

Appendix A: Responses to Peer Review Comments, LFGcost-Web Peer Review, July 2016

Comment ID	Charge Question	Reviewer Name	Reviewer Comment	Charge Question Type	Documentation or File	Topic	EPA Response to Comments
1	A1	Shih	Yes, there are other emerging LFG utilization technologies that warrant consideration in addition to electricity generation, such as gas-to-liquid technology, which could covert biogas produced from landfills into liquid methanol. Methanol has a higher economic value and is widely used as a feedstock for industrial chemicals.	Methods and Assumptions	Model	General	The EPA appreciates this feedback. At this time, there are not sufficient commercial cost data points available to accurately estimate the costs to deploy the alternative technologies mentioned by the commenter.
2	A1	Barlaz	I think that the range provided is extensive. As noted in some of my general comments, I question whether there are enough CHP Projects in operation to warrant including in a model. An alternative would be to qualitatively point out that CHP projects will increase efficiency and therefore environmental benefits. As long as Cornerstone thinks that the data are no more uncertain than for the other energy recovery alternatives, including CHP is fine.	Methods and Assumptions	Model	General	Based on the LMOP Landfill and LFG Energy Project Database as of February 2016, there are 47 LFG energy CHP projects in operation nationwide, and collectively these projects have 131.4 MW of capacity. Based on data collected for the basis of the CHP project costs in past revisions to the LFGcost model, the EPA believes the uncertainty levels are comparable to the 30-50% range in the model. While CHP is a small fraction of the overall LFG energy industry, CHP continues to be an important but niche segment of the industry. For these reasons, the EPA believes it is important to retain the CHP modules in the LFGcost model.
3	A1	Stafford	Reviewer indicated this was beyond area of expertise to answer.	Methods and Assumptions	General	N/A	No response needed.
4	A2	Shih	LFGCost could provide a range to the economy of scale parameter, which is currently a fixed number of 0.61 in the capital cost equation for the blower and flaring system.	Methods and Assumptions	Model	Approach (underlying calculations, etc.)	In general, the LFGcost model provides an estimated cost based on a range of project sizes. More specifically, the 0.61 factor was part of the equation developed using actual project installations representing a range of project sizes. There were seven different collection and flaring systems to base the costs on, three of which had sufficient data for estimating the cost of the skid mounted blower, knockout, and flare system. The three systems ranged in size between 700 and 4,000 scfm. As part of the internal technical review of the equation in 2014, the technical reviewers (comprised of other consultants who design and build systems) agreed that the equation represented a wide range of project sizes within the stated uncertainty bounds of the LFGcost model.

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5	A2	Shih	The estimated costs are for the most part reasonable; however, there is much uncertainty and variability associated with the cost and LFG production parameters. Whenever possible, the model should provide uncertainty bounds/ranges for the model parameters, including gas production and cost parameters.	Methods and Assumptions	Model	Approach (underlying calculations, etc.)	Both the 'INST' worksheet of the LFGcost model and the User's Manual discuss the general uncertainty of the model (+/- 30-50%). The uncertainty of each individual parameter cannot be quantified. The level of project raw data detail collected in the development of the LFGcost model did not include an uncertainty estimate on each price component. In addition, the 'INST' worksheet discusses the bounds of appropriate project sizes for each energy recovery module. Several individual input parameters have suggested ranges. Regarding modeling of LFG generation, page 1 (page 4 of the .pdf) of the August 2014 User's Manual discusses the uncertainty of the first-order decay model approach, based on site-specific circumstances. The first-order decay approach to modeling LFG generation is consistent with the modeling approaches in EPA's 1998 MSW Landfills AP-42 chapter (www3.epa.gov/ttn/chief/ap42/ch02/final/c02s04.pdf).
6	A2	Barlaz	I do not have a good background in the economics but rather rely on values presented by consultants such as Cornerstone and landfill owners such as Waste Management. If EPA is concerned with the numbers, then SCS Consultants does a lot of field work maintaining landfill gas collection systems and I would expect them to have excellent O&M and capital cost data. I can provide a contact if desired.	Methods and Assumptions	Model	Approach (underlying calculations, etc.)	SCS Engineers was one of the companies involved in reviewing the LFGcost model's output for cost reasonableness, prior to the initiation of this peer review. SCS Engineers found the costs estimated to be in line with the projects in their portfolio, within the margin of error stated by the model.
7	A2	Stafford	Reviewer indicated this was beyond my area of expertise to answer.	Methods and Assumptions	General	N/A	No response needed.

