United States Environmental Protection Agency (USEPA),[9] estimated that 91 Mt of methane or approximately 2.3 billion tons of CO_2e, will be released to the atmosphere by the oil and gas industry in 2020. Annually, the oil and gas industry contributes 24 percent of global methane emissions[10] (Figure II).

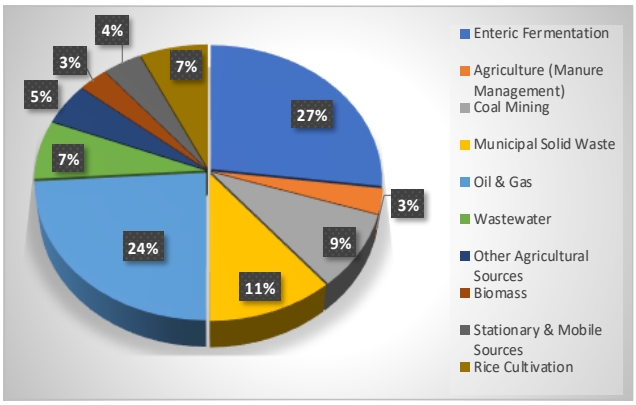
[7] IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

[8] This means that in year zero methane has a GWP of 120 so preventing one tonne of methane from entering the atmosphere is equivalent to preventing 120 tonnes of carbon dioxide from being release to the atmosphere.

[9] USEPA, 2019, op cit.

[10] USEPA, 2019, op cit.

Figure II
Fifty percent of methane emissions come from anthropogenic source

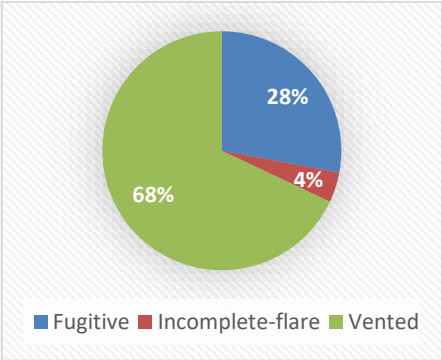


11. USEPA estimates that coal mining activities contribute 9 percent of the global methane emissions (Figure II), although recent estimates of the magnitude of methane emissions from coal mining vary. USEPA projected that global coal production will be responsible for methane emissions amounting to 799 Mt CO_2e[11] in 2020, while International Energy Agency (IEA), estimated 1,200 Mt CO_2e, and Kholod, et al[12], estimated 1,742 Mt CO_2e.[13] The latter two estimates were based on mining depth and the gas content of the coal produced worldwide. All three estimates include surface and underground mining, but only two, USEPA and Kholod, also include abandoned mines. The latter concludes that abandoned mine emissions will continue to grow as the global energy economy continues to evolve and coal fired power plants and coal mines are closed, leaving leaking sources of methane emissions if not prevented.

12. Methane emissions are substantial and so are reduction opportunities.

B. Oil and gas industry

Figure III
Relative proportions of methane emissions from oil and gas operations



13. Results of previous detailed studies performed by IEA (2017)[14] concluded that 40 percent of methane released by the oil and gas industry can be avoided at no net cost as the value of the captured methane exceeds the cost of the actions required to mitigate or abate the emissions. Even though the economic analysis performed by the IEA show this as an opportunity, many of the emissions continue. The majority are releases that occur during everyday operations and only a relatively small proportion are fugitive emissions (Figure III).

[11] USEPA, 2019, op cit.
[12] Kholod, et al., 2020, op cit.
[13] The USEPA used a GWP of 25 and the IEA used a GWP of 30.
[14] Paris (IEA, Fuel Report, March 2020, https://www.iea.org/reports/methane-tracker-2020/methane-from-oil-gas#abstract accessed July 2020

14. The IEA developed marginal abatement curves for all oil and gas producing countries and an aggregated curve for the global industry. The analysis demonstrates that there are many activities which derive pay-out from the gas which is captured rather than released to the atmosphere. Yet, 68 percent of global emissions come from venting gas from oil wells, oil and gas treatment equipment, storage tanks, and pneumatic devices which are part of the vast network of production and transport facilities operated by the industry. Options for emissions reductions and abatement include:

- adopting completion and testing practices that reduce or eliminate emissions,
- replacement of existing devices and equipment,
- installing new emission control devices and monitoring and measuring devices.

