STOPPING LANDFILL METHANE EMISSIONS

LIFE BEYOND 1.5 DEGREES: HARD TRUTHS AND SOLUTIONS

PLANNING AND CONSERVATION LEAGUE'S 2024 CALIFORNIA ENVIRONMENTAL ASSEMBLY JANUARY 27, 2024

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AGENDA

Introduction

Current technologies

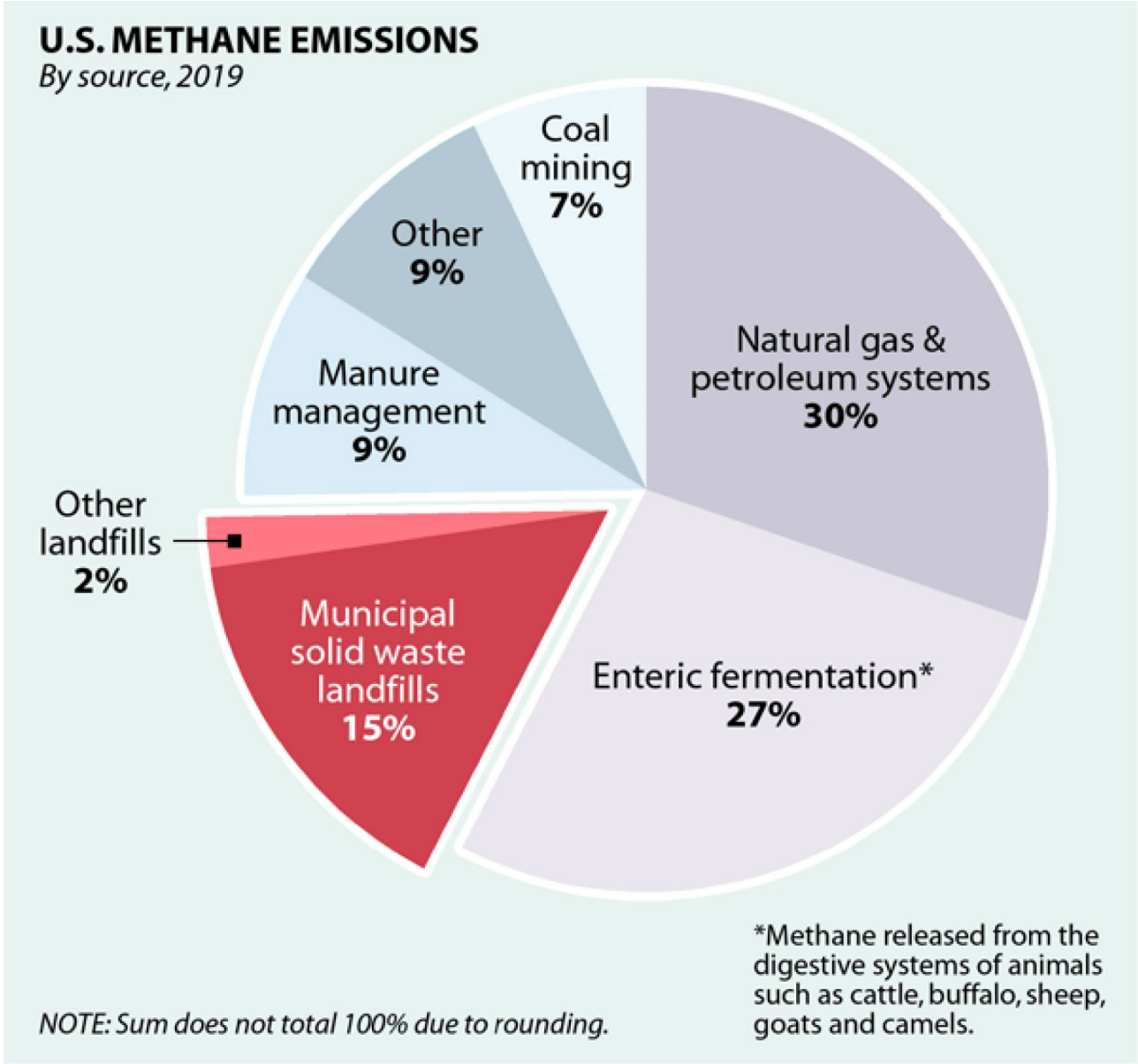
Landfill basics

Potential opportunities

Summary

U.S. METHANE EMISSIONS

- MSW Landfills (15%)
- Natural gas & petroleum systems (30%)
- Manure Management (9%)



