CLIMATE ACTION RESERVE

Landfill Project Protocol V5.0

Workgroup Meeting 2

January 16th 2018

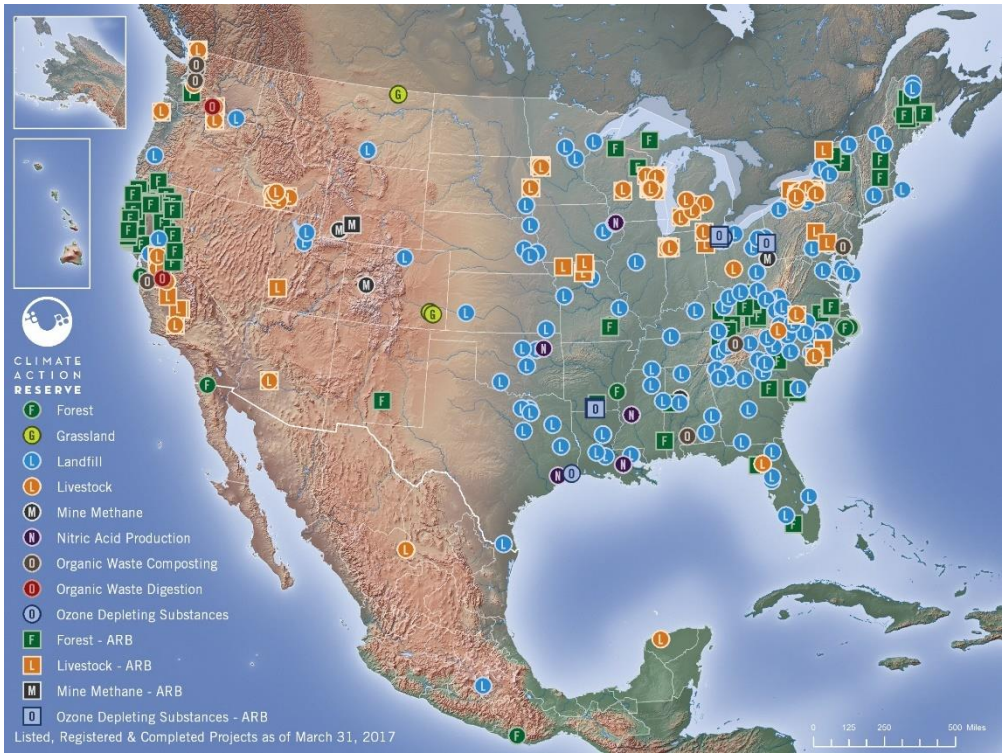
Agenda

1. Background
2. Introductions
3. Process Overview
4. Key updates
5. Open forum for feedback and suggestions
6. Next steps

BACKGROUND

Climate Action Reserve

- Private, nonprofit carbon offset registry, founded in 2001:
  - Develop carbon offset policies and protocols
  - Manage a registry of voluntary offset projects
  - Oversee independent verification program
  - Accredited Offset Project Registry for California Air Resources Board
- 18 different project protocols for U.S. and Mexico
- 122M offset credits issued, both voluntary and compliance (CA)



Landfill protocol development history

Version	Adoption Date	Notes
V1.0	Nov 29, 2007	Protocol adopted
V2.0	Nov 18, 2008	Improved accuracy and conservativeness in ER calculations and better guidance for MRV
V3.0	Dec 2, 2009	Eligibility for closed landfills with flares, updated definitions and QA/QC guidance
V4.0	June 29, 2011	Introduction of size threshold for LFG-to-energy projects in Performance Standard Test (PST)

CLIMATE ACTION RESERVE

INTRODUCTIONS

Reserve Staff

- Bety Zavariz, *Policy Associate*
  - Protocol development
- Sami Osman, *Senior Policy Manager*
  - Project management and protocol development support
- Heather Raven, *Senior Project Coordinator*
  - Project management and protocol development support

Workgroup Members

Name (alphabetical)	Organization
Jason Clarke	GHD
Nick Facciola	3Degrees Group, Inc
Jason Hoyle	Appalachian State University
Brian KillKelley	NativeEnergy
John McDougal	Element Markets
Rachel Oster	Diversion Strategies
Adam Penque	Centrica Business Solutions
Andrew Sheppard	US EPA
Patrick Sullivan	SCS Engineers
Barbara Tool O'Neil	Independent consultant

