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Methane Analysis Overview

Discussion Paper

1. Purpose

The purpose of this document is to provide the Steering Committee with a current overview of available information on methane emissions and mitigation measures to better inform future Partnership planning and decision making efforts. This paper provides an overview of the global emissions of methane from each of the four targeted sector along with an analysis of the emissions sources within each sector and, where possible, an overview of the technologies currently available for mitigation. Finally, the paper provides a summary of the economic potential, i.e. the amount of methane emissions reductions that could be achieved in various economic scenarios based on currently available technologies and other mitigation options.

2. Background

At the Rome steering committee meeting in December 2006, representatives from Italy suggested that the Steering Committee would benefit from information on global methane emissions and mitigation technologies so that the partnership could better direct its activities. Italy subsequently provided the Administrative Support Group with a brief outline of the key information areas including global methane emissions data for the target sources, overview of mitigation technologies, and information on emission reduction potential. Upon review of this outline, the ASG surveyed available references and data sources, including the work products of the subcommittees, to compile a basic summary of available information. The results of this effort are summarized below.

3. Global Methane Emissions Data for Target Sectors

Estimates of global emissions from the target sources can be found in a variety of country-prepared, publicly-available reports, including submissions to the UNFCCC Secretariat. The most comprehensive estimate of current and future global anthropogenic methane emission is provided in the *Global Anthropogenic Emissions of Non-CO_2 Greenhouse Gases 1990-2020*[1]**.** This report provides historical and projected estimates of emissions from over 90 countries and 8 regions for all major non-CO_2 greenhouse gas emission sources. Historical estimates are reported for 1990, 1995, and 2000 and projections of emissions, including the achieved effects of sector-level climate policy measures at the time of this report, are provided for 2005, 2010, 2015, and 2020.

Some highlights that are useful to the M2M Partnership are shown in figures 1 and 2 and highlighted below.

- Anthropogenic methane (CH4) emissions worldwide in 2005 are estimated at 6,407 millions of metric tons of CO2 equivalent (Mt CO_2e) and are expected to increase to 7,904 Mt CO_2e in 2020. (See figures 1 and 2)
- From 2005 to 2020, the relative contributions of the 12 top methane emitting sectors are projected to remain relatively constant, with 11 of the 12 changing by 2% or less.

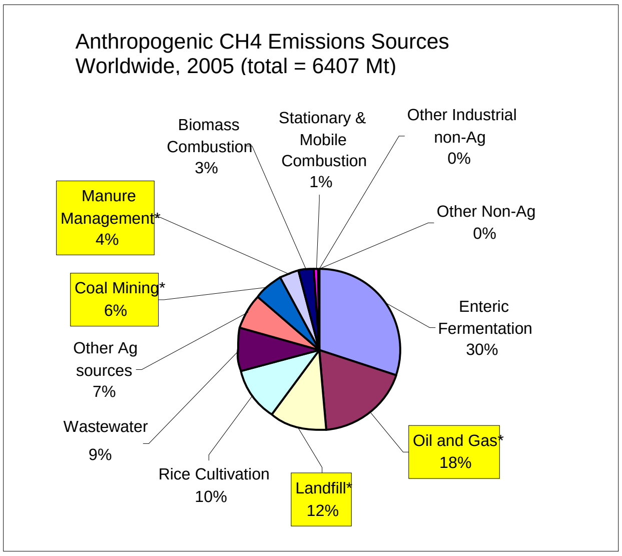
[1] Global Anthropogenic Emissions of Non-CO_2 Greenhouse Gases 1990-2020 (EPA Report 430-R-06-003) This report uses data from a hierarchy of country-prepared, publicly=available reports. These include Annex I inventory submissions to the UNFCCC which consist of a National Inventory Report (NIR) and Common Reporting Format (CRF), National Communications to the UNFCCC, the Asia Least-Cost GHG Abatement Strategy Reports, and/or country prepared reports.