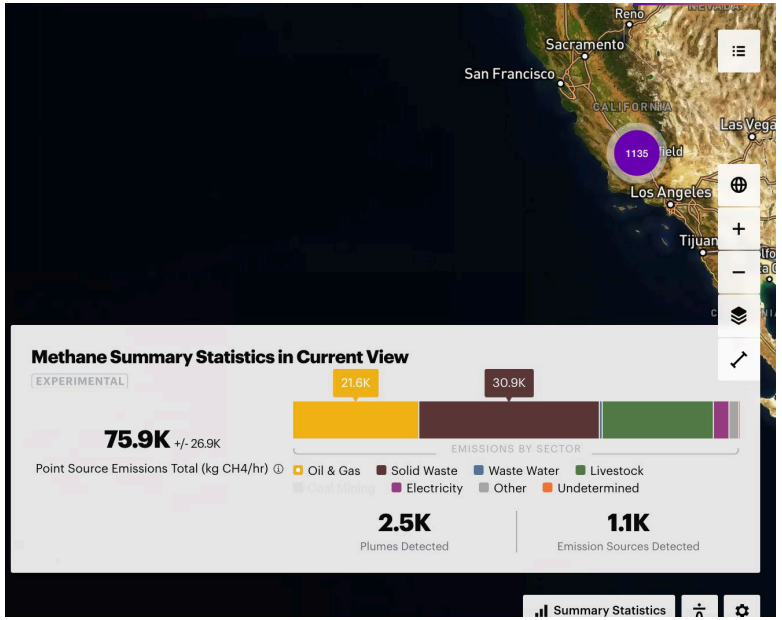
U.S. & CALIFORNIA LANDFILLS

- Per 2021 Inventory Report, U.S. landfills released an **estimated 122.6 million metric tons of carbon dioxide equivalent (MMTCO2e)** of methane into the atmosphere
- MSW landfills contributed 103.7 MMTCO2e (14.3 percent of total U.S. methane emissions) while industrial landfills contributed the remaining 18.9 MMTCO2e (2.6 percent of total)

