LANDFILL GAS DESTRUCTION AND BENEFICIAL USE PROJECTS

Version 1.0

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1.0 BACKGROUND AND APPLICABILITY

1.1 Summary Description of the Methodology

Table 1: Eligible LFG Activities

Project Activity	Description
Destruction in a flare	Burning LFG onsite in an open or an enclosed flare.
Landfill gas to energy	Converting LFG in an engine, turbine or boiler to energy to be used on- or off-site.
Natural gas pipeline injection	Processing of LFG for injection into a natural gas pipeline.
Conversion to CNG/LNG for vehicles	Processing of LFG to use as fuel in fleet vehicles, trucks and cars.

The collection and combustion of landfill gas (LFG) is an effective method for decreasing the greenhouse gas (GHG) emissions from landfills that would have otherwise been vented to the atmosphere. This Methodology provides the quantification and accounting frameworks, including eligibility and monitoring requirements, for the creation of carbon offset credits from the reductions in GHG emissions resulting from the destruction or utilization of landfill gas at eligible landfills. The Methodology is intended to be used as an incentive to increase these activities and utilizes a flexible additionality framework which is based on either a performance standard or ACR's three-prong additionality test, as stipulated in Section 3.

1.2 Definitions and Acronyms

If not explicitly defined here, the definitions in the latest version of the American Carbon Registry (ACR) Standard apply.

Table 2: Definitions

Term	Acronym (if applicable)	Definition
Carbon Dioxide	CO_2	A chemical compound composed of two oxygen atoms and a single carbon atom.
Carbon Dioxide Equivalent	CO_2e	A standard unit of measure to express the impact of each different greenhouse gas in terms of the amount of CO_2 that would create the same amount of global warming.
Carbon Offset Credits	Offsets	A carbon offset is a reduction in emissions of carbon dioxide or greenhouse gases made in order to compensate for or to offset an emission made elsewhere.
Clean Air Act	CAA	A comprehensive federal law designed to regulate both stationary and mobile air emissions in order to improve air quality and human health.
Compressed Natural Gas	CNG	Natural gas under pressure, typically used a fuel substitute.

Term	Acronym (if applicable)	Definition
Gas Collection and Control System	GCCS	A system of wells and pipes designed to collect landfill gas that can be conveyed under vacuum to a combustion device such as a flare or engine.
GHG Source, Sink, or Reservoir	SSR	1) GHG Source – Physical unit or process that releases a GHG into the atmosphere. 2) GHG Sink – Physical unit or process that removes a GHG from the atmosphere. 3) GHG Reservoir - Physical unit or component of the biosphere, geosphere or hydrosphere with the capability to store or accumulate a GHG removed from the atmosphere by a GHG sink or captured from a GHG source.
Global Warming Potential	GWP	An index that attempts to integrate the overall climate impacts of a specific action (e.g., emissions of CH_4, NO_x or aerosols). It relates the impact of emissions of a gas to that of emission of an equivalent mass of CO_2 (CO_2e).
Landfill Gas	LFG	Landfill gas is a product of the decomposition of organic material contained in municipal solid waste landfills.[1]
Landfill Gas-to-Energy	LFGTE	The process of converting landfill gas to electricity, steam or natural gas for fuel.
Liquefied Natural Gas	LNG	Natural gas in a liquid state for ease of use or storage.
Methane	CH_4	A chemical compound composed of four hydrogen atoms and a single carbon atom.
Municipal Solid Waste Landfill	MSW	A designation for landfills that accept household trash.
Non-Methane Organic Compound	NMOC	Non-methane organic compounds consist of hazardous air pollutants and volatile organic compounds, which when exposed to sunlight may form ground-level ozone or smog.
New Source Performance Standard	NSPS	Federal rules for U.S. landfills, codified in 40 CFR Subpart WWW, that govern emissions from existing landfills with a design capacity greater than 2.5 million megagrams that began receiving waste or began construction or made modifications after May 30, 1991.

[1] As defined by the US EPA's Landfill Methane Outreach Project. Found at http://www3.epa.gov/lmop/faq/landfill-gas.html.

Term	Acronym (if applicable)	Definition
Project activity		Activities that reduce methane emissions as a result of the combustion of landfill gas in any of the following activities: 1) The destruction of landfill gas in an eligible flare; 2) The conversion of landfill gas in a turbine, boiler or generator to energy; 3) The enhancement of landfill gas for injection into a natural gas pipeline; and 4) The enhancement of landfill gas for use in fleet vehicles, trucks and cars.
Resource Conservation & Recovery Act	RCRA	A waste disposal standard issued by the U.S. EPA for the removal and handling of municipal solid waste as well as hazardous waste.
Waste in Place	WIP	The amount of waste currently in place at a landfill.