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8	A3	Barlaz	With reference to this statement in the user’s manual: “Landfill gas collection efficiency – The equipment used to collect LFG normally operates at efficiencies between 70 and 95 percent. The suggested default is 85 percent.” I think that 85% is too high unless the site is under final cover. Most gas is produced long before the landfill is under final cover so this value should be reevaluated. I have attached two documents that I prepared for ICF in support of EPA’s WARM model. Both documents have been reviewed by both EPA-ORD and industry representatives. The documents review the available literature on collection efficiency and present what I consider to be the state-of-the-art (but not the state-of-the-practice) for modeling landfill gas collection efficiency.	Methods and Assumptions	General	Input (including data sources)	The LFGcost model's default value for landfill gas collection efficiency is 85%, but users can vary the collection efficiency value based on cover type. The range of efficiencies is discussed in the 'INST' worksheet. The EPA plans to continue to use the default value of 85% because many energy recovery projects are located in landfills or cells that have final cover. The default value of 85% is consistent with the assumptions made in the marginal abatement cost curve analysis for the 2013 report <i>Global Mitigation of Non-CO2 Greenhouse Gases: 2010-2030</i> (www3.epa.gov/climatechange/Downloads/EPAactivities/MAC_Report_2013.pdf). The documents referenced by the commenter in support of the WARM model focus on lifetime gas collection efficiency which is not applicable to the LFGcost model.
9	A3	Barlaz	Figure 1 in the User’s Manual: It is well documented that the gas collection efficiency changes (increases with time). I realize that this concept goes beyond LandGem but suggest that it is time for EPA to start incorporating this issue into its landfill gas models. The background to handle a time varying collection efficiency is described in the aforementioned documents that I am attaching as well as in the manuscript listed below which I have also attached: Levis, J. M. and M. A. Barlaz, 2011, “Is biodegradability a desirable attribute for discarded solid waste? Perspectives from a national landfill greenhouse gas inventory model,” <i>Environ. Sci. and Tech.</i>, 45, 13, p. 5470 – 76. I can assist with this if desired.	Methods and Assumptions	General	Input (including data sources)	The EPA recognizes that gas collection efficiency could vary at different points in the landfill lifetime. Currently, LFGcost uses a single gas collection efficiency for the project lifetime; however, the EPA plans to evaluate whether incorporating a variable gas collection efficiency would be appropriate for the LFGcost model.

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10	A3	Barlaz	The default GWP – I do not think the user should be forced to decide between 21 and 25. I assume that the value is the same as EPA uses in its annual Greenhouse Gas Inventory. I think IPCC is now recommending 28 as of 2013.	Methods and Assumptions	Model	Input (including data sources)	As part of the next update of the LFGcost model, the EPA plans to retain the model's default GWP value of 25. In addition, the EPA will also update the model to allow users to enter an optional input for alternate GWP values. A GWP of 25 is consistent with the IPCC Fourth Assessment Report (AR4), 2007. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp. Further, retaining the use of the IPCC AR4 GWP of 25 for methane allows the LFGcost model to remain consistent with the use of IPCC AR4 GWP values by the annual national-level US GHG inventory submitted to the UNFCCC and emissions reported by large facilities and industrial suppliers to EPA's Greenhouse Gas Reporting Program. While the LFGcost model will retain a default GWP value of 25 for methane, updated estimates for methane GWP have been developed by the IPCC (2013). The most recent 100-year GWP estimates for methane range from 28 to 36.
11	A3	Barlaz	Page 16 – when discussing lifetime CO2 avoided – should the assumed energy grid mix be explicitly stated here? I see a default of 1.18 lb CO2/kwh. This number looks like the entire grid and not just the fossil fuel component. There is a lot of discussion in the LCA literature over appropriate values and I think some articulation of the logic for the approach would strengthen the document.	Methods and Assumptions	General	Input (including data sources)	The EPA plans to adjust the factor for avoided CO ₂ emissions as part of the next update of the LFGcost model. See the response to Comment ID 33.
12	A3	Stafford	Many of the input parameters are in areas beyond my area of expertise. However, I do think that those that deal with economics of the model (inflation, discounting, interest rate, etc.) are appropriate and adequately justified.	Methods and Assumptions	Model	Input (including data sources)	The EPA thanks the commenter for their feedback.

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13	A3	Shih	The default engine capacity factor of 93% seems too high. According to EIA, in 2011, the average capacity factor for generators at industrial CHP plants was only about 57%. (http://www.eia.gov/todayinenergy/detail.cfm?id=8250)	Methods and Assumptions	Model	Input (including data sources)	The average capacity factor for generators cited by the reviewer (www.eia.gov/todayinenergy/detail.cfm?id=8250) is for combined heat and power (CHP) plants, independent of fuel type, and is therefore not entirely relevant for LFG energy projects. For LFG, the gas is generated all the time at the landfill and the alternative to using it for energy is flaring it. Many LFG energy contracts include an offtake agreement for a specified amount of gas, and so it is different than CHP from a fossil fuel source. In addition, many LFG energy projects have a production tax credit incentive, which only pays when producing electricity. This incentive increases the fraction of time electricity is generated. Based on LFG industry experience, 93% is a typical fraction to account for limited cases of equipment downtime such as periodic maintenance. It does not represent the efficiency of the project. For these reasons, the EPA plans to continue using the default value of 93% in the LFGcost model for engine capacity.
14	A3	Shih	The assumption of one well per acre seems very restrictive. The number of extraction wells needed depends on the gas production, well size and density, and the size of the blower. Assuming a fixed gas production rate, the higher the well density, the smaller the size of the blower, and vice versa. Since the extraction well is one of the most expensive components, the developer could use a smaller well density and a bigger blower, instead of a higher well density and a smaller blower. There is a trade-off between the number of wells and the size of the blower. Building this relationship into the model would allow for the optimal choice of well density and blower size.	Methods and Assumptions	Model	Input (including data sources)	The LFGcost model's assumption of one well per acre is a relatively standard industry assumption for wellfield preliminary designs. The assumption was deemed to be appropriate based on the internal technical review of the model by reviewers who represented firms who design and build GCCS at landfills nationwide. In addition, a modeler could decide to increase or decrease the acres included in the cost model estimate to account for site-specific trade-offs. For example, a modeler may choose to enter 70 acres to cost out 70 wells over an 80-acre area. At this time, the EPA is not planning to modify the assumption in the model of one well per acre.

