Summary of Findings Anaerobic Digestion for MSW

Agriculture, Municipal Solid Waste, Municipal Wastewater Subcommittee Meeting

Florianopolis, Brazil

14 March 2014

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Vancouver Follow-up: Anaerobic Digestion Modeling

- Question from delegate Jose Henrique Penido Monteiro (Brazil) regarding default biogas production rate from anaerobic digestion (AD) of municipal solid waste (MSW) – 100 m^3 biogas per tonne MSW
- GMI requested AD modeling information from Subcommittee members in May 2013
- Received responses from Piotr Klimek (Poland) and Janya Sang-Arun (Japan)
- GMI also performed an internet literature search to help answer the question

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Review: Anaerobic Digestion Biogas Production Rate

- Institute for Global Environmental Strategies (IGES) GHG Calculator for Solid Waste (Japan)
  - Assumes 592 m^3 biogas per tonne organic material (dry) for anaerobic digestion of MSW
  - Need to convert dry basis to wet basis to compare
  - MSW typically has about 80% moisture (20% dry material)
  - On a "wet" basis, the IGES model assumption equates to about **118 m^3 biogas per tonne** of MSW organics
  - IGES assumes 60% methane content in the biogas

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Review: Anaerobic Digestion Biogas Production Rate

- Regional Information Service Centre for South East Asia on Appropriate Technology (RISE-AT)
  - "Review of Current Status of Anaerobic Digestion Technology for Treatment of Solid Waste" – November 1998
  - Institute of Science and Technology Research and Development, Chiang Mai University (China)
  - **100 to 200 m^3 biogas per tonne MSW** organics
  - 55-70% methane content

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Review: Anaerobic Digestion Biogas Production Rate

- California Integrated Waste Management Board
  - "Current Anaerobic Digestion Technologies Used for Treatment of Municipal Organic Solid Waste" – March 2008
  - **100 to 150 m^3 biogas per tonne MSW** (wet)
  - 50-70% methane content in biogas
  - Notes that "comparisons of systems based on yield per weight MSW assume consistency of MSW and biogas composition" and "MSW can vary widely in methane content (MC) and digestibility, based largely on the amount of paper, grass, wood, and other lignocellulosic material contained."

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Review: Anaerobic Digestion Biogas Production Rate

- California Integrated Waste Management Board
  - Provided published biogas yields from 14 full-scale digesters in Europe treating a variety of wet MSW types
  - Yields ranged from 40 to 180 m^3 biogas per tonne MSW organics (average = **112 m^3 per tonne MSW** organics)

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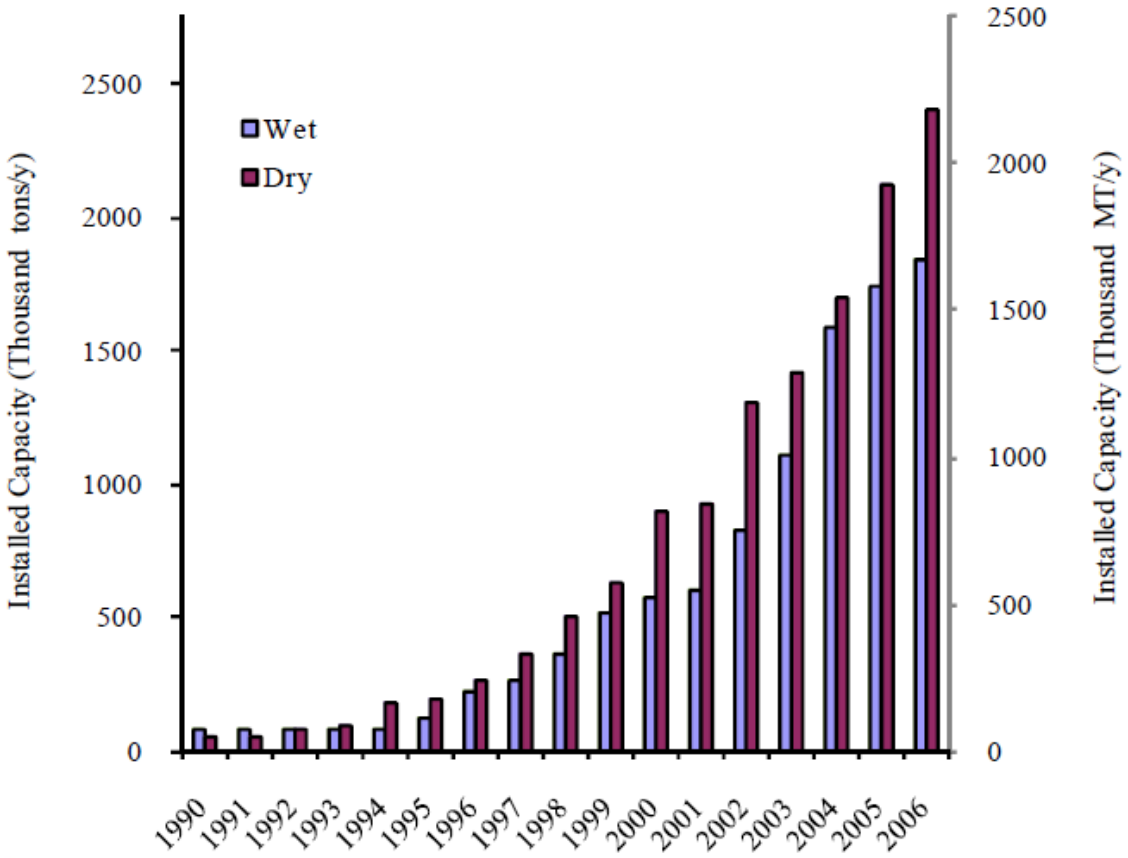
Review: Anaerobic Digestion Biogas Production Rate