- The Oil and Gas sector's share is the only one expected to increase more than 2%, rising from 18% to 23% of the methane volume worldwide (Figures 1, 2 and 3).
- M2M currently addresses 4 of the top 8 methane emissions sectors accounting for 39.5% of global anthropogenic methane emissions in 2005 and 42.5% in 2020.

Key Observations by sector:

- In the manure waste sector, 2005 emissions were 234.57 $MtCO_2eq$ (4% of total anthropogenic methane emissions) and are projected to be 269.7 $MtCO_2eq$ (3% of total emissions) in 2020
- In the coal sector, 2005 emissions were 388.14 $MtCO_2eq$ (6% of total anthropogenic methane emissions) and are projected to be 449.48 $MtCO_2eq$ (5.7% of total emissions) in 2020
- In the landfill sector, 2005 emissions were 730.32 $MtCO_2eq$ (11.7% of total anthropogenic methane emissions) and are projected to be 816.86 $MtCO_2eq$ (10.3% of total emissions) in 2020
- In the oil and gas sector, 2005 emissions were 1165.03 $MtCO_2eq$ (18.2% of total anthropogenic methane emissions) and are projected to be 1827.6 $MtCO_2eq$ (23.1% of total emissions) in 2020

Figure 1: 2005 CH_4 Emissions **Figure 2: 2020 CH_4**



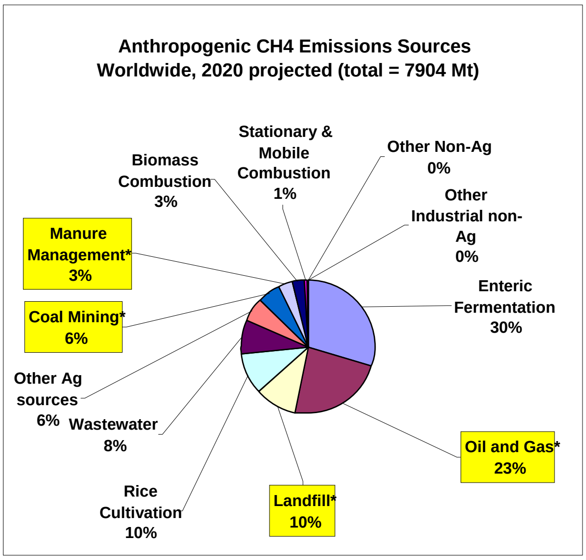
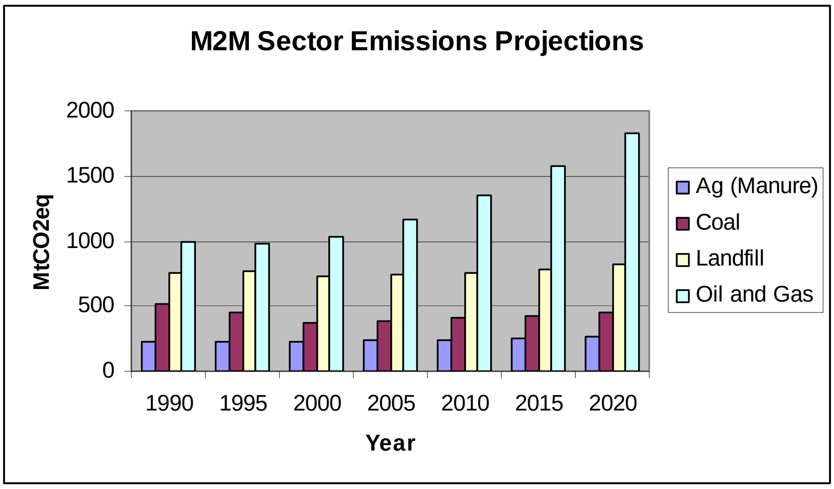


Figure 3: CH_4 Emissions by Sector



4. Overview of Mitigation Technologies by Sector

There is a significant level of information available on the suite of methane recovery and use technologies and practices for each of the Partnership's target sources[2]. In general, these technologies are currently available and are often cost-effective to implement. Below is a brief summary of the technologies by sector complied from the published literature and the work products of the subcommittees.