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15	A4	Barlaz	I think that for the purpose of an analysis of costs and benefits, the work is marginally adequate without the changes described above. I do think that the changes described above would result in a much more robust and defensible analysis but the benefit to cost ratio is well above 1 so I suspect that it will be greater than one even with these changes. There is an aspect of uncertainty that EPA has not considered and I think is important. Waste composition is changing rapidly and this is resulting in changes in the ultimate methane potential (L0) and the decay rate (k). The amount of fiber discarded in the waste stream has and continues to decrease and this is resulting in more food waste in the waste discards stream. This is a result of increasing fiber recycling and less fiber use. As a result, the overall MSW decay rate is increasing since food waste degrades faster than fiber. This has an effect on collection efficiency since food waste degrades faster, the implication of which is that fewer wells are in place while the food waste is decomposing. At the same time, on a wet weight basis, L0 is decreasing since food waste contains a lot of water and the degradable mass is relatively low. I understand that recognizing that these values are changing does not make it possible to recommend new values but I think EPA needs to point this out since the AP-42 defaults were derived in the 1990s. A manuscript that illustrates the significance of changes in waste composition is also attached. De la Cruz, F. B. and M. A. Barlaz, 2010, "Estimation of Waste Component Specific Landfill Decay Rates Using Laboratory-Scale Decomposition Data," Env. Sci. Technol., 44, 4722 - 28	Methods and Assumptions	Model	Approach (underlying calculations, etc.)	Currently the LFGcost model uses a gas generation modeling approach consistent with modeling in the MSW Landfill Rules, and as noted by the reviewer, based on the MSW Landfill AP-42 factors. The k-values included in the 'INP-OUT' sheet as examples are consistent with the range AP-42 defaults (0.02 for arid, 0.04 for non-arid, and 0.1 for bioreactors). A user can override the default and enter alternate values. Gas generation modeling parameters is a topic that more broadly affects the sector. At a future date, the EPA will consider whether to update the LFGcost model to reflect changing parameters impacting waste composition and methane generation as data allows.
16	A4	Shih	The EPA may want to incorporate the social benefit of methane offsets based on or using the social cost of carbon.	Methods and Assumptions	Model	Approach (underlying calculations, etc.)	The social cost of carbon and methane are beyond the scope of the LFGcost model. The regulatory impact analysis and the preamble for the MSW Landfills Rules address social cost of carbon and social cost of methane separately. The EPA will evaluate whether this feature should be included in the next significant update of the LFGcost model.

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17	A4	Shih	Based on our conversation with the LFGE project developer, for the electricity project, the developer/landfill owner is likely to be responsible for the cost of connecting an electricity generation unit to the power grid. The cost of grid connection could be substantial and is usually overlooked. This cost component is not currently available in the LFGCost model, but it something that the EPA might want to include.	Methods and Assumptions	Model	Approach (underlying calculations, etc.)	The cost of electrical interconnection to the grid is included in the LFGcost model calculations for electricity generating projects. The cost of interconnection is an average value of \$250,000 based on data available from recently developed projects. The EPA recognizes that the interconnection costs can vary based on individual power providers and circumstances.
18	A4	Shih	Some states have renewable energy policies such as production tax credits, investment tax credits and feed-in-tariffs, which could subsidize a LFGE project. It seems that the model has the capability to consider these policy instruments through the “Direct Credits” component. That is very good!	Methods and Assumptions	Model	Input (including data sources)	The EPA appreciates this feedback.
19	A4	Stafford	All [of my] suggestions [are]for modest improvements would not significantly change the working of the model or the primary results of the cost benefit analysis.	Methods and Assumptions	General	N/A	The EPA appreciates this feedback.
20	B1	Barlaz	I do find the appearance of the INP-OUT sheet to be rather busy and think the appearance could be improved. Even bigger fonts and wider rows would help. I would also move the text on the top of the INST sheet to the INP-OUT sheet, or repeat it there, and list the “12 required inputs” or color code these cells.	Functionality	Model	Format	The EPA intends to consider these usability improvements in a future update of the LFGcost model.
21	B1	Stafford	I think the spreadsheet is well set up for use by a novice user of excel. I particularly like the collection of the input parameters and key outputs on one page and the provision of the glossary of terms. I also like the transparency of the model so that one who is familiar with excel can see exactly how the estimates are developed.	Functionality	Model	Format	The EPA appreciates this feedback.
22	B1	Shih	This model is a valuable tool that provides a useful framework and guidance for landfill owners and LFGE project developers to estimate project-level costs.	Functionality	Model	General	The EPA appreciates this feedback.