- Modeling assumptions and published digester data appear to confirm the 100 m^3 per tonne MSW default "rule of thumb" for biogas yield from anaerobic digestion of MSW

- However, there are several other operational and technology-specific variables that may affect the biogas production rate for AD and should be considered on a project-specific basis:
  - Quality of waste separation and pre-treatment
  - Wet versus Dry feedstock
  - Thermophilic versus Mesophilic process
  - Batch versus Continuous reactor
  - Single stage versus Multi-stage digestion
  - Possible co-digestion with animal manure or other types of waste

AD Technology is Proven

- AD project development for MSW continues to increase, especially in more developed economies where waste management systems are well-established, and incentives exist to promote new projects



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Operational Issues

- Although AD technology for MSW is proven, operational issues remain the greatest challenge
- The majority of operational issues encountered, however, are mechanical as opposed to biological or biochemical
- Waste collection and organics separation are key to ensuring a consistent, high quality feedstock for digestion
- Using high quality equipment helps alleviate mechanical issues, as does minimizing material handling requirements

Operational Issues

- Even source-separated MSW requires some processing to ensure that contaminates are removed
- Some waste managers have eliminated source separation in favor of more extensive mechanical separation at the disposal site or transfer station
- High solids (dry) digesters are more tolerant of contaminates and are better suited for the typically higher solids content of MSW (>20% TS) than low solids (wet) digesters

AD Economics Overview

- Although AD systems may come with a higher initial cost than some other waste treatment technologies, the average payback of AD systems is 5-7 years.
- The true life cycle cost, however, is often difficult to calculate due to the complexity of waste management issues and decisions:
  - Project life expectancy
  - Project Siting
  - Environmental issues (all media)
  - Transportation impacts
  - Jobs creation
  - Social impacts
  - Energy commodity prices (and future prices)
  - Energy balance
  - Tipping fees

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Questions and Next Steps

- Would the Subcommittee like to proceed with additional research?
- Are there any topics or pertinent information you would like to see added to the analysis?
- In what format would the information be most useful (e.g., white paper, fact sheet(s), detailed case studies, etc.)?
- How else might GMI support the Subcommittee's interest in this topic?

Summary and Status of NAMAs in Solid Waste Sector

Tom Frankiewicz, Co-Chair
GMI Municipal Solid Waste Subcommittee Meeting
Florianopolis, Brazil, 13 March 2014

NAMAs in Waste Sector: Summary and Status

- At least 19 countries have waste sector NAMAs under development (most in early stages)
- 3 primary types of NAMAs: strategy, policy and project (or “hybrids”)
- Funding/organizational support include: unilateral, supported, credited
- No formal/sector guidance for NAMAs
- Existing NAMA tools and resources are not specific to waste sector