1.3 Applicability Conditions

Projects that reduce methane emissions as a result of the combustion or beneficial use of landfill gas in any of the following activities are considered a "project activity" under this Methodology:

1) The destruction of landfill gas in an eligible flare;
2) The conversion of landfill gas in a turbine, boiler or generator to energy;
3) The enhancement of landfill gas for injection into a natural gas pipeline; and
4) The enhancement of landfill gas for use in fleet vehicles, trucks and cars.

In addition to satisfying the latest ACR program eligibility requirements as found in the *ACR Standard*, project activities must satisfy the following conditions for this Methodology to be applicable:

a) The project is located in North America; and
b) The project is not required by any regulatory agency.

1.4 Start Date

The Start Date is the date that the landfill gas project became operational. For purposes of this Methodology, a project is considered to be operational when methane is continuously destroyed following a start-up period which may be a maximum of 6 months after the date of project commissioning.

1.5 Crediting Period

A Crediting Period is the finite length of time for which a GHG Project Plan is valid, and during which a project can generate offsets against its baseline scenario. The crediting period for a project activity shall be ten years.

Projects that have previously generated carbon offsets in a GHG Program other than ACR and whose crediting period has expired may apply for a new crediting period under the ACR program. As with all projects, the requirements of this Methodology must be met and the project must receive a positive validation opinion.

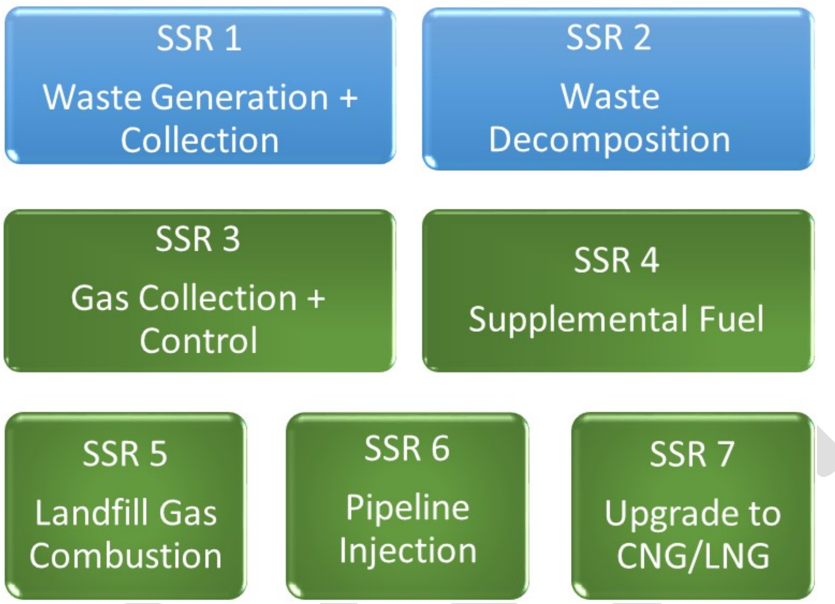
1.6 Periodic Reviews and Revisions

ACR may require revisions to this Methodology to ensure that monitoring, reporting, and verification systems adequately reflect changes in the project's activities. This Methodology may also be periodically updated to reflect regulatory changes, emission factor revisions, or expanded applicability criteria. Before beginning a project, the project proponent should ensure that they are using the latest version of the Methodology.

2.0 PROJECT BOUNDARIES

2.1 Geographic Boundary

Figure 1: Project Boundary Diagram for Landfill Gas Projects



Blue SSRs represent emission sources outside of the project boundary while green SSRs are those included in the project boundary. Within the boundaries, the sources of GHG emissions are from the landfill gas collection and control system, the maintenance or operations of the destruction or combustion device(s), and any emissions associated with the enhancement of LFG. Table 3 lists the GHG sources included and excluded depending on whether the sources are within or outside project boundaries.