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23	B1	Barlaz	Yes it does. I am using a Mac with Office 2011. I enabled macros and added the solver add-in. I nonetheless could not make the feature work where the model is to calculate the price required to break even on a project.	Functionality	Model	Operation	As part of the next update of the LFGcost model, the EPA plans to add a disclaimer about MAC compatibility in the 'INST' worksheet of the model, the comment in cell F27 of the 'INP-OUT' sheet, and the User's Manual. Due to resource constraints, the EPA does not have near-term plans to revise the model to be MAC compatible, but will evaluate options for MAC compatibility in the future.
24	B2	Shih	It seems that there is a bug in the energy project type of “Microturbine.” When changing the energy project type, but keeping all other inputs the same, I got a different design project size for Microturbine. Other energy project types all have the same numbers.	Functionality	Model	Operation	The EPA investigated this difference and determined that it was not an error. As stated in the 'INST' worksheet, the lifetime for microturbines is based on 10 years whereas the default lifetime for other project types is 15 years. As a result, the basis of the design flow to projects for microturbines (non-CHP applications) is based on the flow available over the 10-year project period instead of a 15-year project period. The EPA will review the model for clarity.
25	B2	Barlaz	I would like a disaggregated list of all the capital and O&M costs in the "REPORT" worksheet.	Functionality	Model	Outputs	At present, due to resource constraints, the EPA does not have near-term plans to provide a breakdown of capital and O&M costs in the 'REPORT' worksheet; further breakdown of project-specific costs will remain in the individual project worksheets.
26	B2	Shih	I would suggest that the model could consider quantifying the environmental benefit in monetary value using social cost of carbon and then reporting it in the environmental benefit section of the REPORT spreadsheet.	Functionality	Model	Output	Please see the response to Comment ID 16.
27	B2	Shih	Yes, the REPORT spreadsheet provides the estimated cost components in a clear manner.	Functionality	Model	Output	The EPA appreciates this feedback.
28	B2	Stafford	I think that the Report worksheet provides a nice, high level accounting of the costs and benefits for the inputted project. The RPT- Cashflow worksheet provides a useful breakdown by year and cost category. I also appreciate that one can get more detail by looking at the particular worksheet for each project type.	Functionality	Model	Outputs	The EPA appreciates this feedback.
29	B3	Barlaz	I find it overall to be a little clumsy. Everything is here but I would like a notice when I have input all the variables and am ready for a model run.	Functionality	Model	Format	The EPA intends to consider these usability improvements in a future significant update of the LFGcost model.

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30	B3	Shih	In the INST spreadsheet, please add “Back to the top” at the end of every table.	Functionality	Model	Format	As part of the next update of the LFGcost model, the EPA plans to add “Back to the top” at the end of each table.
31	B3	Stafford	Why is there an option to pick the GWP of methane – shouldn’t the IPCC number always be used, and if not, why would any user of this model need to change it? If the option to change the number remains, perhaps an explanation should be added to Appendix A as to why someone might choose the non-IPCC number.	Functionality	Model	Input (including data sources)	Please see the response to Comment ID 10.
32	B3	Stafford	I think it would be helpful to provide alternative energy product prices based on region or at least a link to a website where users could go to find better estimates for the energy costs for their particular area, given that differences in energy price can be quite large and may make a difference to the bottom line.	Functionality	Model	Input (including data sources)	As part of the next update of the LFGcost model, the EPA plans to add a new worksheet with regional electricity pricing for electricity market modules based on the U.S. DOE/EIA Annual Energy Outlook 2015 (AEO 2015) Reference Case.
33	B3	Stafford	I would like to see an option to change the “Total lifetime carbon dioxide from avoided energy generation” and “Average annual carbon dioxide from avoided energy generation” driver (Avg. U.S. Power emissions factor on the ENV sheet) for electricity projects – i.e. allow the user to input the fuel being replaced. One again, this may make a significant difference depending on where the project is located.	Functionality	Model	Input (including data sources)	As part of the next update of the LFGcost model, the EPA plans to add a new worksheet with regional CO ₂ grid offset factors, by electricity market module, based on the U.S. DOE/EIA Annual Energy Outlook 2015 (AEO 2015) Reference Case.
34	B3	Shih	In the WASTE spreadsheet, the program allows me to change the numbers, but doesn’t allow me to delete the numbers I have entered previously in the “waste-in-place” and “Annual Waste Acceptance” columns.	Functionality	Model	Operation	The "Waste-in-Place" column is a calculated value based on the values entered in the "Annual Waste Acceptance" column. Edits are not intended to be allowed in the "Waste-in-Place" column. The EPA was not able to re-create the error identified by the reviewer in the "Annual Waste Acceptance" column, as we are able to revise the values in this column without an error. The column does allow for blank values or any value greater than zero.

