

U.S. Greenhouse Gas Inventory: Update on Methodology Improvements for MSW Landfills

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Agenda



- Where we are in the Inventory development process
- Update on improvements to the 1990-2016 Inventory
 - Data on landfills that do not report to the EPA's GHGRP
 - Scale-up factor
 - Oxidation factor
- Expert review comments received on the 1990-2016 Inventory
- Q&A and discussion
- Schedule and next steps for the 1990-2016 Inventory

1990-2016 Inventory Schedule



Expert Review

- Oct. 16 – Nov. 14

Public Review

- Feb. 7 – Mar. 7

Submit to UNFCCC

- Apr. 12

Incorporate Expert Review Comments/ Compile Full Inventory Report

Incorporate Public Review Comments and QA/QC Review

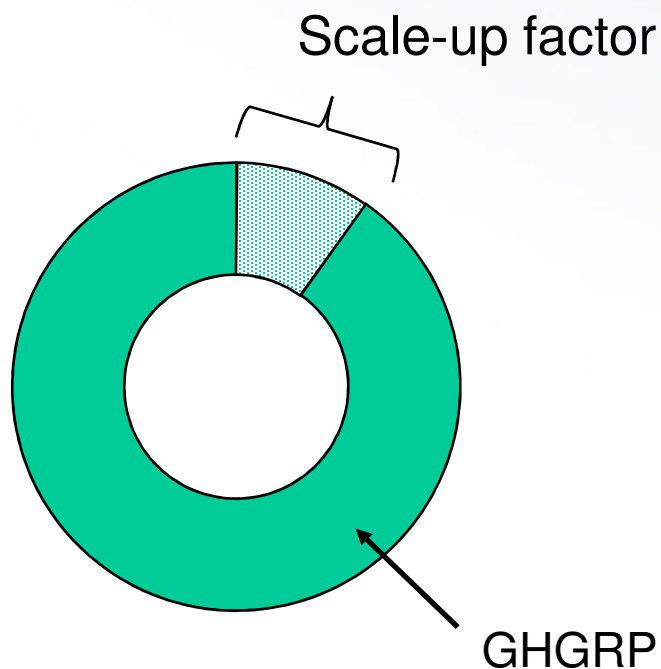
Potential Improvements to the 1990-2016 Inventory

1990-2015 Inventory



- For the first time, we used CH₄ emissions as directly reported to the GHGRP
 - Facility-specific CH₄ recovery (where applicable)
 - Variety of oxidation factors (0, 0.10, 0.25, 0.35)
 - GHGRP DOC (0.20 for MSW, 0.31 for bulk MSW)
 - Facility-reported annual waste disposal quantities 50 years prior to first acceptance
- Gap = emissions from facilities that do not report to the GHGRP

Scale-Up Factor



- Completes the Inventory
- Proxy for emissions from landfills that do not report to the GHGRP
- Roughly estimated at 12.5% with the goal of revising for the 1990-2016 Inventory

Efforts to Revise the Scale-up Factor



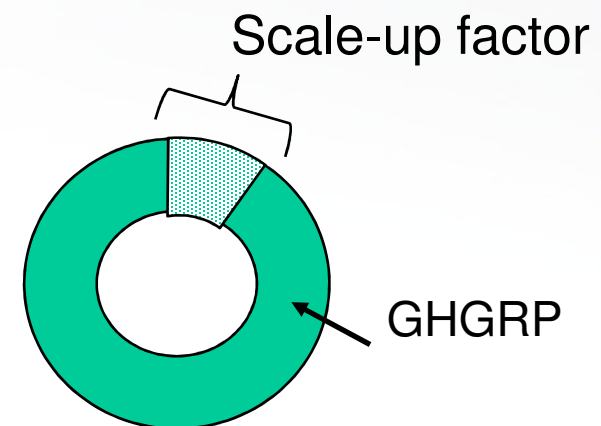
1. Create a master list of MSW landfills (open and closed) that have never reported to the GHGRP
2. Develop the scale-up factor based on total waste-in-place (WIP) from the non-reporting landfills

Scale-up factor =

$$\text{Non-reporting landfill WIP} / \text{Total WIP}$$

where

$$\text{Total WIP} = \text{GHGRP WIP} + \text{Non-reporting landfill WIP}$$



Background on Datasets



Landfill Methane Outreach Program (LMOP) database 2017

- Voluntary program
- Dataset used in this analysis contains all landfills in the 2017 database, regardless of LMOP project status (i.e. Active, Planned, Shutdown, etc.)