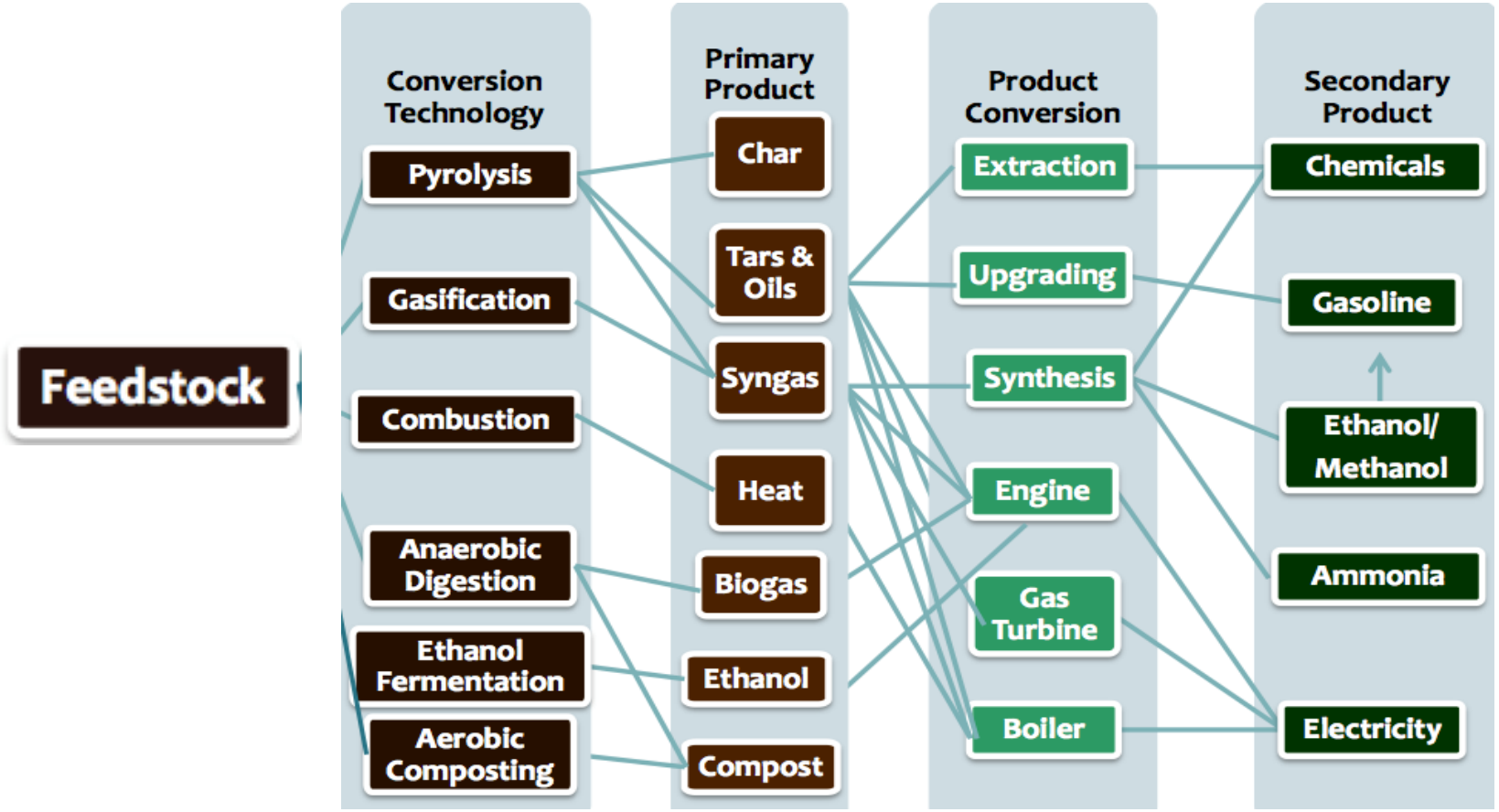
- California Landfills Estimated GHG Emissions (Data used from recent Carbon Mapper Satellite Methane Surveys)
- Assumption: 30,000 to 48,000 kg of CH4 per hour continuously emitted

7.8 to 12.5 MMTCO2e per year

6% to 10% of total CO2e released in U.S. from landfills



CONVERSION TECHNOLOGIES AND PRODUCTS



Source: Renewable Energy from Waste Technologies and Projects, GBB, Inc. Dec. 3, 2013 Presentation

MASS BURN WASTE-TO-ENERGY FACILITIES NOT IN CALIFORNIA

North Broward County, FL - Wheelabrator

Alexandria/Arlington, VA - Covanta

Springfield, MA -Covanta

Baltimore, MD - Wheelabrator

Source: Renewable Energy from Waste Technologies and Projects, GBB, Inc. Dec. 3, 2013 Presentation

CALIFORNIA WASTE TO ENERGY FACILITIES

California has been moving away from incineration as a disposal option. In 2022, Gov. Gavin Newsom signed a law that ended jurisdictions' ability to count incineration as a means of diverting waste from landfills under California AB 939.