Coal

At active underground mines, methane must be removed from underground operations for safety reasons. This is done with large-scale ventilation systems that move massive quantities of air through the mines. These ventilation systems keep mines safe, but also release large amounts of methane at very low concentrations. At some active and abandoned mines, methane is also produced from degasification systems (also referred to as gas drainage systems) that employ vertical and/or horizontal wells to recover methane.

There are a variety of profitable uses for coal mine methane (CMM) , and the optimal use at a given location is dependent on factors such as the quality of methane, availability of end-use options, and project economics. The range of CMM projects and technologies includes natural gas pipeline injection, electric power production, co-firing in boilers, district heating, mine heating, coal drying, vehicle fuel, flaring, and manufacturing/industrial uses such as feedstock for carbon black, methanol and dimethyl ether (DME) production. For the very low concentration methane in mine ventilation air, technological development has progressed now to the point that this CMM source can be oxidized and the resulting thermal energy can then be used to produce heat, electricity, and refrigeration[3].

A comprehensive listing of available CMM technologies has been prepared for the Partnership by Australia. This database titled *Methane Technologies for Mitigation and Utilization* can be found on the M2M website at: http://www.methanetomarkets.org/resources/coalmines/index.htm

Landfills

The major factors driving landfill gas (LFG) emission levels from individual landfill sites are the amount of organic material deposited in landfills, the type of land filling practices, the extent of anaerobic decomposition, and the level of landfill methane recovery and combustion (e.g., energy use or flaring). LFG is extracted from landfills using a series of wells and a vacuum system, which directs the collected gas to a point to be processed. From there, the LFG can be used for a variety of purposes. One option is to produce electricity with engines, turbines, microturbines, and other technologies. Landfill gas utilization technologies focus on electricity generation and direct gas use. Electricity generation involves piping collected methane to reciprocating engines or combustion turbines where it can be converted to electricity. Direct use technologies may use landfill gas directly as a medium-Btu fuel, while others require the gas to be upgraded and distributed to a natural gas pipeline.

The Landfill Subcommittee has developed comprehensive guide to resources and information on landfill gas to energy projects, policies, emission reduction methodologies, and mitigation technologies. The document includes detailed resources on both collection and utilization technologies and is available on the Partnership website at http://www.methanetomarkets.org/resources/landfills/index.htm

Agriculture

Methane is produced when animal manure is managed under anaerobic conditions. Methane released from liquid manure management systems can be captured and used as a clean energy source. Techniques and

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[2] The recently released *Fourth Assessment Report of Working Group III of the IPCC (Mitigation)* and The U.S. Environmental Protection Agency Report, *Global Mitigation of Non-CO2 Greenhouse Gases (2006)* both contain an excellent summary of information on methane mitigation options.

[3] Assessment of the Worldwide Market Potential for Oxidizing Coal Mine Ventilation Air Methane, U. S. Environmental Protection Agency, July 2003 (EPA 430-R-03-002)

technologies for recovery include covered anaerobic lagoons, plug flow digesters, complete mix digesters, and small scale digesters. These technologies commonly referred to as biogas recovery systems or anaerobic digesters are a central component of the manure management system that optimizes naturally occurring anaerobic bacteria to decompose and treat the manure while producing biogas. The choice of which digester to use is driven by the existing (or planned) manure handling system at the facility.

Once recovered, biogas can be utilized in a variety of ways with a variety of end use technologies. Gas utilization options include electricity generation; boiler fuel, space heating, or fuel for refrigeration equipment; or it may be directly combusted as a cooking and lighting fuel. The most common technology for generating electricity is an internal combustion engine with a generator.