Waste Business Journal Directory 2016

- Directory is comprised of data gathered from telephone surveys of owners and operators
- Directory includes other waste processing and disposal operations – not limited to landfills

EPA/OAQPS Landfill dataset

- Developed for the NSPS and EG for MSW landfills
- Contains a combination of GHGRP and LMOP landfills, as well as NSPS/EG model landfills and newer, smaller landfills identified by OAQPS

Number of Facilities in each Dataset



Dataset	Number of Landfills	Comments
GHGRP	1,292	Landfills reporting to the GHGRP in any reporting year
LMOP 2017	2,405	Unique landfills in the LMOP database
WBJ Directory 2016	1,578	Landfills that accept MSW (could not confirm all were MSW landfills vs. C&D, transfer station, etc.); likely does not include all closed landfills
OAQPS (for NSPS/EG for MSW landfills)	1,812	Omitting 5 EG model landfills; 22 separate facilities matched a WBJ facility not designated as a landfill and were omitted

Data Gaps Across the Datasets



- 60% of the list had all data needed to estimate WIP
- 40% of landfills were missing 1 or 2 data elements to estimate WIP
 - Used forced assumptions for landfills with 1 missing data element

Missing Data Needed to Estimate WIP	Number of landfills	Percentage of 1,773 Landfills
0 (all data available)	1,069	60%
1 (1 missing data element, made assumptions to estimate WIP)	437	25%
2 (2 or more missing data elements, could not estimate WIP)	267	15%
Total	1,773	100%

Expert Review Charge Questions



- Best approaches to estimate a scale-up factor to account for landfills that do not report to the GHGRP.
- Additional datasets that we can use to generate a list non-reporting landfills with waste-in-place data, and start/closure years to develop a scale-up factor for landfills that do not report to the GHGRP.
- How to consider landfills that off-ramp from the GHGRP going forward with respect to the scale-up factor?
- Best approach for applying a scale-up factor
 - Apply the same scale-up factor for 2005 and later years
 - Apply a variable scale-up factor in blocks of time (e.g., 5 years), annually, when GHGRP facilities off-ramp, etc.

Methods to Improve Completeness



- Shared our list of facilities with informed stakeholders with the goal of
 - Verifying landfill (e.g., WIP) data
 - Confirming matches to GHGRP facilities
 - Filling data gaps
- Reviewers looked at our list in different ways
 - Highest WIP
 - By states with large numbers of landfills
 - By facilities with no information on WIP or years of operation

Reviewer Input Provided

	Number	Comments
Initial Number	1,773	
Reviewed	1,207	279 of the total landfills were reviewed by more than one reviewer
<i>Matches to GHGRP facilities</i>	<i>165</i>	<i>Matched by landfill name aliases, geographical plotting</i>
<i>Non-MSW landfills</i>	<i>57</i>	<i>Mostly transfer stations, limited information found online</i>
<i>Duplicates</i>	<i>7</i>	<i>Similar names between LMOP and WBJ databases</i>
<i>Total removed</i>	<i>229</i>	
Not reviewed	566	37% of 1,544
New Total Number	1,544	
New information provided for	829*	*Less than half of the input was related to WIP (n=403) and 33% of that data was for 1 year only
Unmatched GHGRP facilities	29	Indicates that our main list does not provide complete coverage

New Information to Estimate WIP



- Identified WIP data for 403 landfills
 - Confirmed or revised WIP data from LMOP and WBJ
 - New WIP data for 54 landfills (6.5% of the 403)
- Data for 134 landfills are for 1 year only
 - Requires us to make broad assumptions to estimate WIP if we use the reviewer-provided values
- Still a high amount of uncertainty in this analysis