Covanta Stanislaus
- Modesto, CA, began operation in 1989
- 800 TPD
- 22.5 MW sold to Pacific Gas and Electric

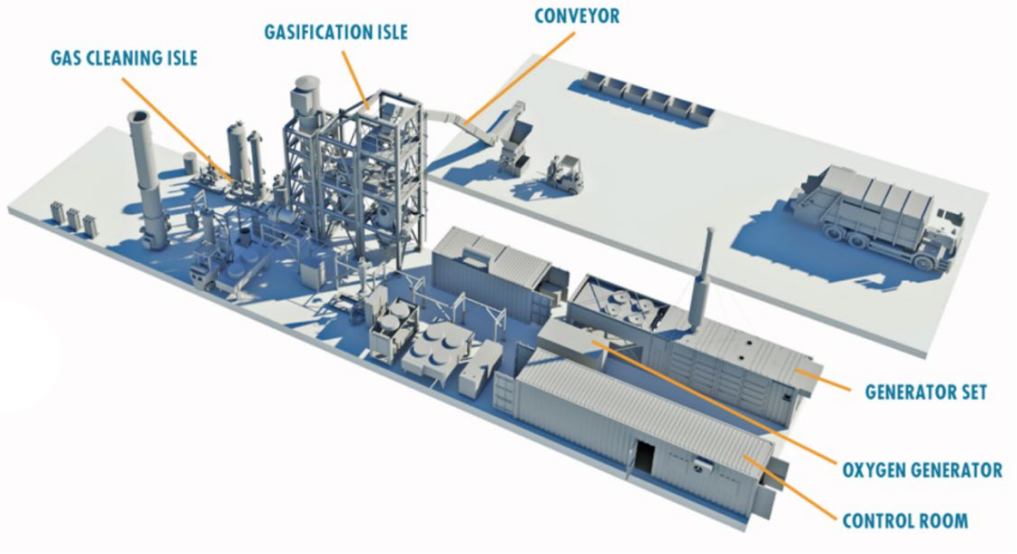
Commerce Refuse-to-Energy
- Commerce City, CA, began operation in 1987
- Owned/operated by Los Angeles County Sanitation District
- 360 TPD
- 10 MW sold to Southern California Edison

Southeast Resource Recovery
- Long Beach, CA, began operation in 1988
- Owned by City of Long Beach and LA County Sanitation District and operated by Covanta
- 1,380 TPD
- 36 MW sold to Southern CA Edison

Stops operation by June 2024

Source: Renewable Energy from Waste Technologies and Projects, GBB, Inc. Dec. 3, 2013 Presentation

EXAMPLE: SIERRA ENERGY FASTOX GASIFICATION



Source: https://sierraenergy.com/

WHAT IS THE BEST OPTION FOR CALIFORNIA?

STOP LANDFILLING?

TECHNOLOGY, PERMITTING, AND COST?