* Note that US EPA's LMOP members are now observers

PROCESS OVERVIEW

Protocol development timeline

Milestone/Task	Timeline
Public Scoping Meeting	Oct 2018
Convene Work Group & staff commences update analysis	Oct 2018
1st WG meeting (webinar)	Nov 15th 2018
Staff begins drafting – working with WG	Nov 2018
2nd WG meeting to review draft (webinar)	Jan 16th 2019
Staff revises draft, incorporating WG feedback	Jan 2019
Public Comment period	1st wk Feb 2019
Public Comment Meeting (webinar)	2nd wk Feb 2019
Staff revises draft, incorporating public feedback	Feb – Mar 2019
Final protocol adoption by Reserve Board	Apr 2019

Workgroup expectations

- Attend and participate in WG meetings to the fullest extent possible
- Provide feedback on specific policy and technical questions
  - At WG meetings, one-on-one with staff, or in sub-committees
- Provide comments on draft protocols and protocol sections
- Be constructive, collaborative, and productive

KEY UPDATES

Summary of Proposed Updates – major issues

Protocol Element	Proposed change
Project definition	Updated to allow for expansions into new cell to optionally be considered new project or part of existing project
Crediting period	Allow for 2nd CP – with transition period for projects that have not maintained continuous reporting
Performance Standard Test	New end-use technology specific PST thresholds
Legal Requirement Test	Removed local NMOC threshold
Monitoring	New optional indirect monitoring alternative
Verification	Optional 24 month verification periods

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Summary of Proposed Updates – lessons from E&Cs / other protocols

Protocol Element	Proposed change
LRT	Updated NSPS / EG NMOC thresholds
Quant	OX factor guidance, hierarchy options for destruction efficiency values
Monitoring	Metering multiple devices with single meter, monitoring off-site destruction; monitoring for multiple projects at single facility
QA/QC	**Did not remove req for quarterly clean / inspect**; temporary stationary meters; extra on-site field check; which instruments subject to portable meter requirements; **Did not remove requirement to calibrate handheld device to known gas prior to each use;** drift for Sage meters
Appendices	Updating default factors

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Section 2.2

PROJECT DEFINITION

Project Definition: Expanding existing GCCS = new project

- OPTIONAL: expansion of existing GCCS into new cell(s) =
  - expansion of existing project OR
  - submitted as a new project – with new crediting period;
- Rationale: cost of expanding is high enough to warrant offset revenue for entire new CP
- Allow projects to share common destruction devices
  - provided monitoring is adequate
  - extra guidance for regulatory compliance – presumption any problems apply equally to all projects at site

Section 3.3

CREDITING PERIOD

2 Crediting Periods

- Allow for projects to apply for 2nd crediting periods (CP)
- Removing V4.0 PST size threshold – greater opportunities for existing projects to transition into V5.0 for 2nd CP
- **Mechanism to address any periods where did not maintain continuous reporting**
- Adopted ***look-back period***, during which projects that expired under previous version can be submitted under this version for 2nd CP
  - provided project submit 1/more ZCRP(s) for any period in between when completed first CP and commenced 2nd CP;
  - NOTE: Also considering similar programmatic options for projects still within their first CP
  - Parties interested in 2nd CP should maintain monitoring and associated QA/QC until such time as they submit for a 2nd CP under v5.0

Section 3

LEGAL REQUIREMENT TEST

Legal Requirement Test

- Removed local NMOC threshold (Section 3.4.2.3)
- NMOC emissions threshold developed to address projects at landfills where treatment of LFG for NMOC was mandated but LFG destruction was not only treatment option
- Was 2 thresholds, if total mass flow of NMOC for LFG control system was greater than threshold, then project not eligible:
  - For sites which closed flares not required by law, threshold = 1,775 pounds NMOC/mth
  - For sites where closed flares were required by law, threshold = 2,575 pounds NMOC/mth
- WG feedback / research indicates flares are primary mechanism to address NMOC emission control mandates, therefore removing rationale underlying these thresholds
- Projects subject to closed flare mandate at local level are no longer eligible

Section 6

INDIRECT MONITORING ALTERNATIVE

Monitoring

- Section 6.1.1 Indirect Monitoring Alternative (Optional)
- Instead of using flow meters – can present method to use destruction device output data
- Output must be measured using commercial transfer meter (i.e. meter used to measure output for energy delivery contract)
- Conditions:
  - must propose appropriate conversion method (Break-specific fuel consumption calculations may be considered appropriate method)
  - must set out method clearly in monitoring report
  - must apply method consistently throughout the reporting period
  - must demonstrate to VB satisfaction:
    - that use of such data and method is reasonable in circumstances
    - results in conservative estimation of volume of CH4 destroyed