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35	B4	Barlaz	Yes, the model seems to conduct a reasonable level of error checking. Row 20: Why does the model only allow me to start an energy recovery project ten years after the landfill opened but not six years after? This is probably someplace in the User's Manual but not intuitive and seemingly erroneous. When I get the error message, ideally it would either refer me to an embedded pdf file with the information I need for the specific variable, or give me a pop-up box with the information on the variable I am having trouble with.	Functionality	Model	Operation	The LFGcost model restricts the project start year in cell C20 of the 'INP-OUT' worksheet to be between years 2010 and 2025. The warning message in cell C20 states that the project start year entered must be a whole number between 2010 and 2025. This validation is to protect the integrity of the estimated project cost output, which is based on recent project installation data. Projects built well into the future or costs for historical projects may have an additional uncertainty beyond the stated scope of this model.
36	B4	Stafford	The worksheet allowed me to do the following which I would think should not be possible: • Enter a landfill closure year earlier than the landfill opening year. • Enter a year for waste in place earlier than the landfill opening year. Otherwise the error checking is very well done.	Functionality	Model	Operation	Regarding adding error checking for the closure year to be later than the open year, in future model revisions, the EPA will evaluate adding such a restriction. Regarding the second bullet, the EPA could not replicate this error. The waste-in-place year column in the 'WASTE' worksheet is a calculated field based on the values entered in the 'INP-OUT' worksheet for year landfill opened. So the first row of waste acceptance will always equal the year the landfill opened according to the 'INP-OUT' worksheet.
37	B4	Shih	The model has done an excellent job in error checking. There are still some minor bugs, such as the one I mentioned above.	Functionality	Model	Operation	The EPA appreciates this feedback.
38	C1	Barlaz	Page 11 – “Acreage should represent area of landfill for gas collection to feed project, not total landfill area. Gas collection and flaring cost estimates represent a complete new system (costs for expansion of an existing system will be higher); inaccurate cost estimates may result for smaller landfill areas (<10 acres) due to economic infeasibility of designing and installing an entire new collection and flaring system.” I would expect costs for expansion of an existing system to be lower since some infrastructure is already in place.	Documentation	Documentation	Approach (underlying calculations, etc.)	Based on comments received during the 2014 internal technical review, there are additional costs associated with GCCS expansions, such as cover repairs or leachate management improvements that are not represented by the LFGcost model. As such, the wording on page 8 (page 11 of the .pdf) of the August 2014 User's Manual and the note in cell C8 of the 'INP-OUT' worksheet indicate that the costs are representative of new systems.

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39	C1	Barlaz	<u>Waste Burial Rate</u> I see on page 17 that the waste burial rate vary annually and the user can easily explore different rates. I think that this option should be mentioned earlier.	Documentation	Documentation	Diction	The waste acceptance rate calculator is mentioned on pages 3 and 14 (pages 6 and 17 of the .pdf) of the User's Manual (August 2014). The EPA will review the User's Manual for clarity.
40	C1	Stafford	The manual needs to clearly state at the beginning, and ideally as a disclaimer on all materials connected to the model, that some of the macros do not work in Microsoft Excel for Mac. (At least they did not work on any of the three Mac computers I tried with varying versions of MS Excel for Mac.) Otherwise I generally found the manual straightforward to use and it did walk me through the Excel spreadsheet in a nice way.	Documentation	Documentation	Operation	Please see the response to Comment ID 23.
41	C1	Shih	Yes, the User's Manual is very well written.	Documentation	Documentation	Diction	The EPA thanks the commenter for their feedback.

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42	C2	Stafford	I had the following questions about the assumptions/methodology when I read the manual. (Note that some of these questions were answered by looking at the spreadsheet, but I think they should be in the manual as well.): • What is the discount rate used to calculate NPV? (It should be upfront, not just in Appendix A since there is no reference to App A on page 4.) • I assume that the energy price escalation rates are increases in real prices. If so, I think that should be indicated as a naïve user may use nominal prices. If not, what inflation rate is used for energy prices, as that is not spelled out? (I would be troubled if there were a negative real energy price factor.) • Perhaps if I were a government entity using the model I would know why the inputs need to be adjusted as shown in Table D-1, but perhaps not. I think additional discussion as to why these changes need to be made and how a particular government owned project should be represented would be helpful. Other minor comments: • I think the definition offered for “Net present value at year of construction” is really bad. If I didn’t know what NPV was, this definition would certainly not make it any clearer. • I’m not sure the term “Net present value payback (years after operation begins)” is the correct one – I prefer “Years to Breakeven”.	Documentation	Documentation	Diction and Approach	> Discount Rate - The discount rate used to calculate NPV is the rate entered by the user in cell D46 of the 'INP-OUT' worksheet. The default discount rate is 8%, as detailed on page 11 (page 14 of the .pdf) of the August 2014 User's Manual, in addition to in Appendix A. In the model, the value of 8% is also discussed on the 'INST' worksheet and is entered as a default value on the 'INP-OUT' worksheet. As part of the next update of the LFGcost model, the EPA plans to add a mention of this on page 12 (page 15 of the .pdf) of the User's Manual. > Energy Price Escalation - The basis of the default escalation rate is real prices. The distinction of real vs. nominal is not explained anywhere in the LFGcost model nor documentation. As part of the next update of the LFGcost model, the EPA plans to add this discussion to the 'INST' worksheet in the model and to page 12 (page 15 of the .pdf) and Appendix A of the August 2014 User's Manual. > Table D-1 of User's Manual - The EPA will consider future ways to improve and clarify this section of the User's Manual. > Definition of Net Present Value - As part of the next update of the LFGcost model, the EPA intends to adjust the definition, consistent with EPA Guidelines, to be "The NPV is calculated as the present value of a stream of current and future benefits minus the present value of a stream of current and future costs." > Net present value payback (years after operation begins) - As part of the next update of the LFGcost model, the EPA plans to adjust the term to "Years to Breakeven" in the User's Manual and the model.
43	C2	Barlaz	Yes, the documentation clearly explains the assumptions and methodology incorporated in the model.	Documentation	Documentation	Approach (underlying calculations, etc.)	The EPA appreciates this feedback.
44	C2	Shih	The documentation clearly explains the assumptions and methodology incorporated in the model.	Documentation	Documentation	Approach (underlying calculations, etc.)	The EPA appreciates this feedback.