15. Capital for these projects lies with the operators of the oil and gas industry and their normal financial sources. Although the IEA and the Climate and Clean Air Coalition (CCAC)[15] state that there are ample technological solutions, more effort is necessary to engage the industry. In that regard, CCAC and its partners have created an alliance to reduce methane emissions to near zero in the oil and gas sector by 2030.

C. Coal mining industry

16. USEPA estimates that 98 percent of methane emissions from the coal industry come from underground mines while surface mines contribute only two percent.[16] Potential emissions reductions during mining cycle rely on capture, use, or abatement using available technology. These include oxidation of ventilation air, degasification of coal seams and surrounding strata for power generation, degasification for pipeline injection, flares, on site use for heat generation, and for coal drying.

17. More than half of underground coal mining methane emissions comes from the mine ventilation systems. Underground mines use large fans to circulate large volumes of ventilation air through the workings to supply fresh air to miners and to dilute methane thereby lowering the risk of methane related accidents. Exhaust air from the mine shafts typically contains less than one percent methane, presenting a challenge for development of technology that safely destroys the methane. Such systems primarily rely on auto-oxidation of the methane and have been deployed and operated at a few mines, but the systems are expensive to purchase and operate. These systems typically operate at 750ºC or higher and are required to move large volumes of mine exhaust air through the oxidizer to function as effective emission reduction systems. Since these systems should not be directly attached to a mine ventilation system due to safety concerns, moving air from the mine's exhaust to the oxidation device requires another large fan with a substantial power requirement to pull the mine air through the system.

18. USEPA (2019)[17] prepared marginal abatement cost curves for the five countries, China, Russia, United States, India, and Australia, which collectively are responsible for more than three-quarters of the world's coal mine methane emissions. More than half of those emissions come from China's coal mines. Unlike the oil and gas industry, most of the gas emitted from coal mines can only be avoided with additional investment. The report concludes that apart from the typical 20-30% of gas volume that can be captured from a coal mine's borehole degasification system and used for power generation or coal drying, additional investment will be necessary to capture use or abate the majority of the emissions.

[15] Global Alliance to Significantly Reduce Methane Emissions in the Oil and Gas Sector by 2030, https://ccacoalition.org/en/activity/global-alliance-significantly-reduce-methane-emissions-oil-and-gas-sector-2030, accessed June, 2020.

[16] USEPA, 2019, Global Non-CO2 Greenhouse Gas Emission Projections & Mitigation: 2015–2050, EPA-430-R-19-010, https://www.epa.gov/sites/production/files/2019-09/documents/epa_non-co2_greenhouse_gases_rpt-epa430r19010.pdf

[17] USEPA, 2019, Global Non-CO2 Greenhouse Gas Emission Projections & Mitigation: 2015–2050, EPA-430-R-19-010, https://www.epa.gov/sites/production/files/2019-09/documents/epa_non-co2_greenhouse_gases_rpt-epa430r19010.pdf

19. In the early part of the 21st century, the Clean Development Mechanism (CDM) and Joint Implementation (JI) invested USD365 billion into funding clean energy projects, of which, several hundred million went to coal mine methane related projects.[18] However, many of these projects were shuttered after the international carbon markets shrank post 2012. Since 2012 a few coal mine methane related projects have been funded and registered on local and regional carbon registries and others constructed on purely commercial terms, but substantive investment in the sector has not occurred.