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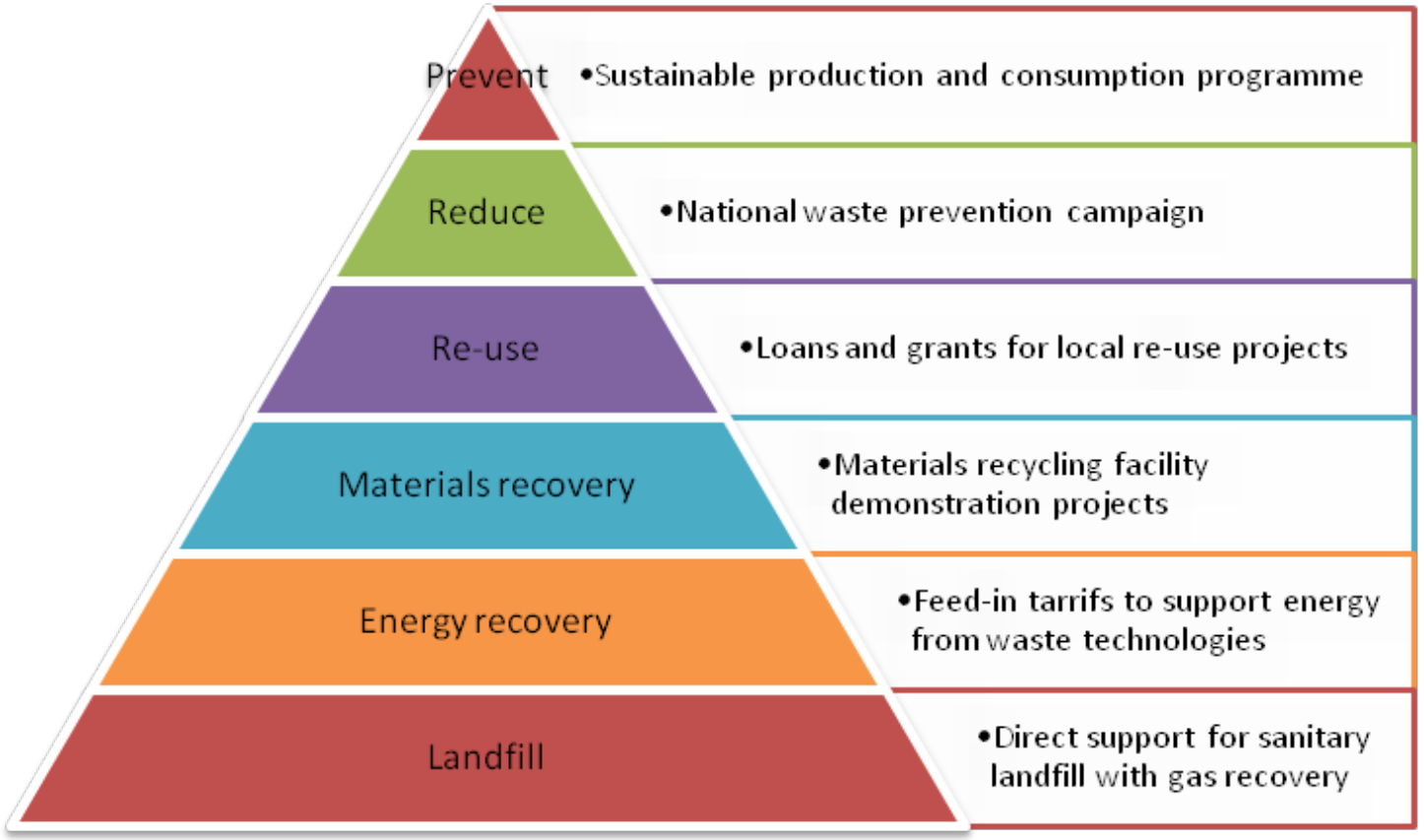
Examples of Waste Sector NAMA and Waste Hierarchy