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45	C3	Shih	As mentioned earlier, there exists much uncertainly and variability in the gas production and economic cost parameters. Whenever possible, the model should provide uncertainty bounds/ranges for the model parameters, including those for gas production and cost.	Documentation	Documentation	Limitations (including issues of precision)	See response to Comment ID 5.
46	C3	Stafford	The uncertainty level is an issue. The manual states that the estimates provided have a ± 30-50 percent accuracy rate. It would be helpful to have more clarification on this. From the [6/16/14 background memo to Kirsten Cappel] we were sent, it is clear that the cost estimates are upperbound estimates. What might make the numbers underestimates? I think it would be helpful to know things that generally increase costs and things that decrease costs. Page 5 [of the User's Manual] does provide a short list, but could this be expanded on in an appendix? Given that region affects the estimates, can you provide anything about which regions will have higher/lower costs? I know that the model can't fully capture the magnitude of the range of costs, but just knowing directions would be helpful.	Documentation	Documentation	Limitations (including issues of precision)	As part of the next update of the LFGcost model, the EPA plans to provide additional detail in the User's Manual on items that affect the estimates.

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47	C3	Stafford	Given the uncertainty of the model, it's not clear to me why you allow the user to add a cost uncertainty factor of ± 20 percent. Since the underlying uncertainty ± 30 -50 percent, providing for calculations of ± 20 percent could make users think that they had fully captured the uncertainty by using that factor when in fact significant uncertainty remains. Would it make sense to present the ± 30 -50 percent numbers somewhere instead of allowing users to adjust by only ± 20 percent? At a minimum when this adjustment factor is presented in the manual I think you need to say something to reiterate the inherent uncertainty that already exists in the estimates.	Documentation	General	Limitations (including issues of precision)	As part of the next update of the LFGcost model, the EPA plans to remove the 'cost uncertainty' factor.
48	C3	Barlaz	The document does a reasonable job of documenting uncertainty. As noted elsewhere, I think uncertainty in k and L0 should be discussed.	Documentation	Documentation	Limitations (including issues of precision)	See response to Comment ID 15.
49	D1	Stafford	Second, when estimating which landfills will be able to reduce costs through electricity generation, the decision rule is pretty conservative, as it assumes a facility has to operate at capacity for 15 years even if operating at capacity for less than 50 years would be profitable. For example, a landfill in a region with a particularly high electricity buy back rate could be profitable if it operates at full capacity for only 10 years and partial capacity after that.	Application to Regulation	Documentation	Approach (underlying calculations, etc.)	The EPA agrees that project lifetime will vary by landfill. However, based on data available in the LMOP Landfill and LFG Energy Project Database as of February 2016, the EPA has concluded that a 15-year project lifetime is representative of the actual project lifetimes of reciprocating engine projects. For this reason, the EPA has retained this assumption in the final rule analysis.
50	D1	Stafford	Additionally, the write up [in the June 2015 memo] does not make it clear how electricity prices are modeled in the future – I assume that the default 1% energy price increase used in the model is also used in the cost-benefit analysis and that this is a real price increase.	Application to Regulation	Documentation	Approach (underlying calculations, etc.)	In the final rule analysis the EPA revised the approach for revenue from LFG electricity prices. For a detailed description of the changes made to revenue estimates, please see the docketed memo "Updated Methodology for Estimating Cost and Emission Impacts of MSW Landfill Regulations. ERG 2016."