Revised List of Non-Reporting Landfills



- Similar results when compared to the initial list and a lot more conflicting data at the landfill-level
- High degree of uncertainty in how we use this data

Missing Data Needed to Estimate WIP	Number of landfills	% of 1,544 LFs	% of Initial List (1,773 LFs)
0 (all data available)	969	63%*	60%
1 (1 missing data element, made assumptions to estimate WIP)	341	22%	25%
2 (2 or more missing data elements, could not estimate WIP)	234	15%	15%
Total	1,544	100%	

* Most of this information is coming from LMOP or WBJ versus reviewer feedback.

Impact on WIP from Data Gaps for Non-Reporting Landfills



- Reviewer input contributed approximately 50% of the estimated WIP data that was not forced
- Remainder of unforced data are from LMOP or WBJ

	Total Estimated WIP (MT)	Amount of Total Estimated WIP Contributed by Reviewers Input (MT)
Without forcing data	509,943,345	257,108,109 (50%)
With forcing data	412,031,366	28,810,664 (7%)
Total	921,974,711	285,918,774 (31%)

Handling Data Gaps for Non-Reporting Landfills



- Forced data assumptions:
 - If closure year, but no start year: forced start year back 30 years
 - If start year, but no closure year: forced 2016 for facilities with waste acceptance data
 - If only 1 year of waste disposed was provided, we assumed the same quantity disposed for all estimated years of operation

	Estimated WIP (MT)	Amount of Total Estimated WIP Contributed by Reviewers Input (MT)
Without forcing data	509,943,345	257,108,109 (50%)
With forcing data	412,031,366	28,810,664 (7%)
Total	921,974,711	285,918,774 (31%)