III. Uncharted paths in the transition of the energy sector

20. In many western countries the energy sector is undergoing an extensive reorganization effort. As the cost to install and commission renewable power facilities continues to decrease, the capital markets reflect greater preference for investing in renewable energy rather than conventional energy companies. In response, many conventional energy companies are moving away from fossil fuels and in countries of the Organisation for Economic Co-operation and Development (OECD), an unprecedented number of coal-fired power plants and coal mines are closing. Modernization and moving away from fossil fuels, adoption of low emission power production, renewables, and energy efficiency is a trend that will continue. It is likely that many of the coal mines and power plants that are operating at a loss in North America and the European Union (EU) will close when a market tipping point is reached as the cost of competing against renewable energy becomes untenable. The Covid-19 pandemic has exacerbated this trend as energy usage dropped along with energy fuel commodity prices and many coal mines in the United States closed in response. In contrast, new coal mines and coal-fired power plants are being constructed in the Asia Pacific region although environmentally aware citizens are increasingly voicing objections.

21. As changing energy markets move away from fossil fuels, funding to sustain communities and invest in the future will be needed during the transition. Identification of the regions that will be hardest hit by closures of coal mines and coal fired power plants are being conducted at the national and regional level, but funding for transition may not be at the level necessary to stave off massive unemployment and unintended destruction of nearby towns. Programmes cannot only focus on closure of coal mines and their impact on coal mine employees and neighbouring communities, but also on communities which have a strong dependence on the oil and gas industry. Although funds are committed for a just transition in many countries and regions, some regions are not prepared. Lost jobs and the reductions in tax base are a double threat to community stability which may be faced by lack of public investment supporting new job creation and funding for social safeguards.

22. Methane emissions from disused oil and gas wells will continue if they are not properly plugged and abandoned. The situation for gassy coal mines is similar as once a mine is closed the emissions will continue even though coal is no longer being mined. It is necessary for governments to recognize the need to repurpose mined land and manage methane emissions from disused wells and coal mines.[19] Mined lands can offer many options for land repurposing if mine closure is planned and executed with a future use in mind. It is critical that early action is taken in order to preserve the value of natural resources and prepare the closing mine in a way that will provide opportunities for new businesses which can utilize the remaining assets and natural resources. Sustainable closure of the mine must employ business models that use the remaining natural resources such as the gas, water, and the surface land. Manmade artefacts of the mining activity such as buildings and the mine void may be used for many other purposes, such as natural gas storage, CO_2 sequestration, energy storage using water in pump and store schemes, waste storage, and for research in development projects that need shielding from electromagnetic energy or stable

[18] Clark Talkington, Raymond C. Pilcher & Felicia A. Ruiz, 2014, Addressing barriers to global deployment of best practices to reduce methane emissions from coal mines, Carbon Management, 5:5-6, 587-594, DOI:1080/17583004.2015.1058144 of Pages 587-594

[19] Underground coal mines which were gassy when active, are likely to be gassy after mining ceases and emit gas for decades; however, gassy mines which are flooding or are likely to flood will emit gas until the workings are flooded and the gas no longer escapes from the coal. Over time the amount of methane can be significant.

temperatures. Also, repurposed mine sites can be used for recovering critical elements and rare earth elements from mine waste. Such sites can be an important element in re-employing ex-miners.

IV. The problem is clear - how can the Economic Commission for Europe be a part of the solution?

23. ECE is in a unique position, it has deep experience and expertise, and can avoid entanglement in the politics of a just transition. Rather, it has the advantage of its convening power and the knowledge base resident in the Secretariat and expert groups, especially on international standards and best-practice guidance. The role of ECE is to help member States develop strategies which may be tailored to a country's specific needs. These strategies must incorporate available best practices and standards and because the ECE possesses the history, integrity, and infrastructure, these ideas can be debated in a forum to encourage the creation of policies that improve lives. With respect to methane, the ECE[20] has published best practices that provide principles that can be applied to help the coal mining and oil gas industry to reduce methane emissions.