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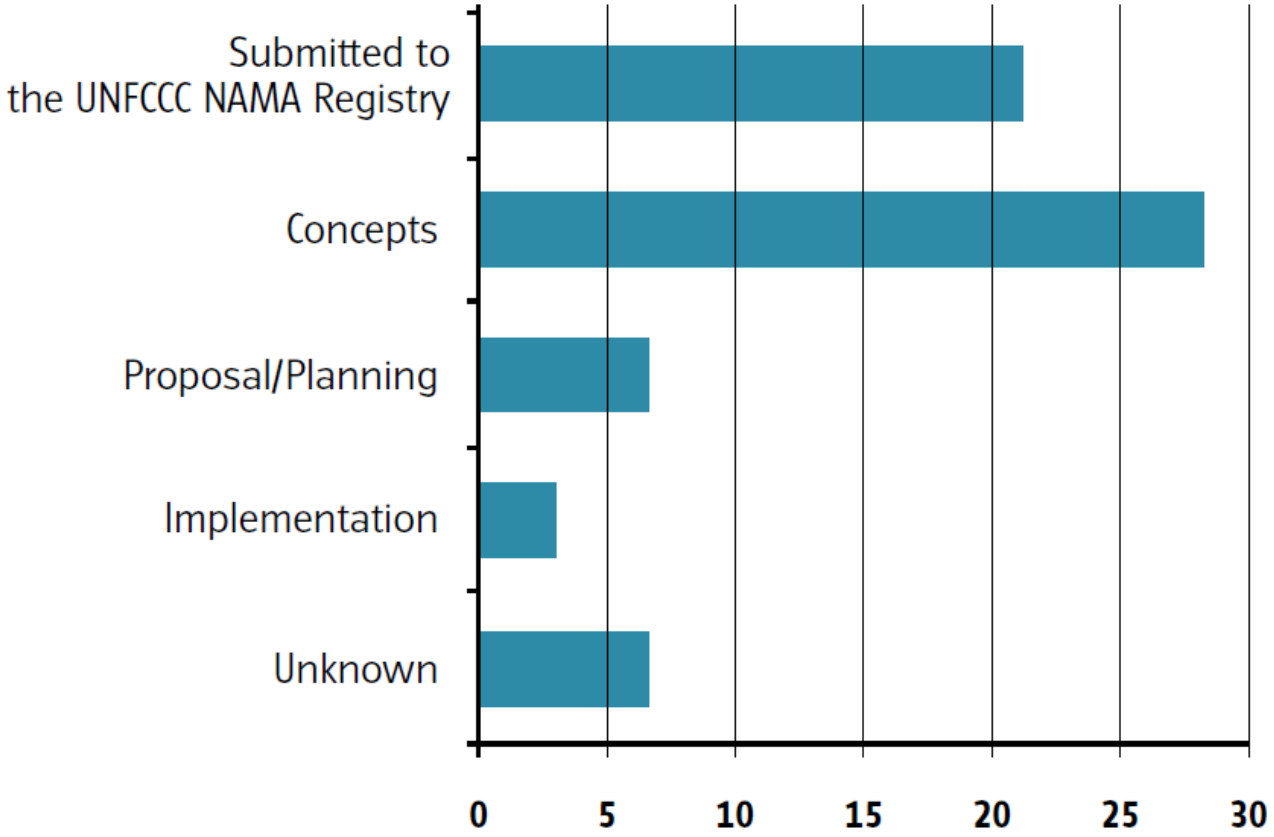
Summary of Existing Waste Sector NAMAs

Country	Description	Status
Bangladesh	Integrated Solid Waste Management in Dhaka; community-based composting	Implementation
Chile	National Program for Catalyzing Industrial and Commercial Organic Waste Management	Proposal/Planning – seeking financing
Colombia	Recycling program	Proposal/Planning – partially funded
Costa Rica	Solid Waste Management	Concept
Dominica	Support the implementation of the Low Carbon Climate Resilient Development Strategy	Concept – seeking financing
Dominican Republic	Achieve wide-spread adoption of alternative energy technologies and address waste management in the tourism sector	Concept – seeking financing
Ethiopia	Urban Solid Waste Management	
Indonesia	Municipal Waste Management	Feasibility Study
Jordan	Strategy for domestic waste management	Various, ranging from concept to implementation
Kenya	Landfill Gas Methane Capture	Unknown
Mexico	Sustainable use and disposal of biomass, turning it into renewable energy	Feasibility Study – seeking financing
Mozambique	Municipal Waste Programme of Activities	Concept
Pakistan	Integrated Municipal Solid Waste collection and Waste to Energy NAMA for Pakistan's cities	Concept
Peru	Solid Waste Programme; Developing a Solid Waste Inventory and Identifying NAMA Options	Various: funded concept and feasibility study, respectively
Philippines	Catalyze private investment in methane capture and utilization technology in the waste sector through increased regulation, incentives, capacity building and innovative financing	Concept – seeking financing
Thailand	Development of a methodology for planning in the waste management sector	Feasibility Study
Tunisia	Treatment of biowaste from agriculture, food production, restaurants and hotels, sewage and wood waste	Concept
Uruguay	Development of a programme to promote alternative use of waste, specifically for energy production	Concept – seeking financing
Vietnam	Capacity-building for development of waste NAMAs	Concept – seeking financing