PROBLEM SOLVING PROCESS

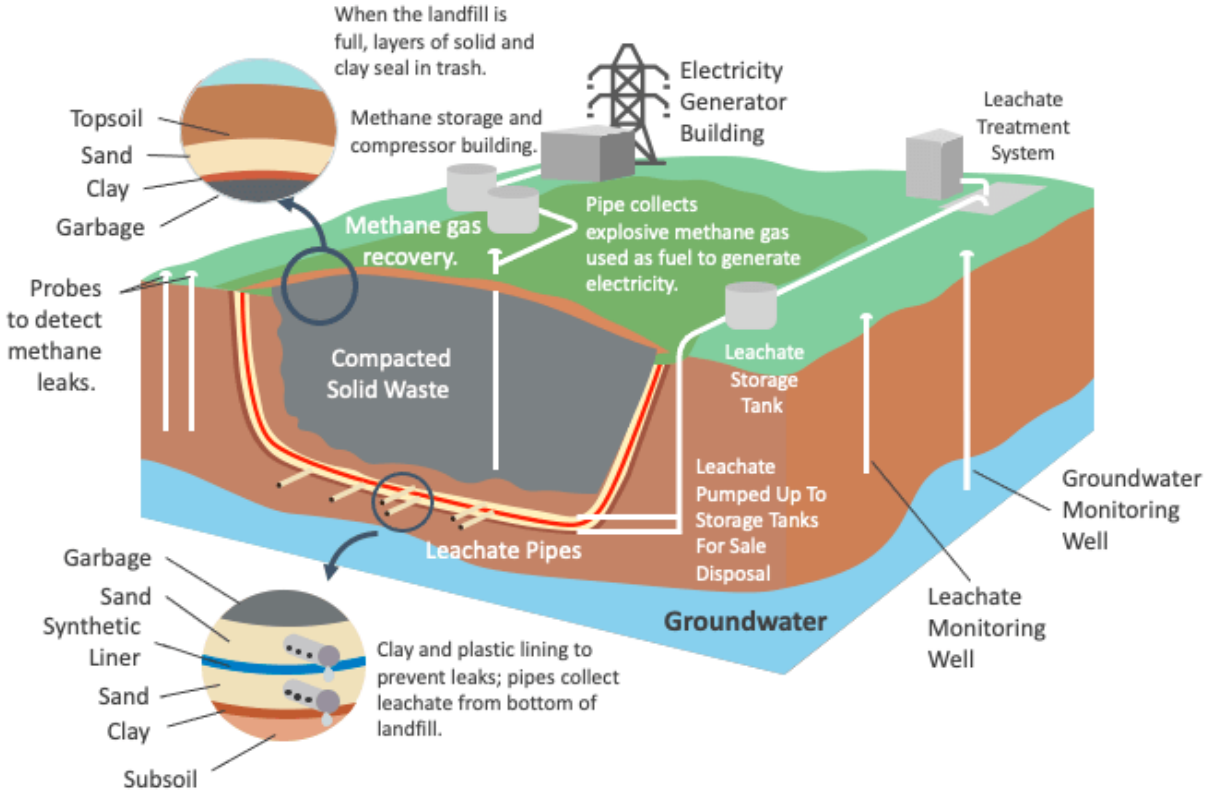
- COLLECT DATA & USE
- Identify problem
- Identify Goal
- Identify Solution
- Implement Solution
- Monitor & Evaluate
- Make Decision

OCCAM'S RAZOR

- William of Ockham, a 14th-century English philosopher and theologian
- “problem-solving principle that recommends searching for explanations constructed with the smallest possible set of elements.”
