Saving Money by Maximizing Energy Use Efficiency in Swine Production

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▪ Introduction

Last winters' rapid rise in natural gas prices coupled with electricity deregulation in Alberta and Ontario presents both opportunities and challenges for hog producers. While heating fuel and electricity are a small part of hog production costs, energy does play a significant role in optimal health and feed conversion. It is possible to reduce barn energy costs and actually improve performance. This paper discusses some energy cost reduction methods associated with heating, lighting, and mechanical ventilation systems. All recommendations relate to an all-in, all-out building management style unless otherwise noted.

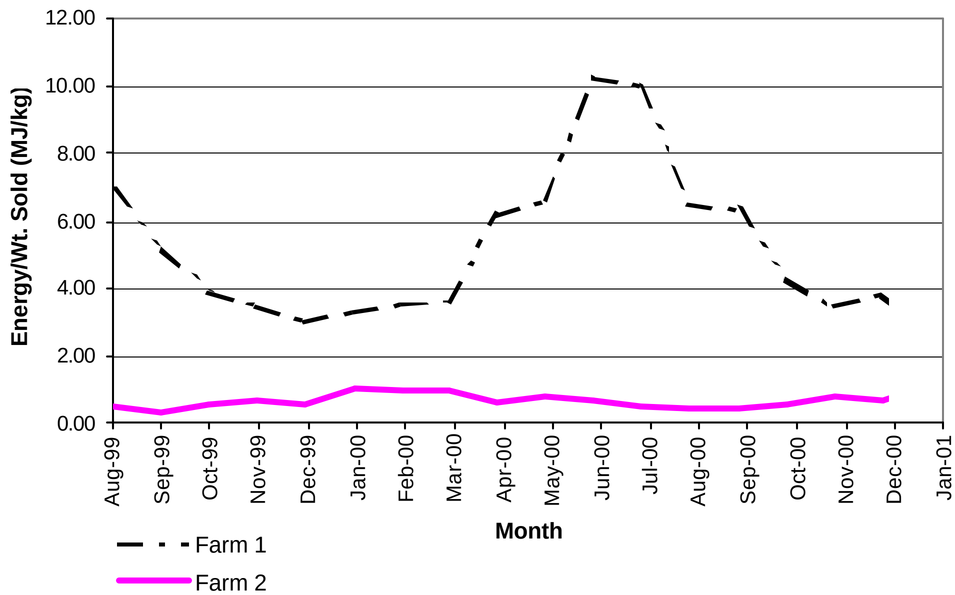
▪ Management

Assuming that the ventilation and heating system has been properly designed, installed, commissioned and calibrated; then the single most important factor in energy use efficiency is management. The setting of the controls, maintenance and monitoring clearly show that small slips can have large consequences to the final energy bill. For example, operating exhaust fans in winter at higher than the necessary minimum rates can quickly cause heat bills to double. In summer, judicious use of sprinklers and stirring fans with exhaust fans can increase pig comfort and performance while reducing the electric demand.

▪ Benchmarking

One of the most effective methods of evaluating a farm's energy performance is through the use of benchmarking. This allows the operation to review its energy use performance on a comparative basis. Weather will have a large effect, but can be accounted for as well. Even better is to compare the farm to another similar style in the same geographic area. Figure 1 shows two farrow-finish operations with widely varying energy costs (shown in MJ/kg marketed).

Figure 1. Energy use per month (MJ/kg sold) for 2 farms (farrow to finish, with on-farm feed mill).



Although some of the variation can be explained, there are enough added costs to Farm 1 to trigger an intensive audit.

■ Creep Heating

The following techniques improve comfort, performance and energy efficiency in the newborn and nursery pig environment, based on a 250 W heat lamp costing about $110/year (@ $0.06/kWh):

- Use high radiant output lower wattage IR-PAR heat lamps (175 and 100 W) to direct the heat on the piglets. Saves $33 annually per creep heat lamp.
- Use diode dimmer switches or other form of control to reduce the radiant heat output and more closely meet growing piglet needs, and combine with

a thermostat set to turn the heat lamps off at a room temperature of 80-90 ^{0}F, depending on piglet size. Saves $60 annually per creep heat lamp.

