



## **Bion's Comprehensive Waste Management System vs. Anaerobic Digestion**

Bion's comprehensive environmental management system and anaerobic digestion (AD) rely on fundamentally different approaches for the treatment of livestock manure. While both are capable of generating renewable energy, the physical, chemical and biological characteristics of the two approaches to generating that energy differ greatly. From a biomass-to-energy perspective, Bion's system recovers approximately three times more energy per animal than AD.

Moreover, Bion's technology provides comprehensive treatment of the waste stream to achieve substantial reductions of nitrogen and phosphorous in the liquid effluent and air emissions control including ammonia, odors and greenhouse gasses. AD provides virtually no reductions in effluent nutrients and comparatively limited reductions of air emissions. As such, AD does not support increased herd concentrations.

**Anaerobic digestion** has been used to produce energy from livestock waste since the late 1800's via a biological process that produces biogas (which generally contains around 60% methane). Depending on process design and operation, AD may provide between 25,000 and 30,000 Btu per dairy cow per day. In most instances, the gas is combusted in a turbine or internal combustion engine to produce electricity that is used on-farm, with excess sold to the local power grid at wholesale (or base generation) prices (typically in the range of 2 - 3¢ kWh).

The efficiencies and economics of AD energy production are such that grant money is normally required to offset much of the installation cost combined with ongoing renewable energy subsidies and credits available at the federal and (many) state levels.

The AD process is focused on energy production and provides negligible net reductions in nitrogen or phosphorous in the effluent. AD in fact increases nutrient solubility, making them more readily available and thus increases their potential for runoff to surface water or leaching to groundwater after the effluent is applied to the land compared to the raw manure feedstock. Similarly, AD provides no reduction of (and may actually increase) ammonia emissions that have been shown in sufficient concentrations to cause health problems, as well as contribute to downwind nutrient loading through re-deposition of nitrogen. AD does provide reductions of greenhouse gases, hydrogen sulfide, VOCs and odors, but these reductions are overall rather small compared to the control provided by Bion's technology.

With adequate subsidy, AD provides a biomass to energy solution in locations where there is sufficient local acreage to spread nutrients and where ammonia emissions are not a concern. Because AD does not provide meaningful nutrient control but only offers limited environmental benefits across other media, the technology neither supports permitting new high-density operations nor does it represent a solution to existing farms that need to reduce excess nutrients or air emissions.

**Bion's comprehensive environmental management system** utilizes a combination of mechanical and patented biological processes to produce a cellulose-based solid fuel that reclaims approximately 70,000 Btu per dairy cow per day. This fuel may then be used to provide thermal energy to a steam boiler, replacing the use of natural gas at full retail / commercial rates. However, Bion anticipates near-term technology developments in biomass-to-liquids conversion processes that will deliver greater value through conversion to transportation fuels.

Bion anticipates that renewable energy subsidies, credits and other incentives, consistent with those available for farm-based renewable energy technologies such as AD, as well as wind, solar, and other alternative energy technologies, will also be available for Bion's system.

The key difference between Bion's technology and AD is that Bion's primary focus is on the reduction of environmental impacts to both air and water from livestock waste. Bion's process reduces nutrients in the effluent between 70 and 95%+, depending on the level of treatment desired, while significantly decreasing the percentage of soluble nutrients that remain in the effluent. Bion's technology also reduces ammonia emissions greater than 90% and provides substantially greater reductions than AD for hydrogen sulfide, greenhouse gases, VOC's, and other emissions including odors.

Bion's technology reclaims two and a half times the amount of renewable energy as AD on a net usable basis. Moreover, Bion's system represents the only technology that can provide verifiable data to support its reductions of nutrients and air emissions. By significantly reducing the environmental impacts of livestock operations, Bion enables the development of sustainable large scale livestock facilities that maximize resource and operational efficiencies that can be permitted in non-traditional locations to capitalize on market, processing and / or feedstock proximity.

**See Tables below for comparison data**

## Comparison of Anaerobic Digestion & Bion's Comprehensive Environmental Management System Characteristics

Attributes		Anaerobic Digestion	Bion's Comprehensive System	Comments
Energy Characteristics	Net available energy for external use (Btu per dairy cow per day)	25,000 – 30,000 based on 44 ft <sup>3</sup> per cow per day of methane	~70,000 based upon energy content of captured coarse solids	Bion energy production based upon combustion of large % of total solids vs. AD system destruction of small % of volatile solids

Attributes		Anaerobic Digestion	Bion's Comprehensive System	Comments
Environmental Characteristics: Effluent Nutrients	Nitrogen	<ul style="list-style-type: none"> <li>- No net reduction</li> <li>- Increase in solubility results in <b>65% - 70%</b> of N load released to lagoon in dissolved (mostly ammonia) form</li> </ul>	<ul style="list-style-type: none"> <li>- <b>&gt;70%</b> removal of N from waste stream</li> <li>- Decrease in solubility results in approximately <b>10%</b> of N load released to lagoon in dissolved form</li> </ul>	Excessive nitrogen in the environment has been shown to degrade surface and ground water quality, impact human health, and create greenhouse gas emissions. Re-deposition polluting nearby surface waters.
	Phosphorus	<ul style="list-style-type: none"> <li>- No net reduction</li> <li>- Increase in solubility results in <b>65% - 70%</b> of P load released to lagoon in dissolved form</li> </ul>	<ul style="list-style-type: none"> <li><b>&gt;75%</b> removal of P from waste stream</li> <li>- Decrease in solubility results in approximately <b>5%</b> of P load released to lagoon in dissolved form</li> </ul>	Absent the removal of excessive P, harmful pollution from CAFOs will continue to impact surface waters - highly mobile dissolved P is more prone to runoff than particulate forms (same for N)

Attributes		Anaerobic Digestion	Bion's Comprehensive System	Comments
Environmental Characteristics: Air Emissions	<b>Odor Reduction</b> (compared to a typical dairy anaerobic lagoon system)	Good odor control	Excellent odor control	Bion's comprehensive environmental management systems generate significantly higher reductions in odor causing compounds
	<b>GHG / Methane</b> (annual tons of GHG credits – IPPC - Kyoto protocols)	<b>2-4</b> GHG credits generated on average per cow annually	<b>3-5</b> GHG credits generated on average per cow annually, with <b>7+</b> GHG credits/cow when displacing fossil fuel use	Bion systems generate more GHG credits per cow based on increased volatile solids utilization efficiency.
	<b>Ammonia</b> (compared to a typical dairy anaerobic lagoon system)	Increase in solubility results in <b>65% - 70%</b> of N load released to lagoon in dissolved (mostly ammonia) form	<b>95 - 99%</b> reduction in emissions	Increased ammonia / ammonium percentage may increase the potential for ammonia air emissions. Ammonia is highly volatile; it readily reacts in the atmosphere to form ammonium nitrate and is re-deposited in dry form as PM <sub>2.5</sub> or wet deposited in a soluble form. Bion's protocols to determine nutrient credits for ammonia reductions in the Chesapeake Bay watershed were recently accepted by the Pennsylvania DEP.
	<b>Hydrogen Sulfide</b> (compared to a typical anaerobic lagoon)	<b>30 to 40%</b> reduction	<b>&gt;80%</b> reduction in emissions	H <sub>2</sub> S and ammonia are two of the primary odor causing compounds released from CAFOs.
	<b>VOC's</b> (compared to a typical dairy anaerobic lagoon system)	<b>30 to 40%</b> reduction	<b>&gt;55%</b> reduction	VOC's can potentially contribute substantially to odor generation and many react in the atmosphere to create ground level ozone.