- paraphrased as **"other things being equal, simpler explanations are generally better than more complex ones"**

LANDFILL BASICS

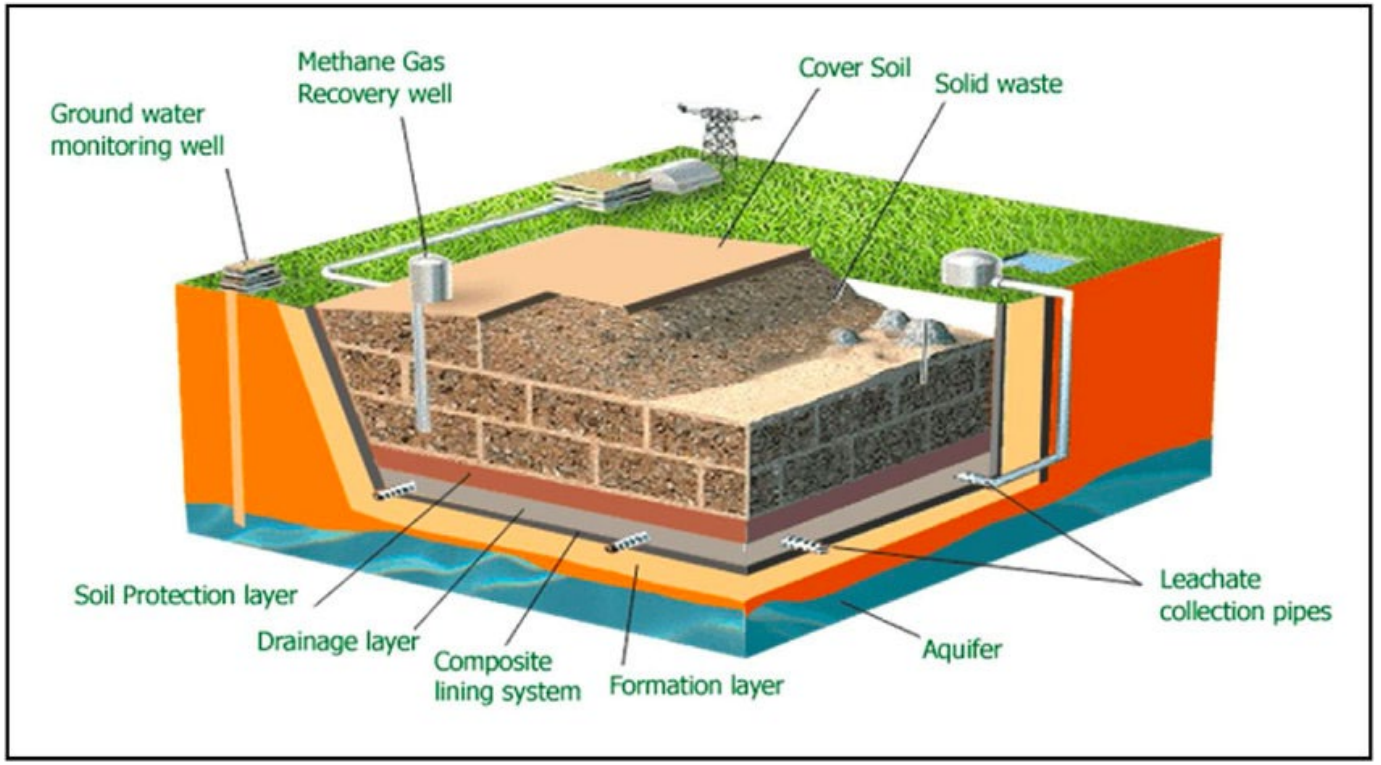
- How is it designed?
- How is constructed?
- How is operated?
- How is landfill gas emissions controlled?
- How long is it monitored and managed?