Section 7

VERIFICATION

Verification Periods

- Optional 24 month verification period
  - Get issued credits once verified
  - Can verify once every 24 months, or more frequently;
  - Can forgo site visit during given verification period if:
    - Site visit occurred during previous RP
    - Using same VB as for previous site visit RP

Section 3.4.1

PERFORMANCE STANDARD TEST (PST)

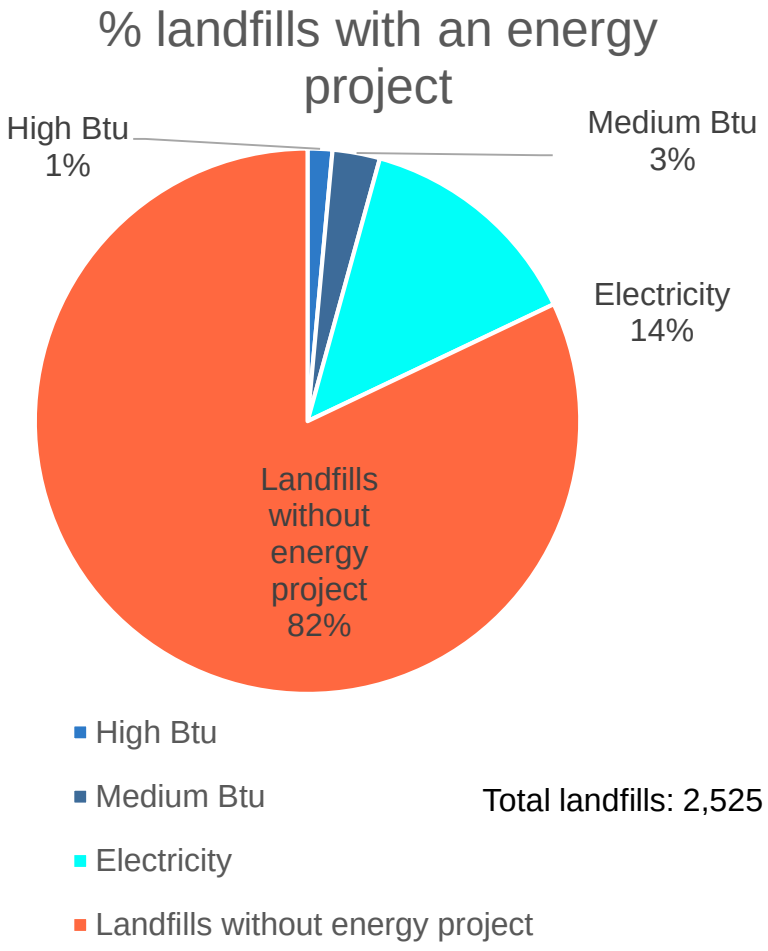
WG feedback

- NG is relevant but is not the whole picture
- Feedback was differentiated by types of LFG end uses
- Consider investment analysis
- Projects require incentives for feasibility
  - Renewable Portfolio Standard
  - Renewable Fuel Standard
  - Low Carbon Fuel Standard
- Due to economies of scale, larger landfills are likely not additional

New approach – three factors

1. LFG end use
   - High Btu – RNG and CG
   - Medium Btu – Direct use
   - Electricity
2. State of the market: Penetration rate and drivers
3. If needed- financial assessment
   - At what capacity can a project reach feasibility in the absence of incentives?

State of the market: penetration rates



Total landfills: 2,525

- Common practice: Electricity projects
- Not-common practice: High Btu and Medium Btu

Drivers per project type

High-Btu Projects

- Currently driven by RFS and LCFS
- Incentives provide approx. $58/tCO$_2$e
- 60% of projects planned for construction in LMOP are RNG

