



Anaerobic Digestion Capital Costs for Dairy Farms

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The cost of anaerobic digestion (AD) of dairy cattle manure for biogas production and utilization will vary with system type and size, type of livestock operation, and site-specific conditions. While as-built costs generally are not available, AgSTAR has analyzed vendor quotes to provide this preliminary guidance on estimating capital costs.

AgSTAR analyzed AD system capital cost data for 28 dairy farms for which itemized cost estimates were available. The 28 AD systems included 10 complete mix digesters, 16 plug flow digesters, and 2 covered lagoons. Included in the capital cost for each system was the cost of the digester, the engine-generator set, engineering design, and installation. The costs are based on quotes for systems in 2005-2008. Systems designed for co-digestion with other wastes were excluded from our analyses.

Table 1. Equations for estimating complete mix and plug flow AD system capital costs (August 2008 \$)

Digester Type	Capital Cost	Capital Cost Per Dairy Cow
Complete Mix (700 – 2,300 head)	Capital Cost (\$) = (615)(Number of Dairy Cows) + 354,866	Capital Cost (\$/dairy cow) = (12,331)(Number of Dairy Cows) ^{-0.362}
Plug Flow (650 – 4,000 head)	Capital Cost (\$) = (563)(Number of Dairy Cows) + 678,064	Capital Cost (\$/dairy cow) = (12,960)(Number of Dairy Cows) ^{-0.332}

One factor that introduces variability in the reported costs of digesters is that not all reported costs include the same equipment. To analyze costs on a common basis, we excluded costs of system components that were not included in all of the available cost estimates. These components were post-digestion solids separation, hydrogen sulfide reduction systems, and utility charges including line upgrades and interconnection equipment costs and fees. With the aforementioned items excluded,

the remaining capital costs were then scaled to August 2008 dollars using the Chemical Engineering Plant Cost Index.¹

Using SAS 9.1, regression analyses were performed for the complete mix and plug flow AD system capital costs versus the number of dairy cows (*Figure 1*). The resulting linear regression equations were then used to estimate the capital costs per dairy cow (*Figure 2*). The equations to estimate total capital costs and capital costs per dairy cow are summarized in *Table 1*.

Sufficient cost data to perform a regression analysis for covered lagoons were not available. However, cost data for two dairies are summarized in *Table 2*.

Table 2. Covered lagoon AD system capital costs for two dairy farms (August 2008 \$)

Number of Dairy Cows	Capital Cost	Capital Cost Per Dairy Cow
496	\$798,699	\$1,610
1,600	\$1,241,395	\$776

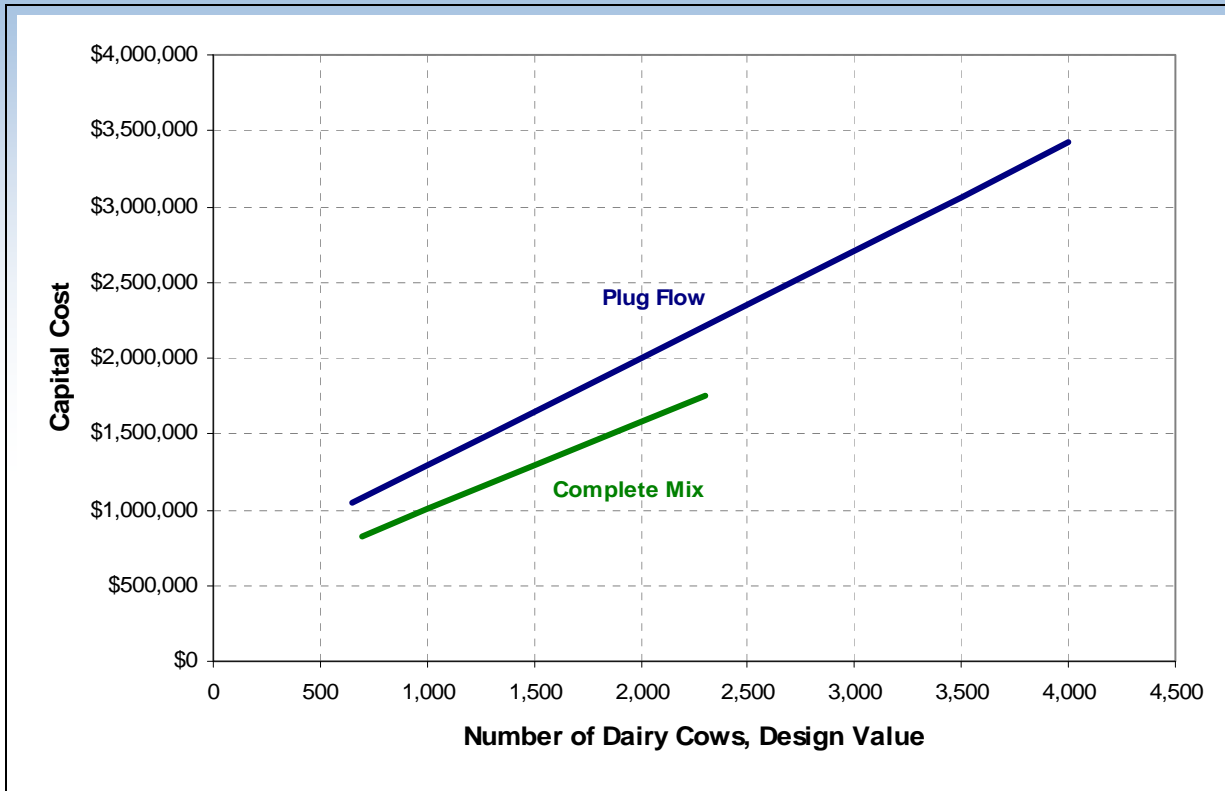
In addition to the digester and engine-generator set, other equipment costs that may be necessary for an economically successful biogas project are shown in *Table 3*. These costs are expressed as a percentage of total capital costs, and were estimated from vendor estimates for the 28 farms.