Table 3: Greenhouse Gases and Sources

SSR		Source Description	Gas	Included (I) or Excluded (E)	Comments
1	Waste Generation & Collection	Emissions from the generation and hauling of waste to the landfill	CO_2	E	Emissions resulting from this SSR should be equivalent in both the project and baseline scenarios.
			CH_4	E	
			N_2O	E	
2	Waste Decomposition	Emissions from the decomposition of waste at the landfill	CO_2	E	Emissions resulting from this SSR should be equivalent in both the project and baseline scenarios.
			CH_4	E	
			N_2O	E	
3	Gas Collection & Control	Emissions associated with the energy consumed to collect and process LFG	CO_2	I	Emissions resulting from the GCCS shall be included.
			CH_4	E	Emissions are assumed to be de minimis.
			N_2O	E	
4			CO_2	I	

	Supplemental fuel	Combustion of fossil fuels to supplement the destruction or use of LFG	CH_4	I	Emissions resulting from the use of supplemental fuel shall be included.
			N_2O	E	Emissions are assumed to be de minimis.
5	Landfill Gas Combustion	The combustion of LFG in an eligible destruction device	CO_2	E	Emissions are assumed to be de minimis.
			CH_4	I	Emissions resulting from the incomplete combustion of LFG shall be included.
			N_2O	E	Emissions are assumed to be de minimis.
6	Pipeline Injection	The enhancement of LFG to be injected into a natural gas pipeline	CO_2	I	Emissions resulting from the enhancement of LFG shall be included.
			CH_4	I	
			N_2O	E	Emissions are assumed to be de minimis.
7	CNG/LNG Upgrade	The enhancement of LFG to be used in fleet vehicles, trucks or cars.	CO_2	I	Emissions resulting from the enhancement of LFG shall be included.
			CH_4	E	Emissions are assumed to be de minimis.
			N_2O	E	

3.0 BASELINE DETERMINATION AND ADDITIONALITY

3.1 Baseline Determination

The baseline for a project activity is determined utilizing industry standards and represents the most commonly used practices and technologies. Landfill gas destruction and beneficial use projects are not eligible to generate Emission Reduction Tons (ERT) in instances where the collection and destruction of landfill gas can be considered a standard business practice or is required by law or as a result of any other legally binding framework. The baseline determination shall be consistent with the pre-project activity prior to the start date.

3.2 Additionality Assessment

Emission reductions from the project must be additional, or deemed not to occur in the "business-as usual" scenario. Assessment of the additionality of a project will be made based on passing a practice-based performance standard OR ACR's three-prong additionality test, in addition to the regulatory surplus test.

This Methodology allows for two options which both assume that the "without project" scenario would be the unmitigated release of landfill gas to the atmosphere. The first option allows for the application of a practice-based performance standard. If a project activity does not qualify under the practice-based performance standard (Section 3.2.1), it also has the option to apply ACR's three prong additionality test (Section 3.2.2). All projects must apply the regulatory surplus test found in Section 3.2.3. For more information on the development of the practice-based performance standard, please see Appendix A.

3.2.1 Practice-based performance standard

Projects with the characteristics described below may apply the practice-based performance standard and are therefore considered additional pending the outcome of the regulatory surplus test:

- Project activities located in non-arid counties (defined as counties with more than 25 inches of precipitation historically) and at landfills with equal to or less than 500,000 tons of waste in place; or
- Project activities located in arid counties (defined as counties with less than 25 inches of precipitation historically) and at landfills with equal to or less than 1,500,000 tons of waste in place.

Appendix A shall be used to determine if a project is located in a non-arid or arid county.

3.2.2 ACR's Three-Prong Additionality Test

For project activities that will not automatically qualify under the practice-based performance standard, ACR's three-prong additionality test may be applied. For a complete description of the ACR Three-Prong Additionality Test, the ACR Standard.

3.2.3 Regulatory Surplus Test

In order to pass the regulatory surplus test a project must not be mandated by existing laws, regulations, statutes, legal rulings, or any other regulatory frameworks in effect as of the project start date that directly or indirectly affect the credited GHG emissions associated with a project. The project proponent must demonstrate that there is no existing regulation that mandates the project or effectively requires the GHG emission reductions associated with the installation of a destruction device or the infrastructure necessary for enhancing the landfill gas.

In order to be eligible to receive offset credits, the project shall not be required to collect and destroy landfill gas under any federal, state or local regulation or other legally binding framework. The project proponent shall provide evidence including all supporting documentation necessary to prove that landfill gas destruction, abatement or mitigation is not required by any federal, state or local regulation or legally binding framework.

4.0 QUANTIFICATION OF GHG EMISSION REDUCTIONS

Quantification of project emission reductions requires calculation of baseline emissions and project emissions.