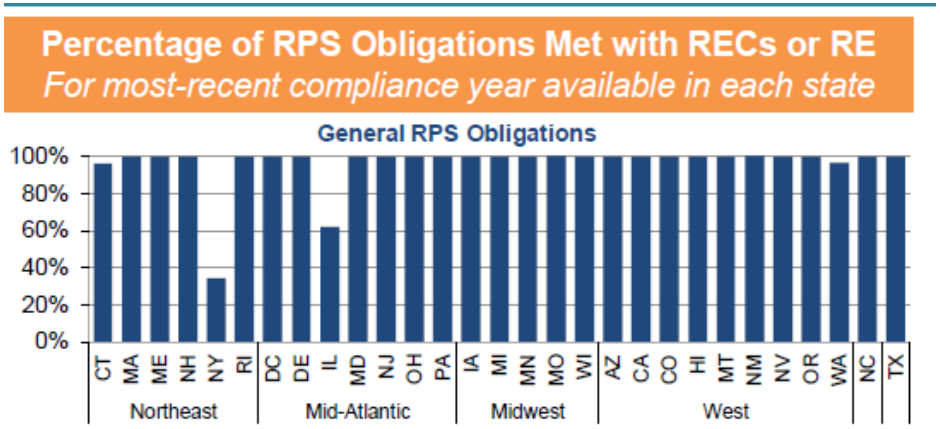
Medium Btu projects

- Linked to Natural Gas prices which are now at low levels
- Feasibility highly depends on distance to purchasing facility
- Gas treatment is a significant cost for feasibility
- There are insufficient incentives to drive these projects

Drivers per project type

Electricity projects

- Very complex market, historically mostly driven by RPS (RECs)
- Most of the states have met their RPS goals.
- High uncertainty in future of REC markets as states are reaching end of RPS goals.
- REC prices at 5 year low levels in some states



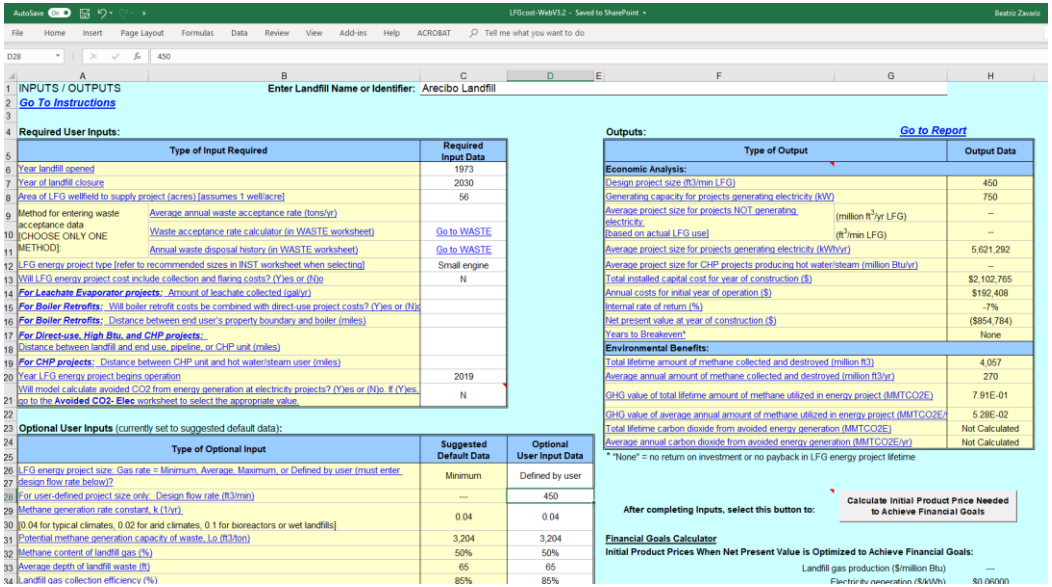
Source: Laurence Berkeley National Laboratory (July 2017).

BAU conclusions

Consideration	High Btu Projects	Medium Btu Projects	Electricity projects
Common practice?	No	No	Yes
Clear market drivers?	Yes	No	No
Given answers to questions above, is it BAU?	Yes	No	Yes
LFPP V5.0 eligible?	No	Yes	Requires further analysis

Financial assessment for electricity projects

- Question: At what electricity generation capacity do projects become feasible in the absence of incentives?
- Tool: LMOP's Landfill Energy Cost Model
- 120 randomly selected projects
- When do they reach a positive NPV?