Steps Taken to Calculate the Scale-up Factor Options

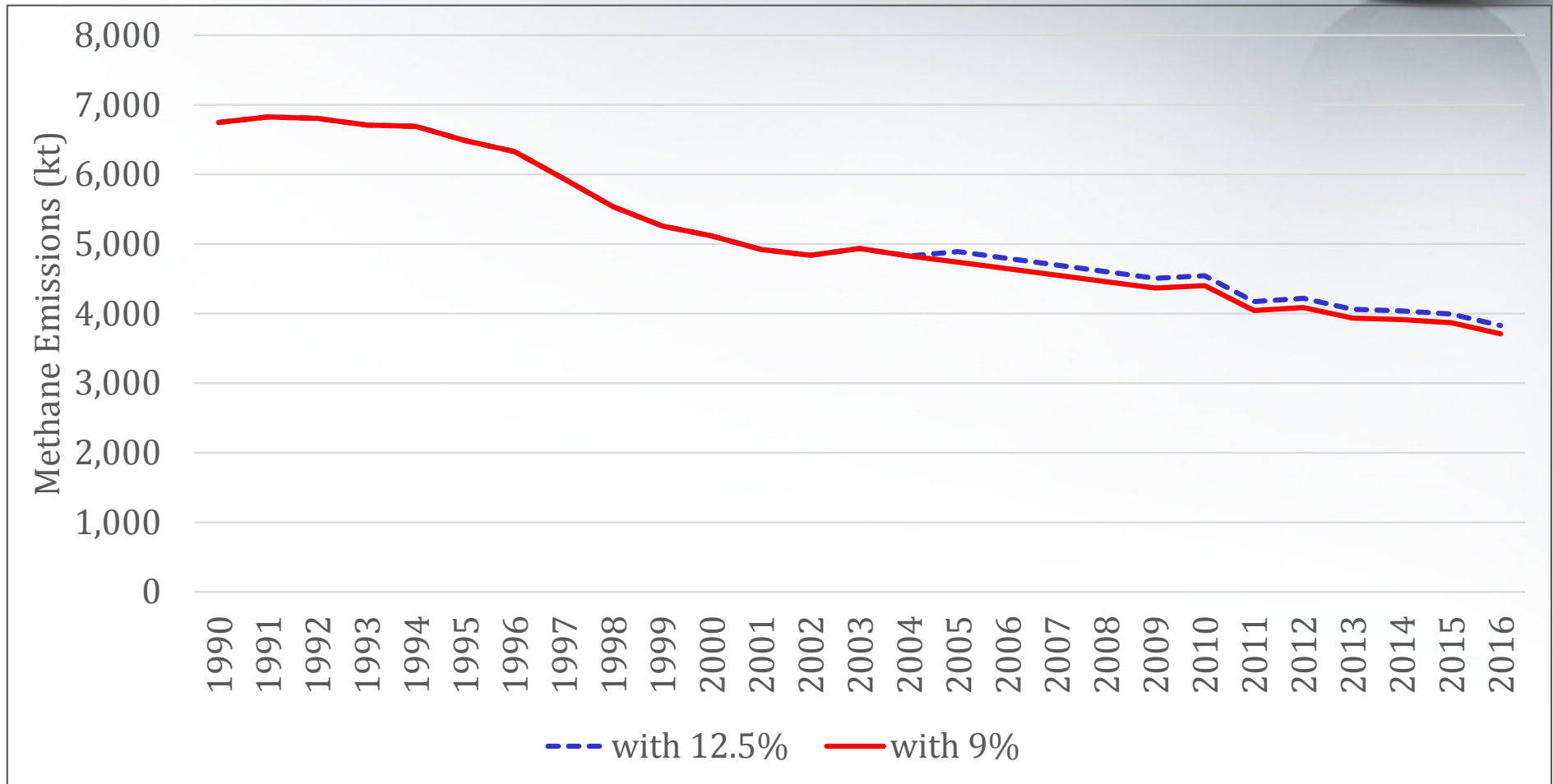


- Estimated scale-up factor = 9%

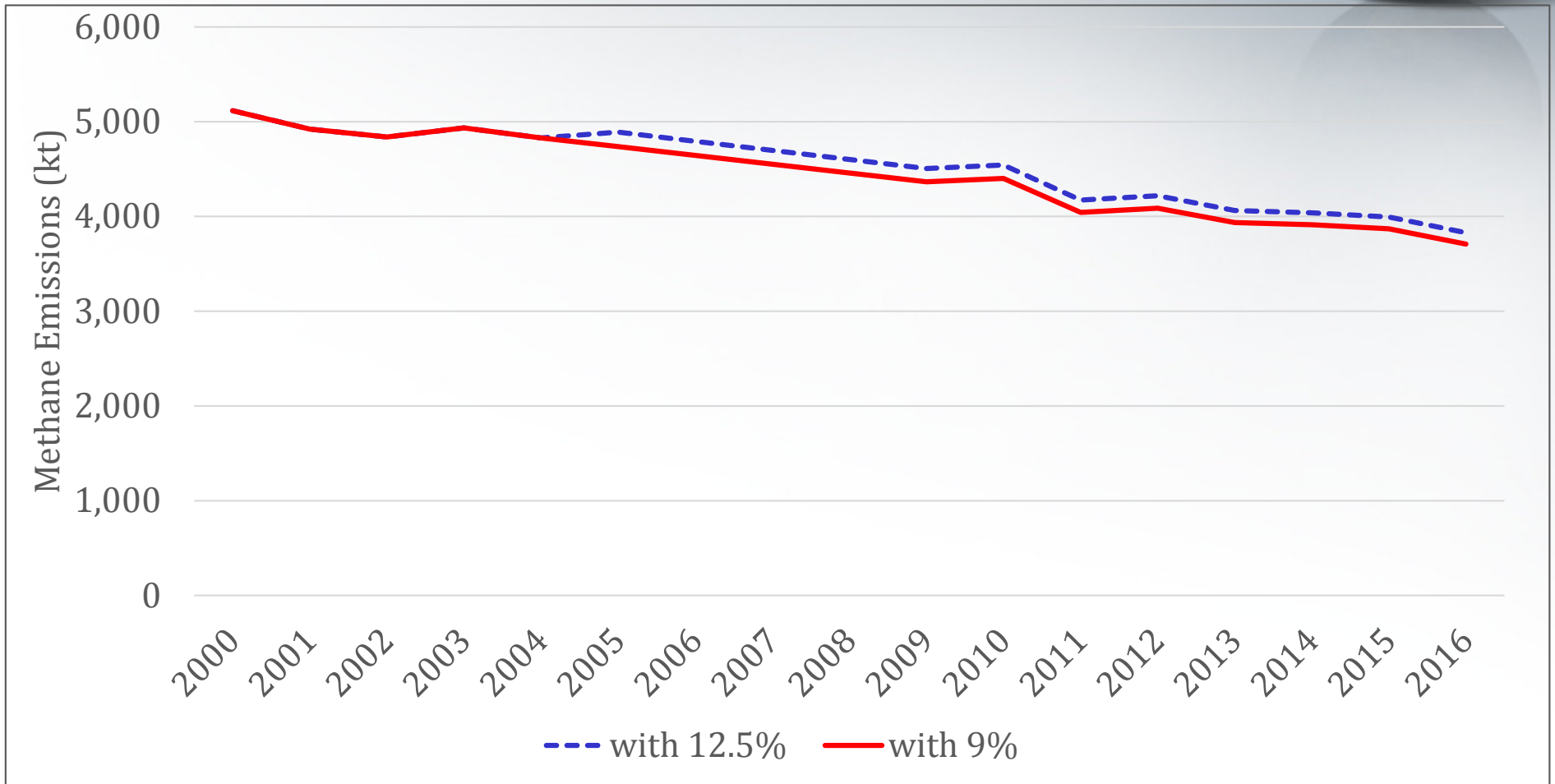
	Estimated WIP (MT)	Percentage
Non-reporting facilities (2016)	921,974,711	9%
GHGRP (RY2016)	9,082,365,791	91%
Total	10,004,340,503	100%