Source: Copyright 2006 Brooks Cole- Thomson

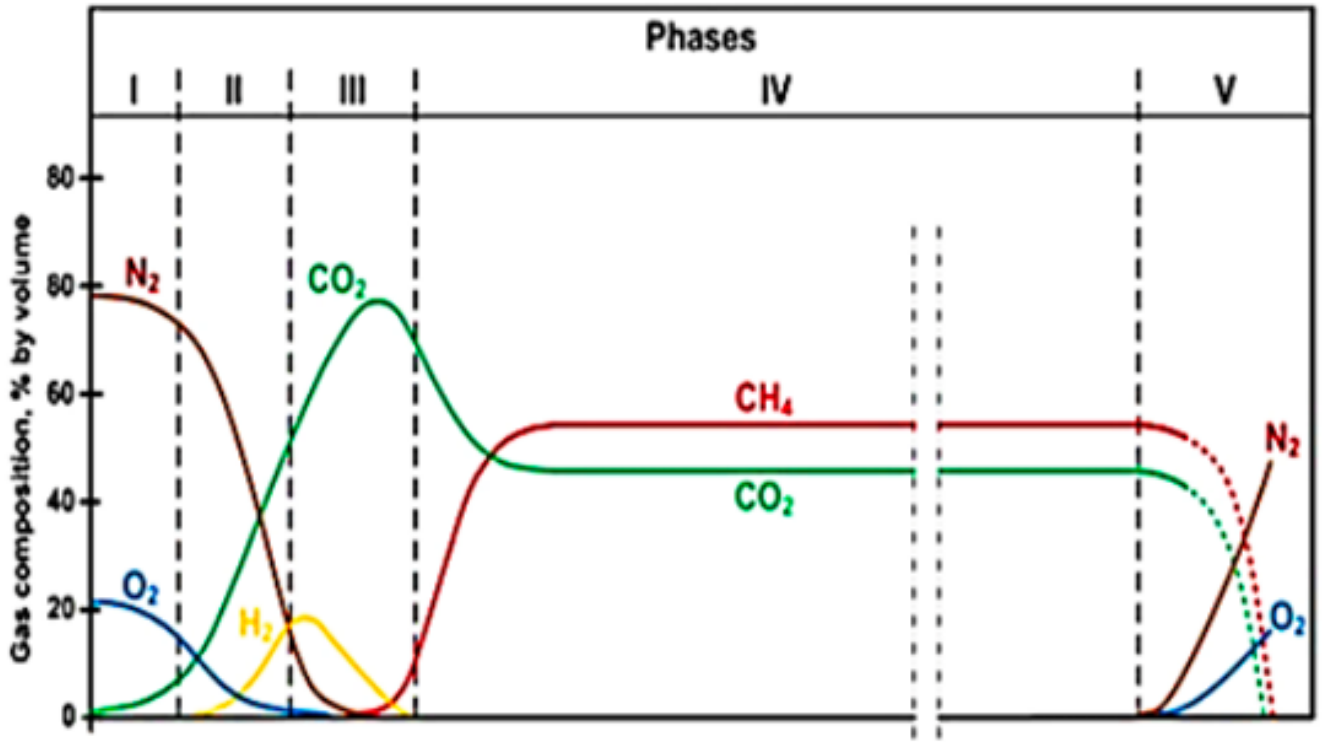
LANDFILL BASICS

- Daily waste filling activity
- Daily cover
- Intermediate cover
- Final cover
- Methane gas recovery system



WASTE DECOMPOSITION PROCESS

- Initial adjustment (Phase I) Aerobic
- Transition (Phase II)-Aerobic
- Acid formation (Phase III)-**days after filling-Anaerobic**
- Methane fermentation (Phase IV) – **starts within weeks after filling**
- Final maturation and stabilization (Phase V)- **decades**



CAN WE DO BETTER TO REDUCE LANDFILL GHG EMISSIONS?

LFG COLLECTION EFFICIENCIES

EPA United States Environmental Protection Agency Office of Air and Radiation June 2011

AVAILABLE AND EMERGING TECHNOLOGIES
FOR REDUCING GREENHOUSE GAS EMISSIONS
FROM MUNICIPAL SOLID WASTE LANDFILLS

Table 2. LFG Collection Efficiencies for Various Cover Materials

Type of Landfill Cover Material	Gas Collection Efficiency
Operating cell (no final cover)	35%
Temporary cover	65%
Clay final cover	85%
Geomembrane final cover	90%

ACTIVE WASTE FILLING (OPERATING CELL)

CURRENT METHOD

- A minimum of 6 inches of compacted earthen material or alternative cover material is used at tend of each day
- Active waste filling area has no active gas collection during filling
- No monitoring or control of methane emissions is required in the active areas:
  - no gas collection system is typically installed until later years
  - gas collection in the waste filling areas could results in overpulling and potential landfill fire if not continuously monitored

OPTIMUM METHOD

- Waste could be covered with less permeable material and thicker layer of soil to reduce emissions
- Active waste filling areas could have an active gas collection during waste filling
  - Horizontal or vertical gas collection system can be installed
  - Horizontal or vertical gas collection system can be adjusted continuously by an automated system to prevent potential landfill fire and overpulling

INTERMEDIATE COVER (TEMP. COVER)

CURRENT METHOD

- Intermediate cover is compacted earthen material of at least 12 inches placed on the surface of a fill where no additional solid waste will be deposited within 180 days
- This area may be in active filling area for several years with no gas collection
- The active filling areas of the landfill are not subject to methane emissions monitoring due to safety concerns
- Steep slopes of the landfill are not subject to emissions monitoring due to safety concerns

OPTIMUM METHOD

- Require geomembrane barrier for intermediate cover with a gas collection system below geomembrane
- Set a time limit that an area would be operated without gas collection (3 months)
- Require horizontal or vertical gas collection system to be installed
- Require gas collection using an automated system to minimize emissions and potential landfill fire
- Use robotic or drones to monitoring emissions in active areas and steep slopes

FINAL COVER (CLAY OR GEOMEMBRANE)

CURRENT METHOD

- A geomembrane barrier or clay final caps can are used, depending on bottom liner design and when the landfill was constructed
- Clay caps are weak in tension and can easily crack and allow gases escape allow liquids into the landfill over time
- Construct clay caps on side slopes can crack over time and allow gases to escape out and liquids enter the landfill
- Infiltration of liquids after closure can generate more emissions and leachate