4.1 Baseline Emissions

This is the amount of GHG emissions that would take place without the destruction or beneficial use of the landfill gas. Records of continuous landfill gas flows (in standard cubic feet per minute) shall be matched with continuous methane content data using Equation 1:

Equation 1: CH_4 Combusted

$$CH4combusted = LFGcaptured * \%CH4 * (1 - OF)$$

Where:

$CH_{4combusted}$	Total methane combusted (scfm)
$LFG_{captured}$	LFG captured (scfm)
$\%CH_{4continuous}$	Methane content of LFG (%)
OF	Oxidation factor (a value of 0.1 should be applied to landfills without a synthetic cover system and 0 for landfills with a synthetic cover system)

Equation 2: CH_4 Combusted

In order to estimate the amount of methane combusted in metric tons, methane combusted needs to be converted to weight using Equation 2:

$$CH4total = \left((CH4combusted * CF) * 16.04 * \left[\frac{1}{10^6}\right] * \left[\frac{1}{24.04}\right] * 28.32\right) * 95\%$$

Where:

CH_{4total}	Total methane combusted (metric tons)
$CH_{4combusted}$	Methane combusted (scfm – as calculated in Equation 1)
CF	Correction factor – calculated per Equation 3[2]
16.04	Molecular weight of CH_4
$1/10^6$	Conversion to metric tons (mt/g)
1/24.04	Gas constant (mol/L – measured at standard temperature and pressure – defined as 68ºF and 14.7psi)

[2] The correction factor shall only be applied in instances where the project flow meter does not use a standard temperature of 68ºF. Where project flow meters do apply a standard temperature of 68ºF, CF = 1.

28.32	Conversion factor (L/cf)
95%	Destruction efficiency of the destruction device[3]

Equation 3: Correcting LFG Flow Temperature

If the monitoring equipment is set to record landfill gas flow at a temperature other than that defined in Equation 2 (68ºF), the project proponent must normalize the landfill gas flow by using the correction factor calculated in Equation 3.

$$CF = \frac{527.67}{T + 459.67}$$

Where:

CF	Correction factor
T	Temperature as measured by project flow meters

4.2 Project Emissions

Depending on project-specific circumstances, certain emissions sources shall be subtracted from total project emission reductions using the equations below.

Equation 4a: CO_2 Emissions from Fossil Fuel Combustion

$$DestCO2 = \sum y(FFy * EFy)$$

Where:

$Dest_{CO2}$	CO_2 emissions from fossil fuel used in methane destruction process (tCO_2)
FF_y	Total quantity of fossil fuel,y, consumed (volume of fuel)
EF_y	Fuel specific emission factor for fuel, y (t CO_2/fuel quantity) – See Appendix B

Equation 4b: CO_2 Emissions from Project Specific Electricity Consumption

$$Elec\ CO2 = \frac{ELtotal * EFEL}{2204.62}$$

Where:

$Elec_{CO2}$	Project specific electricity emissions (tCO_2)

[3]In lieu of the default 95% destruction efficiency, project proponents may apply the results of a third-party source test conducted by an organization meeting or exceeding the U.S. Environmental Protection Agency's *Minimum Competency Requirements for Air Emission Testing* rule to determine the actual destruction efficiency of the device.

EL_{total}	Total grid connected electricity consumption (MWh)
EF_{EL}	Carbon emission factor for grid electricity ($lbCO_2$/MWh) - See Appendix B
2204.62	$lbCO_2/tCO_2$

Equation 5: Project Emissions

$$PE = Elec\ CO2 + DestCO2$$

Where:

PE	Project emissions (tCO_2)
$Elec_{CO2}$	Project specific electricity emissions (tCO_2)
$Dest_{CO2}$	CO_2 emissions from fossil fuel used in methane destruction or transportation process (tCO_2)

4.3 Leakage

Leakage is a term that refers to secondary effects where the GHG emission reductions of a project may be negated by shifts in market activity or shifts in materials, infrastructure, or other physical assets associated with the project. ACR does not expect landfill methane projects to result in any additional activities that would augment GHG emissions outside of the project boundary and, therefore, no leakage assessment is required.