- Previous webinar cited an incorrect total for WIP that has been revised from 12,936 MMT to 9,082 MMT
 - Decrease by 3,854 MMT

Scale-up Factor Impact on the 1990-2016 Inventory



Scale-up Factor Impact 2000-2016



Other Comments on Scale-up Factor



- There are no other datasets to use.
- 12.5% is too high
 - Should be no greater than 5% based on removed WIP from matches to the GHGRP facilities
- Use WIP, not FOD estimated emissions.
- Not necessary to make special account of off-ramped facilities.
- Do not overcomplicate by applying different scale-up factors for different years or blocks of years in time series.

Next Steps for the Scale-up Factor



- Will use 9% in the Public Review draft
- If no additional comments or data are received, we will use the 9% going forward
- Drafting a technical memorandum on how the scale-up factor was developed for technical records and Inventory references.
 - Will be ready when Public Review draft is available

Methodological Improvements for the 1990-2016 and Future Inventories

Oxidation factor

Oxidation Factor (OX) Review



- IPCC 2006 Guidelines recommends a 10% OX
- The literature provides evidence for higher oxidation rates
- Inventory currently uses:
 - 10% for 1990-2004
 - Average of 19.5% for 2005-2015 (because we incorporated the GHGRP data)
 - Allowable GHGRP OX factors: 0, 0.10, 0.25, 0.35

Activities to Assess OX for 1990-2004



1. Reviewed the literature for data specifically for older, or smaller landfills
2. Reviewed the GHGRP data to determine the extent to which older, smaller GHGRP-reporting facilities use an OX based on their calculated methane flux

Findings from the Literature



- Literature tends to focus on landfills that would report to the GHGRP
 - Measurements of oxidation for location-specific facilities and/or gas management and cover systems
- Recent studies (e.g., Chanton and Abichou, 2011; Bogner et al., 2014; SWICS, 2012) provide evidence for higher OX rates at specific facilities
 - Results vary, but range up to 35% or more
 - Some support for 10% OX when accounting for a wide range of facilities, such as those that make up a nationwide Inventory