OPTIMUM METHOD

- Require geomembrane barrier instead of clay final cap
- Reduces landfill gas emissions and infiltration of liquids

GAS COLLECTION SYSTEM

CURRENT METHOD

- By regulations landfill gas wells must be adjusted once per month to control emissions
- Landfill gas wells are sensitive to atmospheric pressures changes that happen within 24 hrs
- Gas volume can change significantly while gas collection wells are set for a constant flow rate which will results in landfill gas overpulling or underpulling

OPTIMUM METHOD

- Require gas wells to be adjusted automatically every hour to reduce fugitive emissions from underpulling of gas

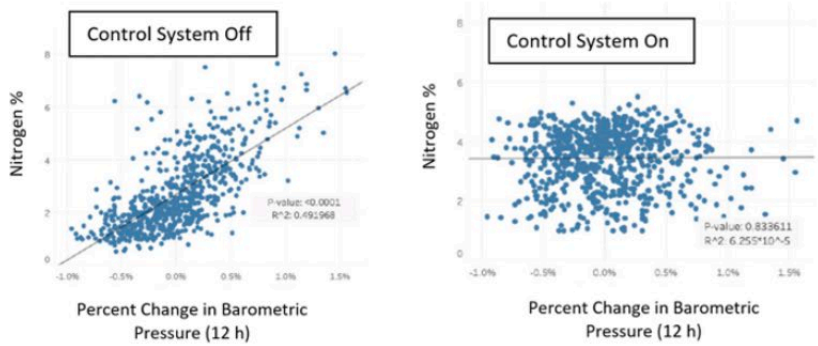


Figure 6. Nitrogen concentration in the gas collection well with control system off (left) and on (right) as a function of changes in barometric pressure during a 12-h period.

GAS COLLECTION SYSTEM

Table 3. LFG Collection Efficiencies in the GHG Reporting Rule

Description	Gas Collection Efficiency
Area without active gas collection, regardless of cover type	0%
Area with daily soil cover and active gas collection	60%
Area with an intermediate soil cover, or a final soil cover not meeting the criteria below to achieve 95% efficiency, and active gas collection	75%
Area with a final soil cover of 3 feet or thicker of clay and/or geomembrane cover system and active gas collection	95%

EPA United States Environmental Protection Agency — Office of Air and Radiation — June 2011

AVAILABLE AND EMERGING TECHNOLOGIES FOR REDUCING GREENHOUSE GAS EMISSIONS FROM MUNICIPAL SOLID WASTE LANDFILLS

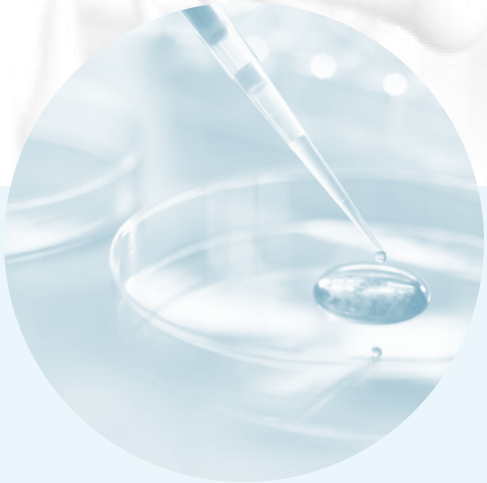
Gas collection efficiencies are site specific and can change significantly depending on field condition and landfill operation

SUMMARY

Changes in landfill operation that are not required by current regulations can results in immediate and significant reduction in fugitive GHG emissions. They can potentially qualify for voluntary carbon credit to fund the additional costs:

1) Early landfill gas collection system to collect more methane
2) Geomembrane intermediate and final cover (where not required)
3) Automated landfill gas collection system to increase the overall gas collection efficiency

Continue to develop better waste management technologies to eliminate landfills and utilize waste as resources



THANK YOU