Table 3. Costs of ancillary equipment

Project Cost Component	Percentage of Total Project Capital Cost
Post-Digestion Solids Separation System	Mean: 6.9% Range: 1.6% - 12.0%
Hydrogen Sulfide Treatment	Mean: 2.7% Range: 0.25% - 4.5%
Estimated Utility Charges	Mean: 7.9% Range: 2.5% - 14%

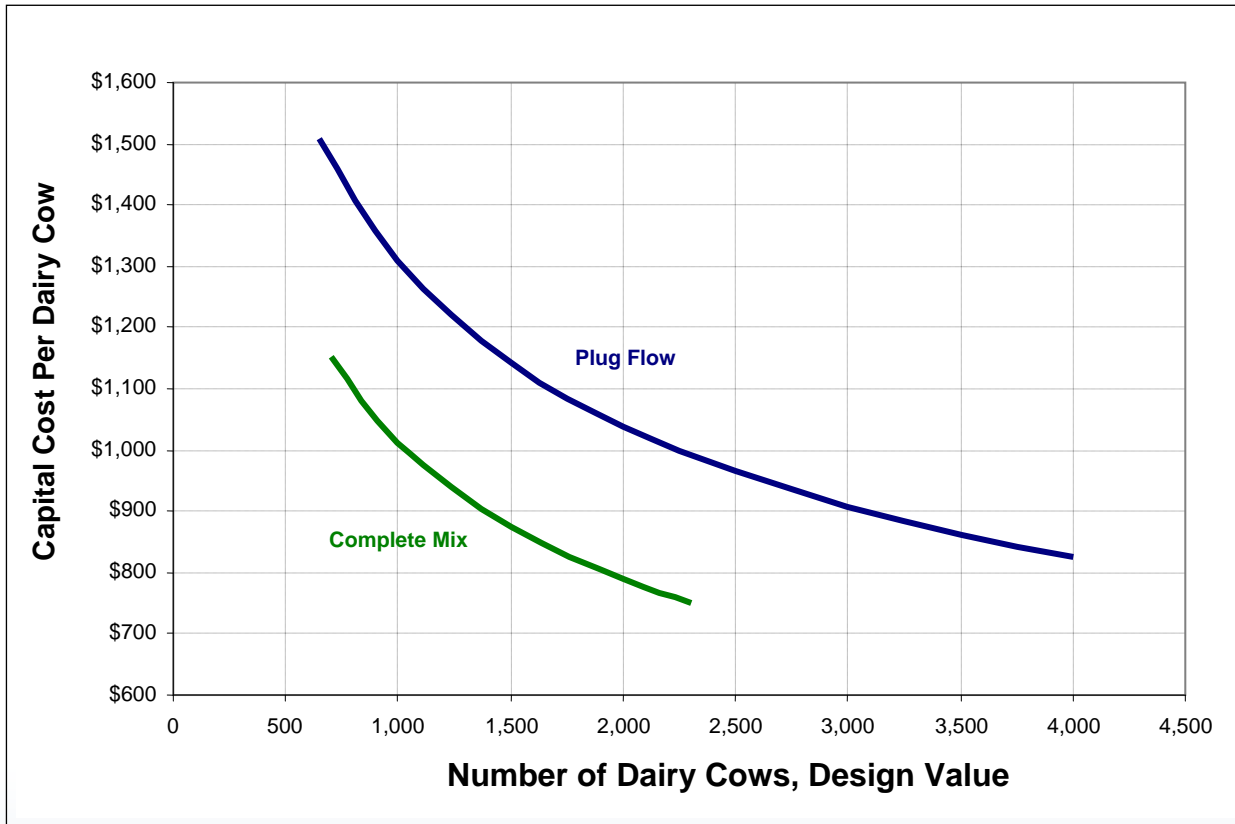
¹ *Chemical Engineering*, Vol. 115, No. 9, Sept. 2008

Figure 1. Total capital cost of complete mix and plug flow AD systems



Costs are stated in August 2008 dollars.

Figure 2. Capital cost per dairy cow for complete mix and plug flow AD systems



Costs are stated in August 2008 dollars.