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51	D1	Barlaz	As described elsewhere, I would modify the manner in which collection efficiency it treated. Specifically, allow it to vary with time and use values below 85% prior to final cover installation.	Application to Regulation	Documentation	Approach (underlying calculations, etc.)	While the EPA has not adopted an approach for variable collection efficiency in each year of the landfill operation, the final rule analysis adjusts the collection efficiency assumption to 85 percent. The 2016 Regulatory Impacts Analysis for the Final Revisions to the Emission Guidelines for Existing Sources and New Source Performance Standards in the Municipal Solid Waste Landfill Sector [available in the docket - EPA-HQ-OAR-2014-0451 (Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills) and EPA-HQ-OAR-2003-0215 (Standards of Performance for Municipal Solid Waste Landfills)] provides additional discussion regarding the basis of this change.
52	D1	Stafford	Overall the methodology for the cost analysis is straightforward and sensible. I do have a couple of minor comments on the approach. First, I wonder if the approach is not overly conservative. According to the 2014 memo provided to us [6/16/14 background memo to Kirsten Cappel], for each cost element the estimates were rounded up – often significantly (particularly when there were multiple components that were each rounded before being summed).	Application to Regulation	Documentation	Approach (underlying calculations, etc.)	Numbers that were used were vetted with industry experts to confirm the values were consistent with actual project costs. The EPA disagrees that the LFGcost model represents the upperbound costs. Values were estimated using the average of different project costs.
53	D1	Shih	The model focuses mostly on private costs. If feasible, EPA should consider and allow the modeling tool to account for the social costs and benefits in the regulatory analysis.	Application to Regulation	Documentation	Approach (underlying calculations, etc.)	The June 2015 memorandum (Draft- Updated Methodology for Estimating Cost and Emission Impacts of MSW Landfill Regulations) is limited to the discussion of control costs and emission reduction estimates. A separate set of documents outlines the procedures used to estimate the social cost of methane in the regulatory analysis. Please refer to the 2016 Regulatory Impacts Analysis for the Final Revisions to the Emission Guidelines for Existing Sources and New Source Performance Standards in the Municipal Solid Waste Landfill Sector located in the docket [EPA-HQ-OAR-2014-0451 (Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills) and EPA-HQ-OAR-2003-0215 (Standards of Performance for Municipal Solid Waste Landfills)].
54	D1	Shih	Reciprocating engines could potentially become a source of NOx emissions. To meet future NOx emission standards, the LFGcost model may want to include NOx control technologies and associated cost components to align with Clean Air Act regulations.	Application to Regulation	Documentation	Approach (underlying calculations, etc.)	The NOx emission standards are not regulated under the MSW Landfills NSPS or Emission Guidelines. Instead, NOx emission standards are regulated based on local and federal ambient air quality standards, in addition to NSPS or NESHAP rules specific to individual types of combustion equipment (i.e., 40 CFR Part 63 Subpart ZZZZ). The cost of those individual subparts are not assessed in the MSW Landfills Rules, but instead the other rulemakings that target NOx.

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55	D2	Stafford	I did wonder how the specifications for “future” landfills were developed. It would have been helpful to know more about those since presumably the details such as location, capacity and AWAR will drive the costs for those landfills.	Application to Regulation	Documentation	Approach (underlying calculations, etc.)	The methodology used to characterize future landfills is contained in another memorandum that was not provided as part of the peer review package. Refer to the docketed memorandum, "Summary of Updated Landfill Dataset Used in the Cost and Emission Impacts Analysis of Landfill Regulations," (Docket ID: EPA-HQ-OAR-2003-0215-0141).
56	D2	Barlaz	Why is it assumed that the “GCCS would collect all of the emitted gas”? 100% collection efficiency is very rare.	Application to Regulation	General	Approach (underlying calculations, etc.)	In the final rule analysis, the collection efficiency assumption has been adjusted from 100 percent to 85 percent. The 2016 Regulatory Impacts Analysis for the Final Revisions to the Emission Guidelines for Existing Sources and New Source Performance Standards in the Municipal Solid Waste Landfill Sector [available in the docket - EPA-HQ-OAR-2014-0451 (Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills) and EPA-HQ-OAR-2003-0215 (Standards of Performance for Municipal Solid Waste Landfills)] provides additional discussion regarding the basis of this change.
57	D2	Barlaz	Tax credits are not mentioned – perhaps this is intentional given the type of analysis but the reason they are excluded should be stated.	Application to Regulation	General	Approach (underlying calculations, etc.)	Every landfill's tax situation is unique. In addition, the ownership of LFG energy projects can vary, with some landfills owning a project directly while others selling gas rights to a third-party developer. Therefore, tax credits were not included in the regulatory analysis for the MSW Landfill Final Rules.
58	D2	Barlaz	Section 2.2: EPA refers to the model calculation as “emissions” when it is actually either “production” of “collectable gas” (a point of confusion in AP-42). I urge EPA to only use “emissions” for gas that is not collected and also to unambiguously clarify whether they consider the AP-42 defaults to be “production” (this is what everyone assumes in practice) or “collectable gas” (which is how the AP-42 defaults were derived).	Application to Regulation	General	Diction	The EPA has revised Section 2.2 of the final memorandum to refer to landfill gas production instead of the term "emissions" as suggested by the commenter. Regarding the reviewer's request for the EPA to clarify whether the AP-42 defaults are "collectable gas" or "production", the EPA notes that AP-42 revisions or interpretations are outside the scope of the LFGcost peer review.
59	D2	Barlaz	Equation 4b: Justify use of a 100 yr GWP of 25 with a citation.	Application to Regulation	General	Approach (underlying calculations, etc.)	The memo equation 4b referenced by the commenter was not edited to provide a justification for why a GWP of 25 was used as the basis of the analysis. The 2016 Regulatory Impacts Analysis for the Final Revisions to the Emission Guidelines for Existing Sources and New Source Performance Standards in the Municipal Solid Waste Landfill Sector [available in the docket - EPA-HQ-OAR-2014-0451 (Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills) and EPA-HQ-OAR-2003-0215 (Standards of Performance for Municipal Solid Waste Landfills)] provides a footnote indicating that this GWP value is consistent with the IPCC Fourth Assessment Report.