4.4 Emission Reductions

Equation 6: GHG Emission Reductions

$$ER = [CH4total * 25] - PE$$

Where:

ER	Total Emission Reductions (tCO_2e)
CH_{4total}	Methane combusted (mt)
1000	Conversion from kg to metric tons
25	Global warming potential of methane
PE	Project emissions (tCO_2)

5.0 MONITORING AND DATA COLLECTION

Each project shall include a GHG project plan sufficient to meet the requirements of the ACR Standard. The plan shall collect all data required to be monitored and in a manner which meets the requirements for accuracy and precision of this Methodology. Project Proponents shall use the template for GHG project plans available at www.americancarbonregistry.org. Additionally, projects are required to submit a GHG monitoring report for each reporting period. Project Proponents shall use the template for GHG monitoring reports available at http://americancarbonregistry.org/carbon-accounting/tools-templates.

5.1 Description of the GHG Project Plan

These are expanded upon in the sections below. The project proponent must prepare a GHG project plan describing (for each separately) the following: a) project implementation; b) technical description of the monitoring task; c) data to be monitored and collected; d) overview of data collection procedures; e) frequency of the monitoring; f) quality control and quality assurance procedures; g) data archiving; and h) organization and responsibilities of the parties involved in all the above.

The rationale of monitoring project implementation is to document all project activities implemented by the project that could cause an increase in GHG emissions compared to the baseline scenario.

5.2 Data Collection and Parameters to be Monitored

Project monitoring and recording shall include the following parameters:

- Continuous monitoring of landfill gas flow to each destruction device,
- Methane content analysis using a continuous gas analyzer,
- Electricity production records, if applicable,
- Quantity of transport fuel or pipeline quality gas generated, if applicable,
- Destruction device operating hours, if applicable,
- Before and after results of field checks, and
- Project-related emission data (grid electricity consumed and/or fossil fuels used by the project).

5.2.1 Flow Monitoring

Landfill gas flow shall be continuously monitored using an adequate flow meter. Continuous monitoring is defined as one data point recorded at least every 15 minutes. The flow meter shall be installed along the header pipe at a location that provides a straight section of pipe sufficient to establish laminar gas flow, in order to mitigate any turbulence resulting from bends, obstructions, or constrictions in the pipe. This turbulence may result in inaccurate flow measurements. The flow meter shall be located downstream of the blower and upstream of the control device. All flow data used to calculate emission reductions must be corrected for standard temperature (68ºF) and standard pressure (14.7psi).

5.2.2 Methane Content Analysis

The methane fraction in the landfill gas shall be continuously monitored using a methane analyzer. Continuous monitoring is defined as one data point at least every 15 minutes.

5.2.3 Monitoring Equipment Calibration/Quality Assurance

The following information regarding flow meter and gas analyzer performance shall be maintained:

- Proof of initial calibration for flow meters and gas analyzers;
- Capability to record flow or methane concentration every 15 minutes;
- Means to correct for temperature and pressure (for flow meter, if necessary); and
- Manufacturer's recommended factory calibration frequency.

It is essential that flow meters and gas analyzers operate properly in order to accurately quantify GHG emission reductions. To ensure proper equipment function, annual field checks for flow meter and methane analyzer accuracy shall be performed by a qualified third-party. Qualifying field checks must be separated by an elapsed time frame of a minimum of 11 months from the date of the preceding field check. Annual field checks must meet the following conditions:

- Field checks must be performed in accordance with manufacturer's specifications and methodologies;
- Field checks must be performed by the manufacturer or other appropriately trained third-party personnel;
- All field checks must be documented and made available for review during the validation and verification process. Documentation must include specific results of the field checks including the percent error demonstrated by the instrumentation capturing the before (as-found) and after (as-left) status;
- Should the instrumentation demonstrate an error in the reading or output of either landfill gas flow or methane content that is greater than or equal to 5%, written documentation must be provided as to the correction applied during the field check and the resulting accuracy of the instrumentation. In situations where the flow meter or methane analyzer percent error is greater than or equal to 5%, all data from the previous field check through to the most recent field check shall be scaled by the percent error documented in the most recent field check.

Projects may choose to conduct more than one field check to ensure that the monitoring equipment continuously meets the requirements of Section 5.2.3. If a project elects to conduct more frequent field checks, they must adhere to the requirements of Section 5.2.3. Additionally, manufacturer specifications regarding instrument calibration shall be followed. No ERTs will be granted for periods where the flow meter or gas analyzer have not been maintained in accordance with manufacturer calibration requirements.

5.2.4 Destruction Device Operating Hours

The operating hours for each destruction device must be monitored to ensure that landfill gas destruction is claimed for landfill gas destroyed only during periods when the device(s) was/were operational. Emission reductions may not be claimed for time periods where the destruction device(s) is not operating or thermocouple readings are below 500 degrees Fahrenheit. Operating hours must be continuously monitored and recorded. In general, operating hours for a flare are tracked through the use of a thermocouple which monitors the presence and temperature of the flame. Operating hours for other destruction devices such as engines should be tracked through operator logs, electricity production records, or other verifiable means.

