Atlantic Swine Research Partnership Inc.

Canadian Pork Council / Conseil canadien du porc

Nova Scotia Agricultural College

fact sheet

# On-Farm Anaerobic Digestion For Swine Operations

## Introduction

Anaerobic digestion (AD) technology has received a great deal of attention in recent years as a means of generating energy on farm, reduce greenhouse gas emissions and as a means of odour control. Historically, only a small portion of livestock operators have justified the capital costs associated with AD technology. Therefore, the agriculture industry has not been witness to its widespread adoption. Digestion technology can provide significant benefits to the farm and under the right federal and provincial policy conditions, AD systems may provide adequate return of investment to warrant its adoption.

An AD system can greatly reduce environmental risks associated with managing liquid swine manure. Although there is no accepted standard for assigning a dollar value to the benefits associated with digestion, a number of social benefits do exist and include:

Anaerobic digestion system on 170 sow farrow-to-finish operation in Sherbrooke, QC

(i) elimination of objectionable manure odours ;
(ii) significantly reduced pathogen levels;
(iii) recovered biogas can produce space heat, hot water, cooling, or electricity;
(iv) manure nutrients become more concentrated and more readily plant available; and
(v) production of greenhouse gases are significantly reduced

### Anaerobic Digestion Basics

Throughout the 1970's energy crisis, numerous AD systems were installed on farms across North America. The majority of these systems failed. It is generally accepted that these systems were designed to be too intricate, requiring far more management and expertise than producers were willing to invest.

Current systems require less management and can be fitted to monitor processes from remote locations. Most new AD systems designed for hog operations are classified as *complete mix digesters.* These digesters are well suited for our cool climate and for liquid manure as they are subjected to constant agitation maximizing contact between methane producing bacteria and manure carbon. They generally include: a pre-mix tank; a digester tank and mixing unit; digester heating; a biogas recovery system; post-digestion manure storage; and a biogas utilization system.

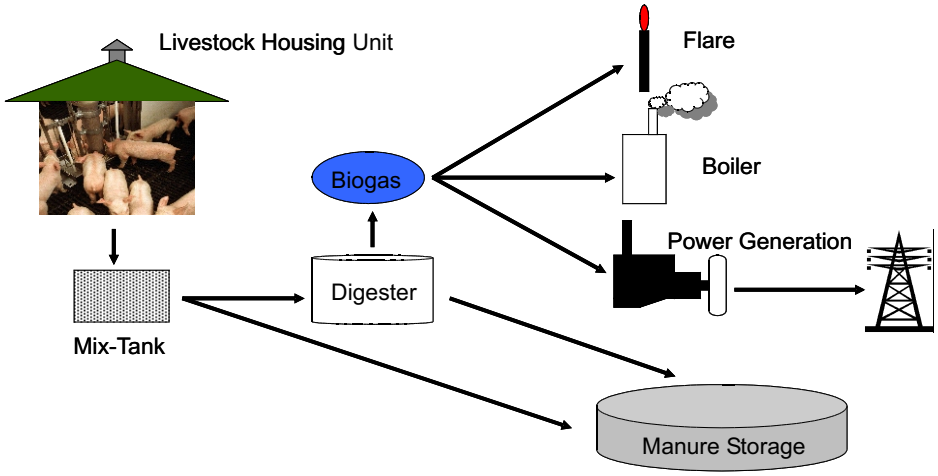
A recent feasibility study conducted in New Brunswick on a hog operation identified a number of challenges to implementing a biogas production system. Challenges included: excess water use; incompatibility of the existing deep-pit barn manure storage system for the storage of post digestion manure; logistical problems limiting on-farm use of heat and power produced; and policy difficulties exporting power off-farm in New Brunswick.

## Farm Management Considerations

Farm water use has a direct effect on manure volume and should be considered for digester feasibility as it is a key variable controlling the cost of a digester. For example, reducing manure water allows for reduced digester sizing. A higher manure solids content requires less heat energy input for maintaining digester temperature, and volumes to be stored and land-applied following digestion are reduced. Options for controlling excessive farm water use include installing water meters to determine the volume of water consumed for various barn uses, installing water conserving drinker systems, using wet/dry feeders to minimize water consumption, using low crude protein diets, and implementing appropriate wash water management strategies for the farm including efficient low-flow rate, high pressure wash nozzles.

For effective digester performance, manure handling systems should allow for frequent removal of manure from the barn to a pre-mix tank to reduce the loss of biogas production potential of the manure. Facilities having deep pit barns do not allow for frequent removal, and require additional post-digestion storage which significantly increases the cost of a digestion system for deep-pit barns. If possible, the pre-mix tank should be sited to allow for gravity feeding of the digester. Ideal placement of the digester tank is between the barn and the end storage although this may not always be feasible considering existing infrastructure. A covered manure storage should be considered to reduce post-digestion ammonia volatilization, to facilitate odour control and exclude rainwater from the system.