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60	D2	Barlaz	Section 3: Cost Equations It is stated that the % of design area filled would track the ratio of waste in place/design capacity. This is a rough approximation since new waste goes on top of old waste and at some point in the life of a landfill, a lot of waste is added to the pile with no additional acreage. An alternate approach would be to use a value of mass/acre which could be derived from the literature (See Camobreco et al, 1999, "Life-Cycle Inventory of a Modern Municipal Solid Waste Landfill," Waste Management and Research, 17, 6, p. 394 – 408.), or derive mass/acre from average density and average height.	Application to Regulation	General	Approach (underlying calculations, etc.)	The EPA is aware of vertical expansions and deeper cell constructions at landfills. However, given the data available for each landfill in the inventory, the EPA has retained its assumption to track the % design area filled with the ratio of waste-in-place to design capacity.
61	D2	Barlaz	Equation 6: I am surprised by the assumption of drilling to within 10' of the liner. I will defer to Cornerstone on this but every time that I have been associated with drilling activity, there has been a huge degree of caution about getting close to the liner and 20' seemed to be closer to the rule – at least double check with Cornerstone.	Application to Regulation	General	Approach (underlying calculations, etc.)	This assumption of well depth within 10 feet of waste depth was vetted through an internal technical review of engineers in a 2014 internal review of the model. The EPA intends to investigate this assumption as part of a future significant LFGcost model update. In the final regulatory analysis, the assumption of drilling within 10 feet of the waste depth will remain the basis of the regulatory costs for wells.
62	D2	Barlaz	Section 2.4: In the second line, the reference to Section 2.1 should be 2.2.	Application to Regulation	General	Diction	The EPA has corrected this section reference in the memorandum supporting the final regulations.
63	D2	Barlaz	Section 2.1: I think that this section could be clearer if written in words without the variable names. Basically, the user can enter annual tons disposed and allow it to vary, or assume a constant rate coupled with site lifetime. The text is hard to follow. Reviewer also states the following under charge question C1: "I found the description of the manner in which historical waste acceptance rate is calculated to be confusing. I think if it were rewritten without variable names in simple works it would be more comprehensible. (this is in reference to page 2 of the memo from Hilary Ward)"	Application to Regulation	General	Diction	This section has not been re-written as the EPA believes it is important to reference variables from the GHGRP dataset in order to assist readers with locating the raw data fields in the database that accompanies the final rules.
64	D2	Barlaz	Section 2.3: The idea to use NSPS values for the initial gas production and AP-42 values to determine when controls could be removed is very good.	Application to Regulation	General	Approach (underlying calculations, etc.)	The EPA appreciates this feedback.
65	D2	Shih	N/A - he references his comments for charge question D1	Application to Regulation	Documentation	General	No response needed.

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66	D3	Barlaz	To my knowledge, there are not are not other models that could be used in lieu of LFGCost-Web or could complement components of LFGCost-Web.	Application to Regulation	Documentation	General	The EPA appreciates this feedback.
67	D3	Shih	I am not aware of any models that could be used in lieu of or complement LFGCost.	Application to Regulation	Documentation	General	The EPA appreciates this feedback.
68	D3	Stafford	I'm not aware of other models that could be used in lieu of LFGCost-Web or that could complement components of LFGCost-Web.	Application to Regulation	Documentation	General	The EPA appreciates this feedback.
69	General	Barlaz	Overall, I think that the report and documentation are very well done. A lot of thought has gone into the model to make it comprehensive. A strength of this activity is that a consulting firm with real world project experience (Cornerstone) was involved in developing the cost data.	Overall Assessment	General	General	The EPA appreciates this feedback.
70	Other	Barlaz	Page 3 of October 2015 LFG Overview paper– I am surprised by the statement that if a landfill is deep, collection costs tend to be higher. The actual cost might be higher but I would expect you collect more gas per well as a deeper landfill. It seems to me that the proper way to analyze this is \$/cubic foot of gas recovered and I am not sure that this analysis was done before making the statement.	Documentation	Other	Approach (underlying calculations, etc.)	The statement (“if a landfill is deep, collection costs tend to be higher”) is referring to the fact that well drilling costs are a function of well depth. Deeper landfills will have higher drilling costs because they are a function of well depth.

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71	Other	Barlaz	<u>Comments on Table 1 of 6/16/14 background memo to Kirsten Cappel.</u> Knockout, Blower and Flare system – I am surprised that EPA did not specify 2-3 systems and ask a vendor for a quote to make this more accurate. Vertical gas extraction wells – specify this is the cost to drill for clarity.	Documentation	Other	Approach and Diction	Regarding the costs for the Knockout, Blower, and Flare system, the costs were not updated in 2014 due to limited installation data from the engineering contractor in recent years. However, the costs do reflect data from vendors for seven different collection and flaring systems that were obtained during the 2009 LFGcost model updates. During the 2014 internal technical review of the LFGcost model, which was conducted by other LFG energy project engineering firms, the collection and flare cost data were still deemed to be representative of actual collection and flaring system costs. For these reasons, the EPA is not making changes to the basis of these costs at this time. Regarding the cost per linear foot, the cost is not just drilling of the wells; rather, it includes the pipe and other materials and labor involved with installing vertical extraction wells.
72	Other	Barlaz	<u>Comments on Table 3 of 6/16/14 background memo to Kirsten Cappel.</u> Is the \$2600/well the annual cost to operate, tune and maintain each well? Text to define “Collection” would be useful.	Documentation	Other	Approach and Diction	This comment refers to a historical background internal memorandum. As part of the next update of the LFGcost model, the EPA plans to edit the User's Manual to provide details on what the O&M costs of the wells cover.