Status of NAMAs: All sectors as of June 2013



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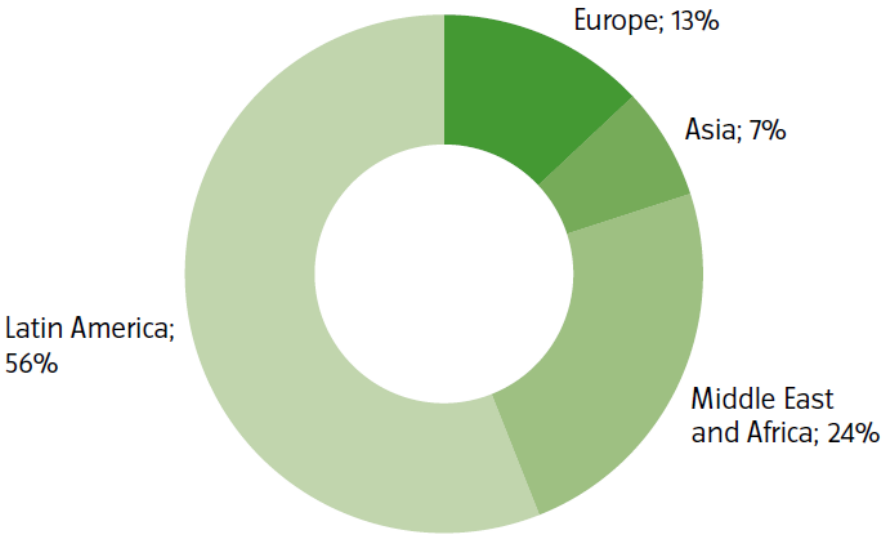
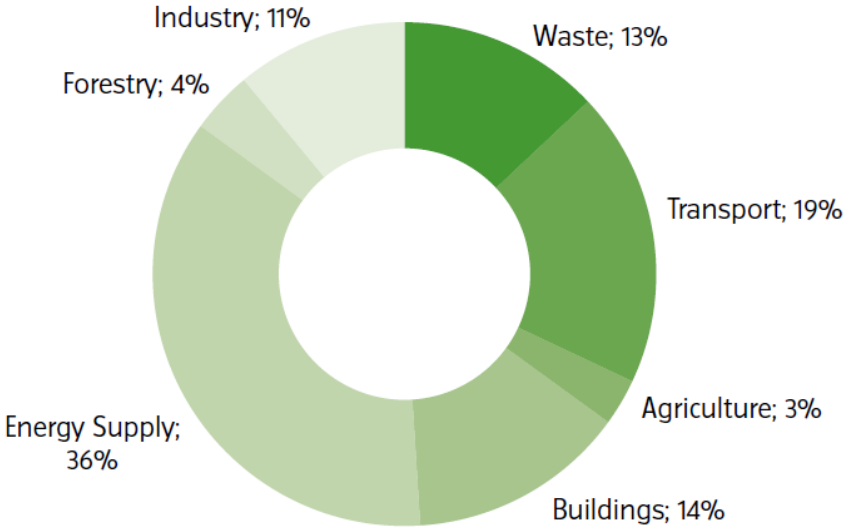
NAMA Development by Region and Sector (June 2013)





NAMAs in Waste Sector: Gaps

- Limited tools to quantify baseline and mitigation benefits for innovative NAMA types
- No centralized location for existing tools for established NAMA types
- No templates for waste sector NAMA implementation plan development
- Limited reference information regarding the full range of waste sector NAMA types
- MRV not well documented and not specific to waste NAMAs

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NAMAs in Waste Sector: Recommendations

- Key elements required to developing a successful waste sector NAMA
- Develop MRV framework specific to waste sector NAMAs
- Develop and promote Best Practices for waste sector NAMAs

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