The agriculture subcommittee has outlined an effort in their action plan to share information on proven technologies taking into consideration relative costs and compatibility with manure type and handling methods.

Oil and Gas

Methane is the principal component (95 percent) of natural gas and is emitted from natural gas production, processing, transmission, and distribution. Oil production and processing can also emit methane in significant quantities since natural gas is often found in conjunction with petroleum deposits. In both oil and natural gas systems, methane is a fugitive emission from leaking equipment, system upsets, and deliberative flaring and venting at production fields, processing facilities, transmission lines, storage facilities, and gas distribution lines.

Emissions primarily result from normal operations, routine maintenance, and system disruptions. Emissions vary greatly from facility to facility and are largely a function of operation and maintenance procedures and equipment conditions. One can reduce methane emissions by upgrading technologies or equipment and by improving management practices and operational procedures. Opportunities to reduce methane emissions generally fall into one of three categories:

- Technologies or equipment upgrades, such as low-emission regulator valves, that reduce or eliminate equipment venting or fugitive emissions
- Improvements in management practices and operational procedures to reduce venting
- Enhanced management practices, such as leak detection and measurement programs, that take advantage of improved measurement or emission reduction technology

In support of the Partnership, Environment Canada developed an interactive tool to assist users in identifying specific methane emissions reduction opportunities and technologies in the oil and gas industry. The tool depicts the oil and gas industry through specific nodes, such as a gas well, compressors and gas processing plants. Under each node, the user can find a detailed flow diagram of the specific piece of equipment or station, a glossary of technical terms, a detailed list of methane control technologies, including associated reports and case studies. The tool is expected to be completed by December, 2008.

5. Emissions Reduction Potential in the Target Sectors

Analyses of the costs and potential of reducing emissions from the four target methane sources: landfills, natural gas and oil systems, coal mining, and livestock manure management was recently completed by the U.S. Environmental Protection Agency (EPA). EPA's analysis, *The Global Mitigation of Non-CO2 Greenhouse Gases" (2006)*[4], applies currently available mitigation options/technologies to global methane emissions baselines in each sector. For each mitigation option, the technical abatement potential and costs are calculated which result in a series of breakeven price calculations for the suite of available options. The results are presented as marginal abatement curves, and provide insight into the mitigation potential and

[4] Global Mitigation of Non-CO_2 Greenhouse Gases (EPA Report 430-R-06-005), full report and background data can be downloaded at http://www.epa.gov/nonco2/econ-inv/international.html

costs for methane. Below is a summary of the global emission reduction potential in each sector in 2020 given a range of costs. The report also provides country and region-specific mitigation analysis.

Global Percentage Reduction from Baseline in tCO2eq in 2020*

Cost per tCO_2e	$0	$15	$30	$45	$60	Baseline (MtCO2eq)
Coal Mining	**14.5%**	**79.8%**	**79.8%**	**79.8%**	**79.8%**	**449.5**
Landfill	**11.8%**	**40.7%**	**49.6%**	**56.8%**	**87.8%**	**816.9**
Oil and Gas	**10.2%**	**25.3%**	**33.2%**	**38.2%**	**53.8%**	**1,695.8**
Agriculture	**13.3%**	**21.2%**	**29.9%**	**33.8%**	**36.4%**	**269.3**

* Details on the inputs and methodologies used in this analysis are fully described in the report

6. Issues for Consideration

The information provided above can be a useful tool in assisting the Steering Committee and the Subcommittees direct future Partnership planning and decision making efforts. A few of the items identified by Italy for possible further consideration include:

- *Information Gaps/Needs* – Does the Steering Committee deem the information provided in this paper as sufficient or is there a need for further research or analysis?
- *Future Priorities/Efforts* – Does the Steering Committee wish to use the information presented to explore future strategic directions for the partnership, such as identifying or establishing priority activities/projects or identifying specific targets or performance metrics?