24. Awareness of methane as a GHG is growing but methane emissions are burgeoning and near term action needs to be taken along with medium term planning and program development aimed at real, substantial, and verifiable emission reductions. Through the adoption of best practices to reduce methane emissions the ECE has a powerful and impactful opportunity to create a thematic approach to tackling this enormous problem systematically. The suggestion is to build on ECE's convening power to unite partners for an immediate, medium-term effort to raise awareness and develop actionable steps toward methane reduction.

25. In this regard the ECE is developing a proposal to establish a United Nations sponsored Decade of Methane Management. This can be a thematic approach offering solutions which fit the needs and budgets of member States identifying the potential for opening new opportunities and forming powerful partnerships among the public and private sector. A United Nations Decade of Methane Management could accomplish the following:

(a) Develop guidance documents and workshops that will assist member States in joining in developing an international approach to methane reductions in the oil gas and mining sectors These documents can be a compilation of good practices that have been shown to be effective and should incorporate the latest science and rely on easily obtainable technology to measure, report and verify emission reductions. These practices have to be documented and agreed before a truly global effort can succeed;

(b) Emphasize any reductions, and not just those which a carbon registry will recognize and certify. These registries are developed to serve many purposes, but chief among them is to create fungible credits that can be traded on markets which thus far have been too small to have significant impact on a problem of this magnitude;

[20] UNECE, 2019, "Best Practice Guidance for Effective Methane Management in the Oil and Gas Sector: Monitoring, Reporting and Verification (MRV) and Mitigation", ECE ENERGY SERIES No. 65: http://www.unece.org/fileadmin/DAM/energy/images/CMM/CMM_CE/Best_Practice_Guidance_for_Effective_Methane_Management_in_the_Oil_and_Gas_Sector__Monitoring__Reporting_and_Verification__MRV__and_Mitigation-_FINAL__with_covers_.pdf ;

UNECE, 2016 "Best Practice Guidance for Effective Methane Drainage and Use in Coal Mines" ECE ENERGY SERIES, No. 47 Second edition: http://www.unece.org/fileadmin/DAM/energy/cmm/docs/BPG_2017.pdf
UNECE, 2019, Best Practice Guidance for Effective Methane Recovery and Use from Abandoned Coal Mines, ECE ENERGY SERIES No. 64, https://www.unece.org/fileadmin/DAM/energy/images/CMM/CMM_CE/Best_Practice_Guidance_for_Effective_Methane_Recovery_and_Use_from_Abandoned_Coal_Mines_FINAL__with_covers_.pdf

(c) Lead discussions on development of robust market and fiscal mechanisms for driving methane emissions reductions. One approach could be to create an international protocol to help member States achieve the goals laid out in their NDCs and the Paris accord;

(d) Establish a robust multinational board that monitors and standardizes the reporting of methane emissions and creates, satellite, air reconnaissance, and other monitoring and reporting databases. A fund could be created to make the information and data available for official member States use. In addition to the database that will be available the system may include machine learning and data mining modules that can be adapted for use of government and research organizations which otherwise may not afford the cost of collecting data and developing spatial analysis systems. Working groups can be developed from a coalition of the leaders in remote sensing detection of methane in the atmosphere such as NASA, the European Space Agency and industry;

(e) Work with member States to develop a series of test cases using approaches to methane emission reductions as a part of mine closure and repurposing;

(f) Work with partners such as the World Bank and other multilateral funding facilities to explore ways to finance the multinational board that monitors methane emissions and methane emissions reductions. Many financial organizations and insurance companies have turned away from investment in fossil fuel related projects for both ethical and sound commercial reasons. A concerted effort will be needed to develop a mechanism that replaces the gap left when CDM and JI funding ended. A critical element will be to ensure that support for emission reductions does not hinder the switch from fossil to renewable energy sources;

(g) Work with partners and with the International Centres of Excellence on coal mine methane to develop training and assistance in countries that are developing methane mitigation programs.