



Comments and Responses to Anaerobic Digester Study

PacifiCorp received comments related to the “Anaerobic Digesters Resource Assessment” study prepared by Harris Group, INC. The study can be found on PacifiCorp’s website at the following location:

<http://www.pacificorp.com/es/irp/irpsupport.html>

We’d like to thank the commentators for taking the time and effort to review the study and provide valuable feedback. Below we have incorporated the statements from the Feedback form prepared by Peter Moulton of the Washington Department of Commerce (in concert with others) as well as the associated responses prepared by PacifiCorp and the Harris Group.

Comment: Manure volumes referenced in assessment appear to reflect average herd size of 60 selected dairies, but the actual assumed herd size (number of head) is not shown in the production estimates.

Response: *The study relied on information from the Washington Department of Agriculture and Ecology in looking at Washington dairies within PacifiCorp’s service territory. The State of Washington does not provide specific herd sizes, but rather ranges. It is our understanding that individual herd sizes by dairy are considered confidential by the dairies.*

Comment: The report uses information about the dairy industry from the 2011 WSDA report, summarizing 2010 registration data. Since then, dairies, on average, have gotten larger. Registration data for 2012 shows the total number of dairies decreased by 28 (from 443 to 415). By size, small- and medium-sized dairies declined by 18 and 13 respectively; the number of large dairies increased by 3. USDA reports that Washington’s total annual milk production increased 7% between 2010 and 2013. This may not be worth more than a footnote as, for the actual analysis, Harris Group used data from the 2012 registration that they requested from WSDA in spring of 2014.

Response: *The analysis was performed on the basis of the data provided by the State of Washington. While the changes noted above may make some projects potentially more economic, it would have a limited impact on the overall electric power generation potential which was the underlying objective of the study.*

Comment: There is no sensitivity analysis demonstrating improved economics of scale for larger operations, many of which are in PacifiCorp’s service territory.

Response: *We agree that larger operations would likely be more attractive economically. However the study was not a farm specific study, but an estimate of total electric power production.*

Comment: Assumes digesters are associated with individual farms, there is no discussion of opportunities to develop digesters serving a number of nearby or adjacent farms. Of the eight commercial dairy digesters in Washington, four digest manure from more than one dairy operation.

Response: *We agree that projects based on larger farms and/or agglomerated operations from multiple farms would have more compelling economics. However, as previously noted, this was not a farm specific study.*

Comment: There are occasional references to the benefits of co-digestion with additional substrates, and resulting improvements in biogas generation, but the model assumes low-cost substrates would only come from distant urban centers and that rural substrates are already committed to animal feed. Therefore, the model only uses manure and precludes substrates that may be readily available from food processing operations and other sources in relatively close proximity.

Response: *It is accurate that the addition of other bio-materials that could boost biogas production may be available, especially in the northern part of the state which is more densely populated. These co-use applications may result in improved economics of specific projects depending on the availability, quantity, transportation cost and composition of these materials. The addition of other materials would be a consideration for individual project evaluations. It should be noted that the addition of other materials contributes to additional nutrient loading which may be at cross purposes with other environmental objectives.*

Comment: The assessment points out the difficulty of realizing any economic return on a manure-only CHP model, but many creative approaches to other value-added revenue streams exist which can often make a digester more economically viable.

Response: *Agreed, please see the responses to the prior set of comments. Sales of byproducts, agglomeration of dairy operations and co-digestion of other materials are options to be considered in evaluating projects. Value-added revenue streams were outside the scope of this study.*

Comment: The Climate Trust data regarding GHG emissions only applies to carbon credits, which capture only a fraction of total avoided methane emissions. Missing are CO₂ reductions from fuel displacement and NO_x reductions from application of nutrients to agricultural lands.

Response: *CO₂ reductions from fuel displacement can be addressed by avoided emissions from future resource operating scenarios. NO_x reductions from application of nutrients to agricultural lands would occur, but are estimated to be minimal.*

Comment: OPEX assumptions of 9 cents/kWh are too high. Multi-year data from a complex digester operation in Idaho shows OPEX of 6.9 cents/kWh. A recent WSU study of actual O&M costs for traditional digesters in Washington State found OPEX of 4 cents/kWh.

