

# Contents

Executive Summary .....	ES-1
Abbreviations .....	ii
Introduction .....	1
1. Basic Concepts of Integrated Solid Waste Management .....	3
2. Solid Waste Disposal Site Design and Operational Considerations .....	11
3. Design, Construction and Operation of Landfill Gas Collection and Control Systems .....	21
4. Landfill Gas Energy Utilization Technologies .....	33
5. Market Drivers for LFGE Projects .....	51
6. Landfill Gas Modeling .....	63
7. Project Economics and Financing .....	77
Appendices	
A Case Studies	
B Health and Safety Considerations	

# Abbreviations

## Units of Measure, Constants and Symbols

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Btu	British thermal unit
cm	Centimeter
CH <sub>4</sub>	Methane
CO	Carbon monoxide
CO <sub>2</sub> e	Carbon dioxide equivalent
°C	Degree Celsius
DOC	Degradable organic carbon
DOC <sub>f</sub>	Fraction of DOC that decomposes
ERU	Emission reduction unit
ft <sup>3</sup>	Cubic foot
H <sub>2</sub> S	Hydrogen sulfide
ha	Hectare
hr	Hour
k	Methane generation rate constant
km	Kilometer
kPa	Kilopascal
kW	Kilowatt
kWh	Kilowatt hour
l/hr	Liters per hour
L <sub>0</sub>	Potential methane generation capacity
m <sup>2</sup>	Square meter
m <sup>3</sup>	Cubic meter
m <sup>3</sup> /hr	Cubic meter per hour
MCF	Methane correction factor
Mg	Megagram
MJ	Megajoule
mm	Millimeter
MMTCO <sub>2</sub> e	Million metric tons of carbon dioxide equivalent
MW	Megawatt
N <sub>2</sub>	Nitrogen
O <sub>2</sub>	Oxygen
Psig	Pounds per square inch
tCO <sub>2</sub> e	Tonnes of carbon dioxide equivalent
µm	Micrometer

## Abbreviations and Acronyms

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AD	Anaerobic digestion
C&D	Construction and demolition
CALMIM	California Landfill Methane Inventory Model
CAR	Climate Action Reserve
CDM	Clean development mechanism
CER	Certified emission reduction
CFR	Code of Federal Regulations
CHP	Combined heat and power
CIGAR	Covered In-Ground Anaerobic Reactor
CNG	Compressed natural gas
CQA	Construction quality assurance
CREB	Clean renewable energy bond
DUKES	Digest of United Kingdom Energy Statistics
ESMAP	Energy Sector Management Assistance Program
EU	European Union
FGC	Fuel gas compressor
FiT	Feed-in tariffs
GCCS	Landfill gas collection and control system
GHCN	Global Historical Climatology Network
GHG	Greenhouse gas
GMI	Global Methane Initiative
HDPE	High density polyethylene
IBAM	Brazilian Institute of Municipal Management
IPCC	Intergovernmental Panel on Climate Change
ISWA	International Solid Waste Association
ISWM	Integrated solid waste management
ITC	Investment tax credit
JI	Joint implementation
JVETS	Japan's Voluntary Emission Trading Scheme
LandGEM	Landfill Gas Emissions Model
LCFS	Low Carbon Fuels Standard
LCRS	Leachate Collection and Removal System
LFG	Landfill gas
LFGE	Landfill gas energy
LMOP	U.S. Environmental Protection Agency's Landfill Methane Outreach Program
LNG	Liquefied natural gas
MCF	Methane correction factor
MDB	Multilateral development banks

MFI	Multilateral financial institutions
MRF	Materials recovery facility
MSW	Municipal solid waste
NGO	Nongovernmental organization
O&M	Operation and maintenance
OECD	Organisation for Economic Co-operation and Development
PBF	Public benefit funds
PDD	Project design document
PET	Potential evapotranspiration
PoA	Programme of activities
PPA	Power purchase agreement
PPE	Personal protective equipment
PPP	Public-private partnership
PTC	Production tax credit
PVC	Polyvinyl chloride
QA/QC	Quality assurance/quality control
REC	Renewable energy certificate
RES	Renewable electricity standard
RFP	Request for proposal
SWANA	Solid Waste Association of North America
SWD	Solid waste disposal
UK	United Kingdom
U.S. EPA	U.S. Environmental Protection Agency
US	United States
UNEP	United Nations Environmental Programme
UNFCCC	United Nations Framework Convention on Climate Change
USD	US Dollar
VCS	Verified Carbon Standard
WARM	Waste reduction model
WTE	Waste-to-energy