INPUTS / OUTPUTS — Enter Landfill Name or Identifier: Arecibo Landfill

Go To Instructions

Required User Inputs:

Type of Input Required	Required Input Data
Year landfill opened	1973
Year of landfill closure	2030
Area of LFG wellfield to supply project [acres] [assumes 1 well/acre]	56
Method for entering waste acceptance data [CHOOSE ONLY ONE METHOD]: Average annual waste acceptance rate (tons/yr)	
Method for entering waste acceptance data [CHOOSE ONLY ONE METHOD]: Waste acceptance rate calculator (in WASTE worksheet)	Go to WASTE
Method for entering waste acceptance data [CHOOSE ONLY ONE METHOD]: Annual waste disposal history (in WASTE worksheet)	Go to WASTE
LFG energy project type [refer to recommended sizes in INST worksheet when selecting]	Small engine
Will LFG energy project cost include collection and flaring costs? (Y)es or (N)o	N
For Leachate Evaporator projects: Amount of leachate collected (gal/yr)	
For Boiler Retrofits: Will boiler retrofit costs be combined with direct-use project costs? (Y)es or (N)o	
For Boiler Retrofits: Distance between end user's property boundary and boiler (miles)	
For Direct-use, High Btu, and CHP projects: Distance between landfill and end use, pipeline, or CHP unit (miles)	
For CHP projects: Distance between CHP unit and hot water/steam user (miles)	
Year LFG energy project begins operation	2019
Will model calculate avoided CO2 from energy generation at electricity projects? (Y)es or (N)o. If (Y)es, go to the **Avoided CO2- Elec** worksheet to select the appropriate value.	N

Optional User Inputs (currently set to suggested default data):

Type of Optional Input	Suggested Default Data	Optional User Input Data
LFG energy project size: Gas rate = Minimum, Average, Maximum, or Defined by user (must enter design flow rate below)?	Minimum	Defined by user
For user-defined project size only: Design flow rate (ft3/min)	---	450
Methane generation rate constant, k (1/yr) [0.04 for typical climates, 0.02 for arid climates, 0.1 for bioreactors or wet landfills]	0.04	0.04
Potential methane generation capacity of waste, Lo (ft3/ton)	3,204	3,204
Methane content of landfill gas (%)	50%	50%
Average depth of landfill waste (ft)	65	65
Landfill gas collection efficiency (%)	85%	85%

Outputs: Go to Report

Type of Output	Output Data
Economic Analysis:	
Design project size (ft3/min LFG)	450
Generating capacity for projects generating electricity (kW)	750
Average project size for projects NOT generating electricity: [based on actual LFG use] (million ft³/yr LFG)	--
Average project size for projects NOT generating electricity: [based on actual LFG use] (ft³/min LFG)	--
Average project size for projects generating electricity (kWh/yr)	5,621,292
Average project size for CHP projects producing hot water/steam (million Btu/yr)	--
Total installed capital cost for year of construction ($)	$2,102,765
Annual costs for initial year of operation ($)	$192,408
Internal rate of return (%)	-7%
Net present value at year of construction ($)	($854,784)
Years to Breakeven*	None
Environmental Benefits:	
Total lifetime amount of methane collected and destroyed (million ft3)	4,057
Average annual amount of methane collected and destroyed (million ft3/yr)	270
GHG value of total lifetime amount of methane utilized in energy project (MMTCO2E)	7.91E-01
GHG value of average annual amount of methane utilized in energy project (MMTCO2E/	5.28E-02
Total lifetime carbon dioxide from avoided energy generation (MMTCO2E)	Not Calculated
Average annual carbon dioxide from avoided energy generation (MMTCO2E/yr)	Not Calculated

* "None" = no return on investment or no payback in LFG energy project lifetime

After completing Inputs, select this button to: Calculate Initial Product Price Needed to Achieve Financial Goals

Financial Goals Calculator

Initial Product Prices When Net Present Value is Optimized to Achieve Financial Goals:

Landfill gas production ($/million Btu) ---

Electricity generation ($/kWh) $0.06000

Model default values

Relevant variables	Value
Loan lifetime	10 years
Interest rate	10%
Inflation rates	2 – 2.5%
Discount rate	8%
Down Payment	20%
Energy tax credits	0%
Electricity sales Price	0.06 $/kWh
REC revenue	0 $/kWh
Annual product price escalation rate	1%

- Other defaults:
  - Methane generation variables
  - Methane content in gas
  - Gas destruction efficiency
  - Operating Schedule
  - Etc. (complete list in protocol)

Project specific variables

- Year Landfill Opened
- Year landfill closure
- Area of LFG wellfield
- WIP
- Year WIP data
- Project type
- Marginal tax rate (21% private or 0% public)
- Collection and flaring installation cost included? No
- Initial year of operation: 2019
- Project size (MW)
- Flow rate: Manually adjusted