Response: *We concur with that conclusion regarding OPEX. The data presented in Table 6-1 (in 2007\$) indicates that the O&M (OPEX) without annualized capital costs ranges from \$9.74 to \$12.79 per 1000 kWh (or \$0.00974/kWh to \$0.01274/kWh). The following table indicates the estimated levelized energy cost based on assumed capital costs ranging from \$3,500 and \$4,500 per kilowatt installed.*



ANAEROBIC DIGESTER - LEVELIZED COST OF ENERGY				
Assumptions				
Annual Capacity Factor	90%			
Escalation Rate, Annual	2%			
Nominal Levelized Fixed Charge Rate	9.495%	25 year book life, 5 year tax life		
Nominal O&M Levelization Factor	1.20	25 Years, 2%/year; Discount rate: 6.66%		
	<i>Expected</i>	<i>High</i>	<i>Notes</i>	
	<i>Large Operation</i>	<i>Small Operation</i>		
Capital Cost, \$/kW	\$ 3,500	\$ 4,500	Excludes interconnection costs	
O&M Costs, 2007\$, \$/MWh	\$ 5.82	\$ 12.79	NRCS Note 1, Table 1, page 3	
O&M Costs, 2014\$, \$/MWh	\$ 6.69	\$ 14.69	Escalated NRCS costs	
Nominal Levelized Cost of Energy (LCOE)				
Capital Cost, \$/kW		\$ 3,500	\$ 4,500	
Cost of Energy, Capital, \$/MWh		\$ 42.15	\$ 54.20	
O&M Costs, 2014\$, \$/MWh	<i>Low</i>	\$ 6.69	\$ 6.69	
O&M Costs, 2014\$, \$/MWh	<i>High</i>	\$ 14.69	\$ 14.69	
O&M Costs, Levelized, \$/MWh	<i>Low</i>	\$ 8.02	\$ 8.02	
O&M Costs, Levelized, \$/MWh	<i>High</i>	\$ 17.63	\$ 17.63	
Total Nominal LCOE		\$ 50.17	\$ 62.22	
		\$ 59.78	\$ 71.83	
		Low	High	
Estimated LCOE Range		\$ 50.2	\$ 71.8	

Comment: The assessment mislabels costs cited in an NRCS report concerning the cost of producing electricity. The data included both annualized CAPEX and OPEX. The business plan prepared by WSU for the DeRuyter digester in PacifiCorp service territory found the baseline cost of electrical production to be 3.3 cents/kWh. A study by the Washington State Housing Finance Commission projected a cost of 2.8 cents/kWh.

Response: Capital costs in the range of \$3,000 (to \$5,000) per installed kW would result in higher costs of energy than 2.8 to 3.3 cents per kWh.

Comment: The assessment projects CAPEX of \$3,000-3,500 per installed kW. This figure is probably closer to \$4,000-5,000, or \$1,370 per cow, since gen-sets, interconnection equipment, buildings, fiber separation and collection equipment, substrate pits, and gas conditioning equipment are all essential components of digester operation. In addition, digester gen-sets are often oversized due to expectations about future feedstocks and increased herd size.

Response: Capital costs may be higher, depending on the specifics of the project. However, capital costs in the range of \$4,000-\$5,000 per installed kW would decrease the economic feasibility of this resource type.

Comment: The assessment fails to recognize the value of digesters as sources of baseload power.

Response: *The study objective was to prepare an estimate of the quantity, general performance, and cost of resources based on bovine fueled and anaerobic digesters. The estimated capacity factor of the generating equipment of 90% illustrates its potential as a baseload resource.*

Comment: A 60% manure collection rate is assumed since most farms are open lots, but there are also tie-stall barn operations with collection rates closer to 90%.

Response: *Anaerobic digester projects are more likely to be economic for larger farms which are typically open lots. For these it is common practice to assume a 60% manure collection rate. Tie-stall barns, and their potential higher collection rates, are more common for smaller dairy operations.*

Comment: Assumes 90% average run time for gen-sets, though a recent study of all 12 Andgar digesters (including nearly all digesters in Washington State) found 94-95% average run time.

Response: *The average run time of a digester is not equivalent to the capacity factor. An overall capacity factor of 90% is proposed as the overall performance level taking into account all the various components in the system.*

Comment: The assessment fails to distinguish between regular plug-flow and mixed plug-flow digesters.

Response: *The digester technology type did not impact the bio-gas flow generation rate which was assumed to be the same.*

Comment: The biogas composition lists nitrogen as N₂. It may be more appropriate to reflect nitrogen as ammonia gas.

Response: *Comment noted.*