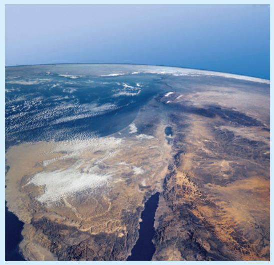
Municipal Wastewater Methane: Reducing Emissions, Advancing Recovery and Use Opportunities

The Global Methane Initiative (GMI)



The Global Methane Initiative (GMI) is a voluntary, multilateral partnership that aims to reduce global methane emissions and advance the abatement, recovery, and use of methane as a valuable clean energy source. GMI achieves this by creating an international network of partner governments, private sector members, development banks, universities and non-governmental organizations in order to build capacity, develop strategies and markets, and remove barriers to project development for methane reduction in Partner Countries.

Launched in 2004, GMI is the only international effort to specifically target the abatement, recovery, and use of the greenhouse gas (GHG) methane by focusing on the five main methane emission sources: agriculture, coal mines, municipal solid waste, municipal wastewater, and oil and gas systems. The Initiative works in concert with other international agreements, including the United Nations' Framework Convention on Climate Change, to reduce GHG emissions. Unlike other GHGs, methane is the primary component of natural gas and can be converted to usable energy. The reduction of methane therefore serves as a cost-effective method to reduce GHGs and increase energy security, enhance economic growth, improve air quality and improve work safety.

Why Target Methane?

Methane (CH_4), the second most important manmade greenhouse gas (GHG) after carbon dioxide (CO_2), is responsible for more than a third of total anthropogenic climate forcing. It is also the second most abundant GHG, accounting for 14 percent of global GHG emissions. Methane is considered a "short-lived climate pollutant," meaning that it has a relatively short lifespan in the atmosphere—approximately 12 years. While methane persists in the atmosphere for a shorter period of time and is emitted in smaller quantities than CO_2, its ability to trap heat in the atmosphere, known as its "global warming potential," is 21 times greater than that of CO_2.

Methane is emitted during the production and transport of coal, natural gas and oil. Emissions also are produced by the decay of organic matter in municipal solid waste landfills, some livestock manure storage systems, and certain agro-industrial and municipal wastewater treatment systems. Methane offers a unique opportunity to mitigate climate change and simultaneously increase available energy supply. Without more efforts to reduce methane, however, methane emissions are expected to increase nearly 20 percent to 8,586 million metric tons of carbon dioxide equivalent ($MMTCO_2E$) between 2010 and 2030.[1] GMI Partner Countries represent approximately 70 percent of the world's estimated anthropogenic methane emissions. Cumulative methane emission reductions that can be attributed to GMI total 157 $MMTCO_2E$ through 2011.

Background on Global Wastewater Methane

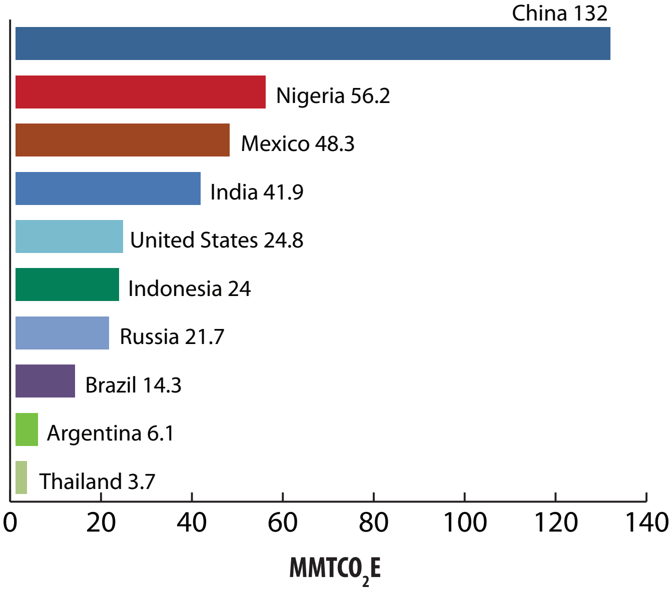
Methane is emitted during the handling and treatment of municipal wastewater through the anaerobic decomposition of organic material. Most developed countries rely on centralized aerobic wastewater treatment systems to collect and treat municipal wastewater. These systems produce small amounts of methane emissions, but also large amounts of biosolids that can result in high rates of methane emissions. In developing countries with little or no collection and treatment of wastewater, systems that do exist tend to be anaerobic, and thus result in greater methane emissions. These systems include lagoons, septic systems, and latrines. Globally, methane from wastewater contributed an estimated 512 $MMTCO_2E$ of methane emissions in 2010, accounting for approximately 7 percent of total global methane emissions.[2] Figure 1 represents methane emissions from municipal wastewater in selected GMI countries.