Findings from the GHGRP



OX	RY2015					
	HH-5		HH-6		HH-8	
0	17	1%	9	1%	10	1%
0.1	763	66%	460	53%	439	51%
0.25	353	30%	286	33%	213	25%
0.35	27	2%	105	12%	198	23%
Total	1160	1	860	1	860	1

- OX averages from RY2015:
 - 19.5% for all facilities (for equation used in facility total)
 - 18.2% for older, smaller facilities (across equations)
 - 15.3% for facilities with GCCS (Equation HH-5)
 - 20-25% for the 13 facilities that have off-ramped

OX Charge Questions



- What should OX be for landfills for 1990-2004 with and without GCCS? Are there data sources on trends?
- What should OX be if we use one value for all of 1990-2004?
- Comment on methane leakage (e.g., from cracks and fissures in the cover) with respect to OX. If we apply a higher oxidation factor, should we also apply a leakage factor to waste disposed at landfills with gas collection and control, or all landfills in general?

OX Comments



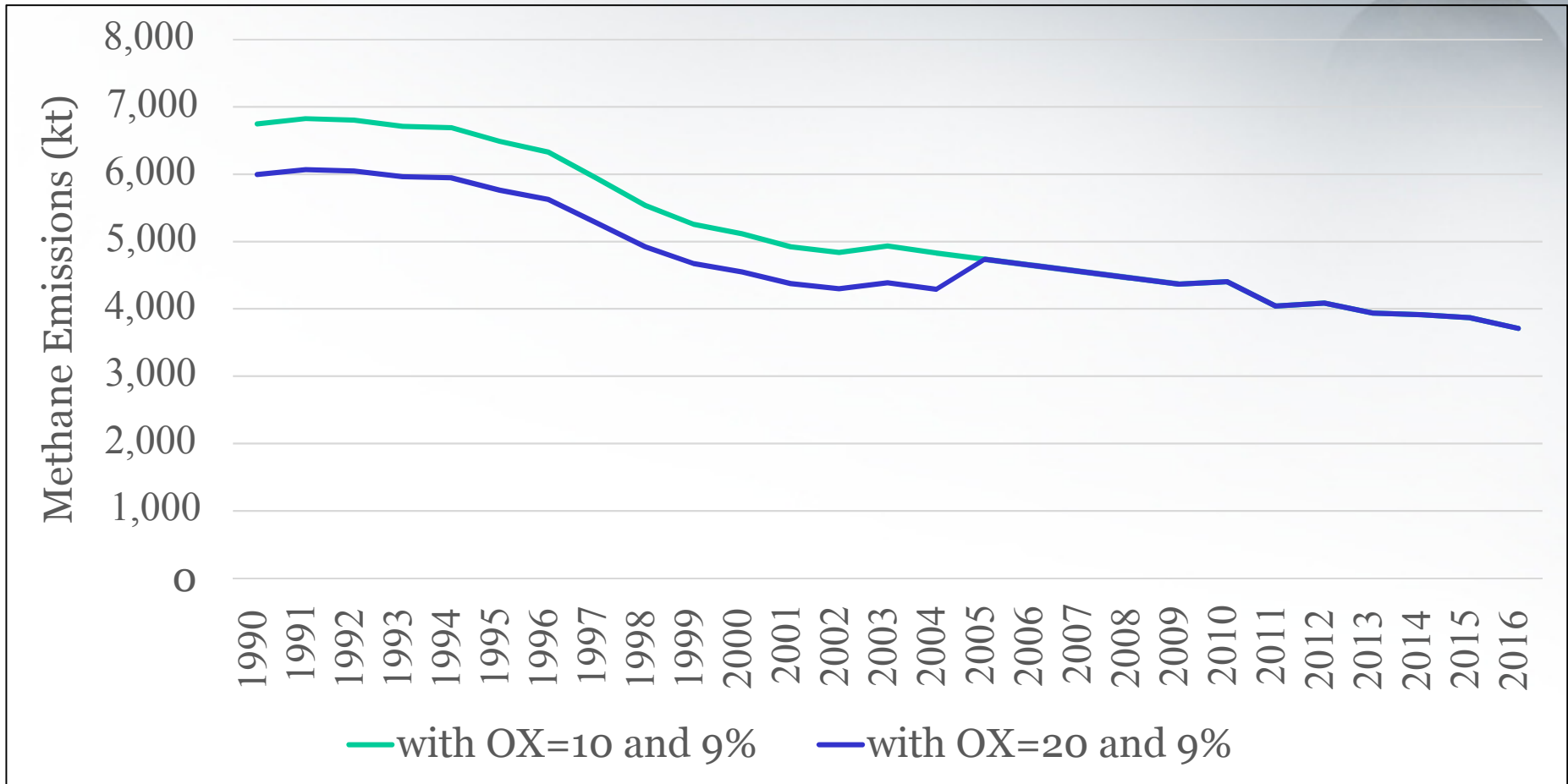
- If using one value for OX for all U.S. landfills for 1990-2004, 10% is biased low, but no clear alternative value to use
- Suggestions to calculate OX were to
 - Assign different value to landfills with gas collection (although this ignores all other variables that impact OX)
 - Calculate the methane flux by landfill and bin appropriately, similar to GHGRP
- Do not apply a leakage factor to an OX factor
 - Too much uncertainty and more uncertainty will not improve emissions estimates