Most complete mix digesters are heated to maximize the activity of methane producing bacteria and biogas yield. The digester tank should be adequately insulated and can be heated using recovered engine heat if biogas is used for electrical power generation, or a portion of the biogas can be diverted to a boiler system, heating water to maintain an




Schematic of a typical on-farm AD system.

appropriate digester temperature. Cogeneration heat and power (CHP) equipment should be situated to minimize the distance between the heat recovery system and the farm's heat uses to maximize operational efficiency. Digesters, as well as hog production facilities require different levels of heat input in summer and in winter which must be considered in the system design. Ideally, any surplus heat could be used on-site or sold in close proximity to the digester.

The system design should allow for gas production to be entirely converted to heat or electricity, however, systems should be assumed to operate only 90% of the time due to outages and required system maintenance. Biogas produced during these down periods cannot be economically stored and should be flared to reduce odour and greenhouse gas emissions.

## Are AD Systems Feasible For Hog Operations?

Traditionally biogas systems have relied heavily on the export and sale of value added 'Green Energy' to the local power grid. Federal and provincial power production policies however, have not allowed small generators to capitalize on power export, resulting in marginal feasibility of agriculture biogas projects.

Recent increases in the price of electrical and thermal energy sources have made on-farm heat and power generation more attractive however, on-farm use of the energy remains the most practical option. Sow and nursery barn operators will generally have the greatest opportunity to offset heat and power costs as these units tend to be energy intensive. Finish barn operators require little supplemental heat energy but may require significant power for ventilation system operation. As the majority of feed volume consumed in the hog production cycle is used in the finishing stages, the opportunity exists to link biogas production at finishing sites with grain drying and processing facilities. Farrow-to-finish operations will tend to exhibit the greatest opportunity for on-farm biogas production and usage.

## Possible Economic Benefits

The economic benefits include offsets against electricity purchased as well as offsets in current and proposed propane or natural gas. Sources of income include a reduction in barn heating costs, reduced farm power expenditures, the potential sale of carbon credits into a domestic trading system, and diversion of organic waste away from landfill sites provides opportunities to accept tipping fees for outside waste coming into the system.

In many jurisdictions discussions are currently underway to establish green pricing and renewable portfolio standards along with pursuing net metering to encourage small-scale generation. Across Canada, partnerships are being developed between manure "treaters", livestock producers, and power companies. These partnerships allow producers to capture the benefits of the

AD system operates efficiently through the winter months on a 1200-sow farrow-to-finish operation near Saskatoon, SK

treatment technology without the time and financial burden as well as providing an opportunity for hog producers to lease or sell manure to the treatment process operator. Another opportunity may involve a producer-run digester selling biogas to an electrical power utility. In both examples, livestock producers will capitalize on the benefits of manure treatment and the use of waste heat from the system, while avoiding the large capital expenditure associated with power generation and electrical grid access. In some cases, linking a digester to the power grid can account for 50% of total system cost.

## Will it Work on my Operation?

A biogas feasibility study is an excellent way to determine the efficiently your farm. These examine energy consumption and ventilation system efficiency, water usage control and animal feeding strategies. An on-farm biogas plant can decrease the risk of rising energy prices cutting significantly into your bottom line. Analysis of past energy consumption will provide an idea of what level of capital expenditure can be justified on an on-farm system to produce heat and energy. Installing a water use metering system and comparison of your farm water usage to other farms or theoretical book values will help to identify opportunities to increase water use efficiency.

It is important to note that AD will reduce manure carbon content only, which will significantly reduce odour of digested manure. Nitrogen and phosphorus content of the manure is conserved during digestion. The resulting digested manure will be more homogenous with more readily available plant nutrients.

A variety of AD systems are available for on-farm biogas production which vary in complexity and cost. Basic systems provide thermal energy for winter heat and biogas for flare during the summer and would be most appropriate for small farrow-to-finish operators, or finish barn operators with mechanically ventilated barns.

Larger, more efficient digesters are better suited to production sites with significant heat and energy loads. These installations may include an on-site grain dryer, or even a greenhouse, which will require significant electrical and thermal energy to operate. The applicability of options will depend on a host of factors. In any case, AD systems should be considered an integral part of a livestock production system. As such, a detailed feasibility study should be conducted prior to construction of a new barn, thus allowing construction to facilitate manure collection and handling and subsequent biogas use at the barn site.

## Summary

Technology advances and increased emphasis on environmental services have made on-farm anaerobic digesters a much more viable option. Producers are encouraged to explore the feasibility of AD for their operations.

## For more information

**CONTACT**

Nova Scotia Agricultural College(www.nsac.ns.ca), or
the Atlantic Swine Research Partnership (www.asrp.ca)

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