Projects that treat landfill gas and inject it into a natural gas pipeline shall only provide evidence of the quantity of gas delivered to the pipeline and are not required to provide evidence of landfill methane destruction.

5.2.5 Project-Related Emissions

Project-related emissions may result from the used of imported electricity or from the use of fossil fuels. Information related to electricity usage and relevant fossil fuel consumption may be obtained from sources such as on-site electricity meters, utility invoices, and fuel purchase records.

5.2.6 Parameters Monitored

Parameter	$LFG_{captured}$
Units	scfm
Description	Landfill gas flow as measured by the flow meter.
Relevant Section	4.1
Relevant Equation(s)	1
Source of Data	Flow meter/data acquisition device
Measurement Frequency	Continuous

Parameter	$CH_4\%$
Units	Percentage
Description	Percent of methane monitored by the gas analyzer.
Relevant Section	4.1
Relevant Equation(s)	1
Source of Data	Gas analyzer/data acquisition device
Measurement Frequency	Continuous

Parameter	Flare Operating Hours
Units	Degrees Fahrenheit

Description	Monitoring of operational activity of destruction device to ensure destruction of landfill gas. Not applicable for pipeline injection projects.
Relevant Section	4.1
Relevant Equation(s)	1
Source of Data	Thermocouple/data acquisition device
Measurement Frequency	Continuous

Parameter	Flare Temperature
Units	Degrees Fahrenheit
Description	Monitoring of temperature of destruction device to ensure destruction of landfill gas. Not applicable for pipeline injection projects.
Relevant Section	4.1
Relevant Equation(s)	1
Source of Data	Thermocouple/data acquisition device
Measurement Frequency	Continuous

Parameter	FF_y
Units	Volume of fuel
Description	Total quantity of fossil fuel,y, consumed.
Relevant Section	4.1.2
Relevant Equation(s)	4a
Source of Data	Utility or fuel Invoices
Measurement Frequency	Collected annually

Parameter	EL_{total}
Units	MWh
Description	Total grid connected electricity consumption.

Relevant Section	4.1.2
Relevant Equation(s)	4b
Source of Data	Electricity Invoices
Measurement Frequency	Collected annually

APPENDIX A: DEVELOPMENT OF PRACTICE-BASED PERFORMANCE STANDARD

While the total number of landfills in the U.S. has declined over time, the amount of waste sent to landfills has increased. As of 2015, landfills accounted for approximately 18%[4] of anthropogenic methane emissions in the U.S. The Environmental Protection Agency's (EPA) Landfill Methane Outreach Program (LMOP) maintains a database of the 2,434 landfills in the U.S. of which there are approximately 1,000 municipal solid waste (MSW) landfills that are subject to the existing New Source Performance Standards (NSPS). Of the 1,000 MSW landfills subject to NSPS, 574 have installed gas collection and control systems (GCCS) as a result of the regulatory requirement, while the remainder are only required to report their annual emissions to the EPA[5]. Only landfills that have a design capacity of 2.5 million metric tons and 2.5 million cubic meters of waste are subject to federal NSPS requirements and landfills are only required to abate emissions if they are found to reach or surpass the 50 megagrams per year of non-methane organic compounds (NMOC) emission threshold or 34 megagrams per year beginning in 2025.

For landfills that have reached or have exceeded the allowable NMOC emission threshold, no credits may be claimed once the landfill is required to install a GCCS. However, landfills that are not subject to NSPS regulations or have not reached the allowable NMOC threshold may participate in a voluntary carbon offset program.

While past landfill gas carbon offset protocols have been predicated upon a low adoption rate for LFG GCCS *nationally* the number of voluntary landfill gas projects has steadily increased to the point where a national, practice-based performance standard is no longer applicable. However, based on analysis of the LMOP database along with assistance from several state or local permitting authorities, ACR has identified that there are still criteria that define landfills with low penetration rates for voluntary landfill gas projects. ACR began by identifying candidate landfills which consisted of the following criteria:

- Landfills that were currently open or had closed within in the last 5 years;
- Landfills that are currently under the waste in place (WIP) threshold for the region (i.e. arid versus non-arid locations, see Table 4); and
- Landfills that are not subject to NSPS or other state/local requirements to install a GCCS.