Results

Threshold round	Landfill Name	Ownership Type	Year Landfill Opened	Landfill Closure Year	Waste in Place (tons)	Waste in Place Year	LFG Energy Project Type	MW Capacity	Proportional landfill ar	Input flow rate	Total installed capital cost for year of constructio	Annual costs for initial year of operation	Internal rate of return (%	Net present value at year of constructio	Years to break ev
2	Camelot Landfill	Public	1980	2028	18,964,223	2016	Reciprocating Engine	3.2	178.9	1185	$6,080,500	$755,332	6%	($279,417)	None
2	I-95 Landfill	Public	1973	1995	20,229,000		Reciprocating Engine	3.2	125.0	1185	$6,080,500	$755,332	6%	($279,417)	None
1	Smiths Creek Landfill	Public	1967	2129	7,914,915	2016	Reciprocating Engine	3.2	138.0	1200	$6,138,601	$764,893	6%	($265,699)	None
2	Foothill Sanitary Landfill, Inc.	Public	1965	2092	5,021,581	2016	Reciprocating Engine	3.6	124.0	1185	$6,080,500	$755,332	6%	($279,417)	None
1	Coyote Canyon SLF	Public	1963	1990	38,999,999	1990	Fuel Cell	4	40.6	1500	$7,300,624	$956,116	8%	$8,657	15
1	Naples Landfill	Public	1990	2080	7,637,805	2016	Reciprocating Engine	4	144.1	1500	$7,300,624	$956,116	8%	$8,657	15
1	Central County Solid Waste Disposa	Public	1998	2055	5,106,424	2016	Reciprocating Engine	4	63.8	1500	$7,300,624	$956,116	8%	$8,657	15
1	Jones Crossroads Landfill	Public	1984	2029	5,966,310	2016	Reciprocating Engine	4.24	99.4	1556	$7,517,535	$991,811	8%	$59,870	15
1	Nelson Gardens LF	Public	1980	1993	11,802,410	1993	Reciprocating Engine	4.24	277.0	1556	$7,517,535	$991,811	8%	$59,870	15
1	Hanes Mill Road Landfill	Public	1972	2036	11,306,698	2016	Gas Turbine	4.3	160.0	1590	$10,076,847	$647,058	8%	$29,151	15
2	Town of Colonie SLF	Public	1963	2022	7,238,944	2016	Reciprocating Engine	4.8	74.5	1800	$8,462,647	$1,147,340	9%	$283,012	14
2	Clinton County Regional Landfill	Public	1977	2035	4,478,561	2016	Reciprocating Engine	4.8	73.5	1800	$8,462,647	$1,147,340	9%	$283,012	14
1	Prince William County Sanitary Lanc	Public	1968	2036	10,032,942	2016	Reciprocating Engine	4.8	90.5	1800	$8,462,647	$1,147,340	9%	$283,012	14
1	Bluff Road Landfill	Public	1988	2033	7,646,011	2015	Reciprocating Engine	4.8	110.5	1800	$8,462,647	$1,147,340	9%	$283,012	14
2	Southeast Berrien County Landfill	Public	1971	2019	5,614,439	2016	Reciprocating Engine	4.8	58.4	1800	$8,462,647	$1,147,340	9%	$283,012	14
2	Prairie View RDF	Public	2004	2034	8,939,286	2016	Reciprocating Engine	4.8	108.4	1800	$8,462,647	$1,147,340	9%	$283,012	14

- Private projects become feasible at 6 MW
- Public projects become feasible at 4 MW

Final Performance Standard Thresholds

Eligible LFGE projects under LPP V5.0	Not eligible LFGE projects under LPP V5.0
▪ Privately owned projects up to an installed capacity of 6 MW ▪ Publicly owned electricity projects up to an installed capacity of 4 MW ▪ All Direct use projects (Medium Btu)	▪ Privately owned projects with an installed capacity above 6 MW ▪ Publicly owned electricity projects with an installed capacity above 4 MW ▪ RNG ▪ CNG

Next steps for the PST

- Incorporate WG feedback
- Refine assumptions
  - Financial assumptions
  - Incentive assumptions
- Threshold will likely shift
- Analysis possible without modeling specific landfills – makes process more efficient

Section 5

FEEDBACK AND SUGGESTIONS

Section 6

NEXT STEPS

Next Steps

- WG to submit comments/feedback by January 23rd
- Public Comment period being 2 weeks after that – wk Feb 4th
- Public Comment meeting – wk Feb 11th

Contact Information

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