[1] U.S. EPA, 2012. *Global Anthropogenic Emissions of Non-CO_2 Greenhouse Gases: 1990–2030* (EPA 430-R-12-006), http://www.epa.gov/climatechange/EPAactivities/economics/nonco2projections.html.

[2] Ibid.

Figure 1: Estimated Global Methane Emissions From Municipal Wastewater in Top 10 GMI Countries, 2010*

*The countries depicted in the figure below had the highest municipal wastewater emissions in 2010. Total municipal wastewater emissions in 2010 were 512 $MMTCO_2E$.



Combined heat and power plant, Viikinmäki WWTP (Helsinki, Finland)

Anaerobic digesters and biogas treatment facilities, La Farfana WWTP (Santiago, Chile)

Growing Importance of Wastewater

The world's population is expected to grow to more than 9 billion people in the next 40 years, resulting in increased water use and food consumption, as well as a corresponding increase in wastewater production.

Global methane emissions from wastewater are expected to grow by approximately 19 percent between 2010 and 2030, with Africa, the Middle East, Asia, and the Central and South American regions projected to experience the greatest growth.[2]

Multiple Benefits of Methane Capture and Use

Methane capture and use at wastewater treatment facilities has multiple benefits:

- Reduces GHGs and associated air pollutants.
- Provides a local source of energy that supports energy independence.
- Converts a waste product into a revenue source.
- Creates renewable energy that can replace fossil fuel use.
- Creates jobs related to project construction and operation.
- Enhances local community image as innovative and sustainable.

Wastewater biogas to CNG vehicle fuel project, Janesville WWTP (Janesville, Wisconsin, USA)

[2] Ibid.

➲ Abatement, Recovery, and Use Opportunities

There are several approaches to wastewater methane mitigation and recovery and also several options for the use of recovered methane. Table 1 identifies a number of methane mitigation and recovery approaches, and Table 2 presents the wastewater methane utilization options.

Table 1: Wastewater Methane Mitigation and Recovery Approaches

Recovery Approach	Description
Installing anaerobic sludge digestion (new construction or retrofit of existing aerobic treatment systems)	Anaerobic digesters are used to process wastewater biosolids and produce biogas, which can be used on site to offset the use of conventional fuel that would otherwise be used to produce electricity and thermal energy.
Installing biogas capture systems at existing open air anaerobic lagoons	Biogas capture systems for anaerobic lagoons are the simplest and easiest method of biogas implementation. Rather than investing in a new centralized aerobic treatment plant, covering an existing lagoon and capturing the biogas can be the most economically feasible means to reduce methane emissions.
Installing new centralized aerobic treatment facilities or covered lagoons	Installing new centralized aerobic treatment systems or new covered lagoons to treat wastewater in place of less-advanced decentralized treatment options (or no treatment at all) can greatly reduce current and future methane emissions associated with wastewater. This option is most viable in areas with expanding populations that have the infrastructure and energy available to support such systems.
Installing simple degassing devices at the effluent discharge of anaerobic municipal reactors	In several developing countries with warm climate (e.g., Brazil, India, Mexico) anaerobic reactors—which are fed directly with municipal wastewater—(e.g., UASBs, anaerobic filters, fluidized or expanded bed, baffled reactors) are being increasingly used for small and medium scale municipal wastewater treatment. In these systems, around 30 percent of produced methane is lost as dissolved gas in the treated effluent. A closed column with enough turbulence right after the reactor can capture a significant amount of methane, which may be used beneficially or directed to a flare.
Optimizing existing facilities/systems that are not being operated correctly and implementing proper operation and maintenance (O&M)	Optimizing existing facilities and wastewater systems that are not being operated correctly to mitigate methane emissions is a viable alternative to installing new facilities or wastewater treatment processes such as anaerobic digesters. Proper O&M also ensures that facilities continue to operate efficiently, with minimal methane emissions.