Decision Moving Forward



- We will continue to use the 10% OX for 1990-2004 to be consistent with IPCC 2006 Guidelines
- We will continue to effectively use an average of 20% OX for 2005 to date in the Inventory by incorporating the GHGRP data
- IPCC is currently refining the Guidelines and may recommend an alternative default

Impact on Time Series of Changing OX to 20% and Scale-up Factor to 9%



Additional Expert Review Comments on the 1990-2016 Inventory

Additional Comments Received for MSW Landfills



- Degradable organic carbon (DOC) value
- Decay (k) value

DOC Value Comments



- Comments
 - Inventory DOC of 0.20 is too high
 - GHGRP values of 0.20 and 0.31 are too high
 - Using a single value of DOC for all U.S. landfills assumes that waste composition does not change over time; DOC should vary annually or in 5-year increments
- Cite evidence from an EREF assessment of recent state-level waste characterization studies
 - Average DOC for MSW only waste = 0.184 with values ranging from 0.142 to 0.209

DOC Value Comments



- The Inventory uses
 - a DOC value of 0.20 for 1990-2004, and
 - A mix of values that the facilities reporting to the GHGRP use in their emissions equation (most use 0.20, followed by 0.31)
- We are still investigating revisions to a DOC value for the earlier years in the Inventory (1990-2004) based on state-level waste characterization studies
- Unsure of the impact on time series consistency if we make changes to other variables (e.g., k value)

k Value Comments



- Inventory and GHGRP use k-values based on climate:

Precipitation range (inches/year)	Inventory k (yr ⁻¹)	Climate Type
<20	0.020	Dry
20-40	0.038	Moderate
>40	0.057	Wet

Precipitation range (inches/year)	GHGRP k (yr ⁻¹)	Waste Type
<20	0.020	Bulk waste
20-40	0.038	
>40	0.057	
Selected k value depends on average annual precipitation	0.02 to 0.057	Bulk MSW excluding inerts and C&D waste

- EPA Draft AP-42 (EPA 2008) notes significant uncertainty in k values
- Commenters recommend that EPA review and resolve the significant problems with the k value data set

Q&A; Discussion

Schedule and Next Steps



- Review cycle for the 1990-2016 Inventory:
 - Address Expert Review comments and update for Public Review draft
 - Anticipated Public Review draft in early February 2018 with comments due early March
 - Public Review will be the full Inventory report
 - Address Public Review comments and update for Final Inventory Report
 - Due to UNFCCC on April 15, 2018; we plan to submit April 12.

For More Information and to Send Feedback



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