

## **Cow2Joules: Distributed Conversion of Organic Waste to Energy Resources**

Background to the project THEY are undertaking at ESF – DLJohnson, Feb. 2009

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The carbon-recycling project aims to enhance the implementation of anaerobic digestion (AD) techniques for the conversion of biomass-related organic waste materials to useful energy products. This approach to industrial ecology, or sustainability, is well advanced in Europe where large-scale biogas plants have been constructed to extract energy from residential, agricultural and industrial organic wastes<sup>1</sup>. While anaerobic digesters have been key components in the treatment of municipal wastewater streams for more than a century, their application to other organic waste feed stocks in the United States has not been widespread. For instance, according to EPA estimates<sup>2</sup>, about 25% of all food prepared in the US is wasted. This amounts to some 50 million tons, or about 12.5% of the municipal solid waste generated each year; most of it is diverted to landfills. Additionally, only a fraction of the more than one billion tons of animal waste produced annually<sup>3</sup> in the US is processed for methane recovery by anaerobic digestion; where such systems exist they are of intermediate size (100 to 10,000 cubic meters methane per day) like that in operation at SUNY Morrisville<sup>4</sup>. If suitably designed and adapted, small scale AD facilities for waste biomass could be deployed at the community level in support of sustainability efforts. The research and development program being initiated targets residential, institutional and commercial restaurant food waste supplies, offering an alternative to the composting, incineration or land filling disposal options that are currently employed.

Anaerobic digestion is a complex biochemical process that requires three different types of bacteria working together; 1) hydrolytic bacteria liquefy insoluble organic materials, 2) acidophilic species generate volatile fatty acids by fermentation, and 3) methanogenic organisms (obligate anaerobes) make methane from the acids, and from hydrogen and carbon dioxide. The three groups of bacteria, each containing several species, grow at different rates and have various nutritional requirements -- the overall process is a delicate balance. "The formation of methane is only maintained as long as all the bacterial consortia involved in the chain are working under optimal conditions. Some of the degradation steps will not yield energy unless the next group of bacteria efficiently removes their products... As a consequence, there are few parameters which allow the process to be controlled".<sup>5</sup> Basically, these are limited to temperature, hydraulic retention time (HRT) and organic loading rate (OLR); the dynamic steady state of biochemical transformation rates requires constant conditions for most stable operation. Thus, anaerobic digester configurations exhibit great variety of design in order to achieve the optimum performance associated with each specific type of organic feedstock, (chemical composition and physical form), waste management goal, and potential use of treatment by-products; facilities are built from "design to need" specifications. We are exploring several configurations of digesters for simple, stable, small-scale operations.

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<sup>1</sup> <http://www.iea-biogas.net/>

<sup>2</sup> <http://www.epa.gov/epawaste/conservation/materials/organics/food/fd-basic.htm>

<sup>3</sup> <http://www.ncifap.org/issues/environment/>

<sup>4</sup> <http://www.morrisville.edu/alternativeenergy/methanedigester.aspx>

<sup>5</sup> Arthur Wellinger (unpublished) <http://homepage2.nifty.com/biogas/cnt/refdoc/whrefdoc/d14prdg.pdf>