## Introduction

GMI's *International Best Practices Guide for Landfill Gas Energy Projects* provides a broad overview of the development process for LFGE projects in international settings and presents the technological, economic and political considerations that typically affect the success of LFGE projects. The goal of the guide is to encourage environmentally and economically sound LFGE projects by connecting stakeholders with available information, tools and services. The guide is not intended to provide a step-by-step protocol for project development.

The guide provides valuable information for representatives of national, regional and local governments; landfill owners; energy service providers; corporations and industries; and representatives of not-for-profit organizations. These and other stakeholders will benefit from information provided in this guide as they work together to develop successful LFGE projects.

The guide is organized into seven chapters:

- Chapter 1 – Basic Concepts of Integrated Solid Waste Management
- Chapter 2 – Solid Waste Disposal Site Design and Operational Considerations
- Chapter 3 – Design, Construction and Operation of Landfill Gas Collection and Control Systems
- Chapter 4 – Landfill Gas Energy Utilization Technologies
- Chapter 5 – Market Drivers for LFGE Projects
- Chapter 6 – Landfill Gas Modeling
- Chapter 7 – Project Economics and Financing

A selection of case studies of successful LFGE projects in GMI Partner Countries is highlighted in Appendix A. Each case study includes a project summary and identifies benefits achieved and the barriers overcome during the project.

Appendix B presents health and safety considerations for construction and operation of LFGE projects.



### Learn More About GMI

GMI is a voluntary, multilateral partnership that aims to reduce global methane emissions and to 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 nongovernmental organizations (NGO) in order to build capacity, develop strategies and markets, and remove barriers to project development for methane reduction in partner countries. This guide advances the purpose and mission of the initiative by providing the tools and necessary information to stakeholders for the development of successful LFGE projects. Details about GMI are available at <http://globalmethane.org>.



## Using this Guide

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The guide is designed to highlight basic concepts and best practices related to LFGE projects. Because LFGE projects operate within a complex framework of political, legal, institutional and financial considerations, this guide does not offer a “one size fits all” approach to implementing best practices. Additional resources, examples and source materials that contain more comprehensive information are described in callout boxes and referenced in extensive footnotes. Readers are encouraged to visit the additional resources listed throughout the document to find specific details that may be relevant to individual projects and topics.

Some aspects of LFGE projects are not discussed in detail. In particular, the guide does not present specific details about governance issues and regulatory authorities because they differ widely among developed and developing countries and among different regions throughout the world. Similarly, limited cost information related to LFGE projects is provided because costs can vary significantly depending on several factors, including the cost of material, labor, import fees and taxes.

The guide includes references to international agreements, programs and mechanisms that are changing over time. For example, the Kyoto Protocol’s market-based mechanisms for meeting greenhouse gas emission reduction targets, including the Clean Development Mechanism (CDM) and Joint Implementation (JI), are evolving; for the timing and purposes of this guide, consistent reference is made throughout to CDM and JI. Economic and regulatory factors that affect the viability of LFGE projects, including the availability of project funding through CDM and JI, also are evolving. These factors include the availability of trading markets for certified emissions reductions (carbon credits) and renewable energy standard regulations. Best practices for financing LFGE projects should be assessed carefully during planning stages because funding mechanisms will vary within and among countries and regions.

## Disclaimer

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The guide is not an official guidance document. Readers of the guide are encouraged to explore opportunities to use the best practices described in the following pages in accordance with applicable regulatory program requirements in their countries or municipalities. This document provides general information regarding LFGE projects. It does not address all information, factors or considerations that may be relevant. Any references to private entities, products or services are strictly for informational purposes and do not constitute an endorsement of that entity, product or service.