Table 2: Wastewater Methane Use Options

Methane Use Option	Description
Digester gas for electric and heat generation with combined heat and power (CHP)	Facilities can use recovered methane as fuel to generate electricity and heat in a CHP system using a variety of prime movers, such as reciprocating engines, microturbines, and fuel cells. Power production on site can offset purchased electricity, and the thermal energy produced can be used to meet digester heat loads and for space heating.
Digester gas for electricity or heat only	Facilities can use recovered methane as fuel to generate electricity and heat in a CHP system using a variety of prime movers, such as reciprocating engines, microturbines, and fuel cells. Power production on site can offset purchased electricity, and the thermal energy produced can be used to meet digester heat loads and for space heating.
Digester gas purification to pipeline quality	Facilities can market and sell properly treated and pressurized biogas to the local natural gas utility.
Direct sale of digester gas to industrial user or electric power producer	Facilities can treat, deliver, and sell biogas to a local industrial user or power producer, where it can be converted to heat and/or power.
Digester gas to vehicle fuel	Facilities can treat and compress biogas on site to produce methane of a quality suitable for use as fleet vehicle fuel.

Global Methane Initiative

The following examples showcase wastewater projects in GMI Partner Countries

La Farfana Wastewater Treatment Plant (WWTP): Santiago, Chile

The La Farfana WWTP, managed by Aguas Andinas, treats more than 60 percent (8.8 cubic meters per second [m^3/s]) of the wastewater in the Santiago Metropolitan Area. This project upgrades biogas from the anaerobic digesters to town gas quality. Town gas quality is achieved using a treatment train consisting of compression and dehydration to eliminate humidity, a bioreactor and a scrubber that removes 95 percent of the hydrogen sulfide (H_2S), and a thermal oxidizer that removes CO_2 and traces of oxygen and nitrogen in the gas. Afterwards, the treated gas is sold to the Metrogas Town Gas Plant located 13.8 kilometers west of the Farfana WWTP. The project was registered as a Clean Development Mechanism project in 2011 and is expected to yield reductions of 26,000 metric tons of CO_2E annually from the avoided use of fossil fuels.

Arrudas WWTP: Sabará, Brazil

The Arrudas WWTP is located in the city of of Sabará, Brazil, and serves the approximately 1.5 million people from the Metropolitan Region of Belo Horizonte. The WWTP is a 3.3 m^3/s (4.5 m^3/s final design flow) activated sludge plant that utilizes anaerobic digesters for sludge treatment. The project captures the biogas produced from the anaerobic digesters, treats it to remove H_2S, and uses it to generate heat and power for the WWTP in a CHP system. The CHP system consists of 12, 200-kilowatt microtrubines, for a total electric generating capacity of 2.4 megawatts. The electricity produced is used completely on site and meets 90 percent of the WWTP's requirements. Hot exhaust gases from the microturbines flow through heat exchangers to heat recirculated sludge from the digesters to optimize biogas production. The biogas energy project began in April 2012.

GMI at Work

GMI brings together the collective resources and expertise of the international community to address technical and policy issues and to facilitate wastewater methane abatement, recovery, and use projects in Partner Countries. It facilitates project development and implementation in the following ways:

- Capacity building and outreach efforts.
- Raising awareness about technologies.
- Assisting with project financing.
- Developing sector-specific and country-specific action plans.
- Providing technical assistance to help assess the feasibility of projects.
- Conducting demonstration projects.
- Providing hands-on training and workshops.
- Helping to leverage investment from the private sector and financial institutions.

Looking Forward

Initial work of the GMI Municipal Wastewater Subcommittee will focus on the following:

- Developing country-specific resource assessments and action plans, which will outline methane reduction and utilization potential in the wastewater sector and detail paths forward.
- Performing project-focused pre-feasibility studies that will assess specific methane recovery and use options at wastewater treatment facilities.
- Conducting training and capacity building focused on biogas utilization opportunities.
- Initiating grant-supported wastewater activities in GMI partner countries.
- Partnering with research organizations focused on wastewater methane to explore opportunities for utilization and reductions.

For additional information,
please visit the GMI website
www.globalmethane.org

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