It should be noted that recently closed landfills may generate enough landfill gas to facilitate a project which is why candidate landfills closed in the last 5 years were included.

Given the above criteria, ACR has calculated that voluntary projects at landfills in non-arid regions (regions with more than 25 inches of rain in the last five years) and less than 500,000 tons of WIP, and at landfills in arid regions (regions with less than or equal to 25 inches of rain in the last five years) with less than 1,500,000 tons of WIP, account for less than 15% of candidate landfills in each region (Table 5)[6]. As these adoption rates are low, landfills that meet the criteria stipulated in Section 3.2.1 automatically qualify under the practice-based performance standard. The historical precipitation map in Figure 2 below shall be used to determine if a project is located in an arid or non-arid region.

[4] EPA's Air Rules for Municipal Solid Waste Landfills, Proposed Emission Guidelines for Existing Landfills: Fact Sheet. Found at http://www3.epa.gov/ttn/atw/landfill/20150814egfs.pdf.
[5] EPA's Air Rules for Municipal Solid Waste Landfills, Proposed Emission Guidelines for Existing Landfills: Fact Sheet. Found at http://www3.epa.gov/ttn/atw/landfill/20150814egfs.pdf.
[6] Precipitation zones defined by the EPA (section 2.4-4). Found at https://www3.epa.gov/ttn/chief/ap42/ch02/final/c02s04.pdf.

Table 5: Penetration Rate of Candidate Landfills

	Non-Arid	Arid
WIP Limit	***500,000***	***1,500,000***
Candidate Landfills	90	92
Candidates Landfills with a Voluntary GCCS	13	12
Percent Adoption	14.44%	13.04%

Figure 2: U.S. Historic Precipitation Map

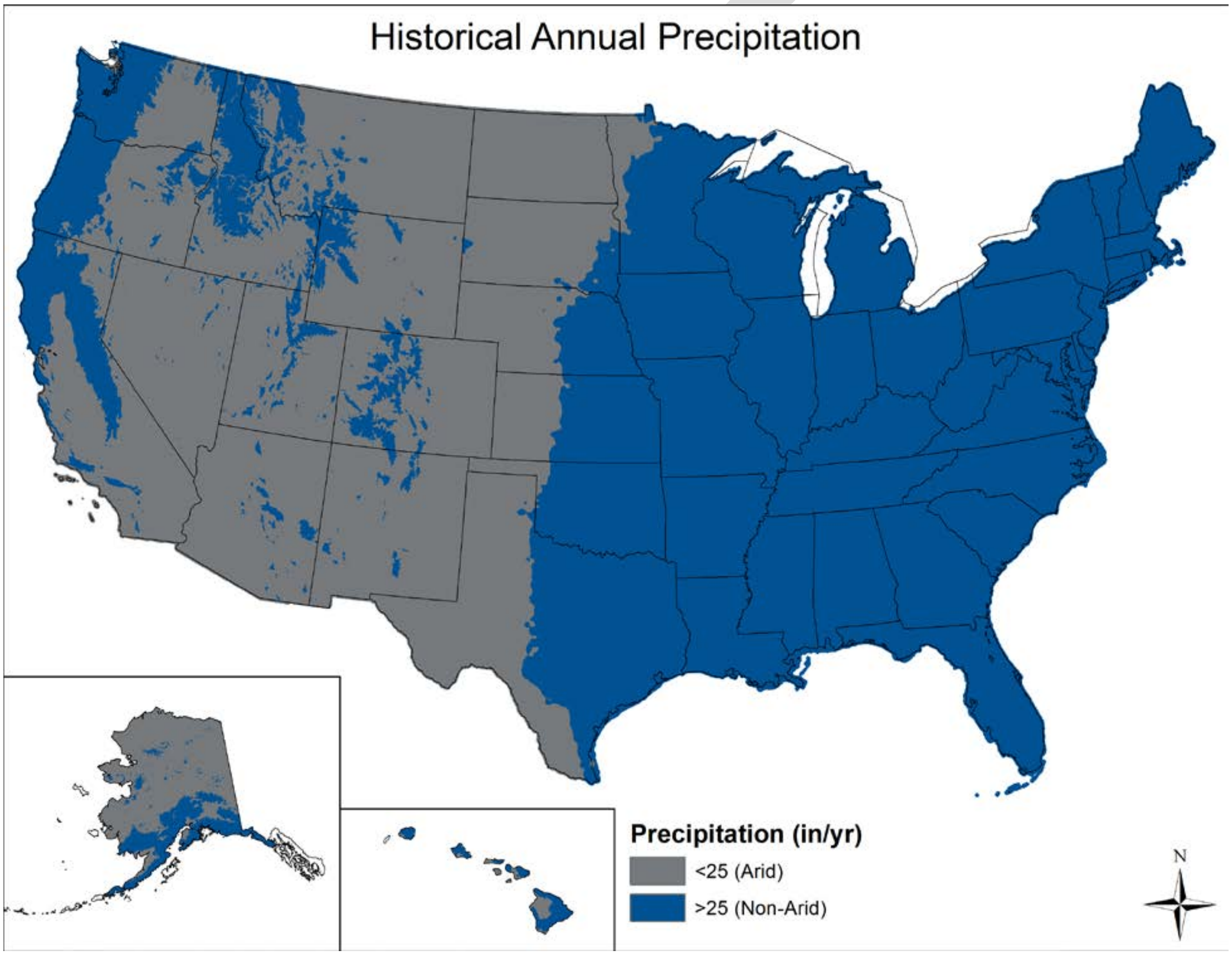


Figure 2 precipitation data sources by region include:

- **Continental U.S.**: PRISM Climate Group, Oregon State University, http://prism.oregonstate.edu, created Feb 4, 2004.
- **Alaska**: Arctic Landscape Conservation Cooperative, 2012. Baseline (1961-1990) average total precipitation (mm) for Alaska and Western Canada. Created by Arctic Landscape Conservation Cooperative staff; data provided by Scenarios Network for Alaska and Arctic Planning. http://arcticlcc.org/products/spatial-data/show/baseline-1961-1990-rasters
- **Hawaii**: Giambelluca, T.W., Q. Chen, A.G. Frazier, J.P. Price, Y.-L. Chen, P.-S. Chu, J.K. Eischeid, and D.M. Delparte, 2013: Online Rainfall Atlas of Hawai'i. Bull. Amer. Meteor. Soc. 94, 313-316, doi: 10.1175/BAMS-D-11-00228.1.

APPENDIX B: EMISSION FACTORS

Project proponents shall use the current version of the U.S. Environmental Protection Agency's Power Profiler (http://oaspub.epa.gov/powpro/ept_pack.charts) to determine what regional emission factor should be used in accordance with the Emissions & Generation Resource Integrated Database (eGRID) for EF_{EL}. eGRID emission factors are available at http://www.epa.gov/energy/egrid.

To calculate $Dest_{CO2}$, project proponents shall use the below emission factors for EF_y which will be revised periodically based on updated information.

	CO_2 EF_y					
Fossil Fuel Type	**Pounds (lbs.) CO_2**	**Per Unit**	**Kilograms (kg) CO_2**	**Per Unit**	**Lbs. CO_2/ MMBtu**	**kg CO_2/ MMBtu**
Gases						
Propane	12.70	Gallon	5.76	Gallon	139.05	63.07
Butane	14.80	Gallon	6.71	Gallon	143.20	64.95
Butane/Propane Mix	13.70	Gallon	6.21	Gallon	141.12	64.01
Home Heating and Diesel Fuel	22.40	Gallon	10.16	Gallon	161.30	73.16
Kerosene	21.50	Gallon	9.75	Gallon	159.40	72.30
Coal (All types)	4,631.50	Short ton	2,100.82	Short ton	210.20	95.35
Natural Gas	117.10	Thousand cubic feet	53.12	Thousand cubic feet	117.00	53.07
Gasoline	19.60	Gallon	8.89	Gallon	157.20	71.30
Residual Heating Fuel (Businesses only)	26.00	Gallon	11.79	Gallon	173.70	78.79
Flared natural gas	120.70	Thousand cubic feet	54.75	Thousand cubic feet	120.60	54.70
Petroleum coke	32.40	Gallon	14.70	Gallon	225.10	102.10
Other petroleum & miscellaneous	22.09	Gallon	10.02	Gallon	160.10	72.62
Coals						
Anthracite	5,685.00	Short ton	2,578.68	Short ton	228.60	103.70
Bituminous	4,931.30	Short ton	2,236.80	Short ton	205.70	93.30
Subbituminous	3,715.90	Short ton	1,685.51	Short ton	214.30	97.20
Lignite	2,791.60	Short ton	1,266.25	Short ton	215.40	97.70
Coke	6,239.68	Short ton	2,830.27	Short ton	251.60	114.12

Source: U.S. Energy Information Administration, published February 2, 2016.

APPENDIX C: REFERENCES

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