- Hot water floor heating or electric heat pads are more cost effective than heat lamps, but more expensive to install. Attract newborn piglets to the heat with a heat lamp or light. Saves up to $75 annually per hot water floor creep/crate (Depends on heat fuel cost)

▪ Hot Water Heating

Hot water can move large quantities of heat long distances and allows switching to the most cost effective fuel source. It does not consume barn air or add exhaust combustion by-products into the barn, which improves air quality. The large thermal capacitance and delay in temperature rise means it requires a good control system.

▪ Radiant Tube Heating

Infra-red (IR) radiant tube heaters suit weaning, breed/gestation and grower-finisher facilities especially those with high ceilings. Only objects, not the air, are heated. Use removable mats or pads on full slat floors with IR heaters.

Infra-red heaters reduce heater output sizing by 15-20% compared to forced air systems. The introduction of the two stage heater has yielded greater savings by matching heat output to heat requirements more closely.

▪ Forced Air Heat

Forced air systems heat the entire air space. A re-circulation system is necessary to reduce stratification and distribute the heat more uniformly throughout the room.

Gas fired, unvented unit heaters have relatively economic operating costs. These units consume $O_{2,}$ and vent CO, CO_2 and H_2O into the room. As a result, minimum ventilation increases to ensure a quality environment. Typically, heater sizing also will rise by as much as 25%.

▪ Lighting Systems

Each production stage requires different light levels and photoperiods. The 1993 Recommended Code of Practice for the Care and Handling of Farm Animals - Pigs (Publication 1998/E, Agriculture and Agri-Food Canada) recommends at least 8 h of light per day, at a level adequate to observe pigs. Five foot-candles at least doubles the light level typically found in many older swine barns. Design is critical to maximize light efficiency and eliminate over/underlit areas. White paint maximizes reflectance and reduces the number of lighting fixtures required.

T-8 fluorescent tubes with electronic ballast, mounted in a weatherproof fibreglass or plastic housing with gasketed diffuser are the new standard. These units are more than four times as efficient as regular life incandescents and the lamps last at least 24 times longer.

Incandescent lamps convert only 10% of the energy to light, losing the remainder as heat, and have a relatively short rated life. An alternative to the incandescent is the compact fluorescent (C.F.) lamp. The CF lamp and ballast system has a shorter life and higher cost, making it more expensive to operate than the T-8 fluorescent tube system.

▪ Ventilation

Fans

Fans must be properly sized to meet production unit requirements. The University of Illinois Bioenvironmental and Structural Systems (BESS) Laboratory is the main source of ventilation fan performance data.

Table 1: CFM /W versus CFM Output

Air Flow (CFM)	Recommended Minimum CFM/W	Range CFM/W
< 1200	5	4-8
1200-5000	8	5-11
5000-10,500	14	10-19
>10,500	17	15-25

Within various fan diameter ranges, airflow output and efficiencies vary widely. A properly designed system optimizes CFM output which can reduce capital costs, and can reduce operating costs by selecting for high CFM/W energy efficiency. All CFM/W values should be taken at 0.10" water column of static pressure (Table 1).

Use the following guidelines to select an energy efficient fan.

- Sized to meet design air requirements at expected static pressures
- Select proper equipment (i.e. pit fan, wall fans, wind hood, etc.)
- Energy efficiency
- Product reliability
- Manufacturer/supplier reputation
- Price

Natural and Dual Ventilation

Natural ventilation reduces reliance on electricity; however, cold weather tends to produce erratic results. A dual ventilation system uses fans for exhaust stability in cold weather and natural systems for warm weather. Benefits include: no need for stand-by power; controlled environment in winter; no large summer fan systems (and operating costs), quieter, bright in summer. A fan-only system will cost about $1.00/hog for fan operating costs; dual ventilation systems decrease this cost to about $0.33/hog marketed, average.

▪ Heat Recovery

A heat exchanger recovers heat from exhaust air. Styles range from modular through-the-wall to multiple room systems. Relatively high capital costs and maintenance requirements are disadvantages of these systems.

▪ Electricity: Alternate Rate Structures

Producers should review their energy usage patterns and modify operations to take advantage of rate structures offered by electricity suppliers such as:

Electricity Demand Management Techniques

Load shifting

A farm may have lots of equipment operating from 8AM to 12PM Monday to Friday causing a peak power demand (kW). Some electricity suppliers may offer reduced rates to shift a load, such as an on-site feed mill, to off-peak hours (eg. 5PM to 9PM) yielding demand savings.

Time-of-use

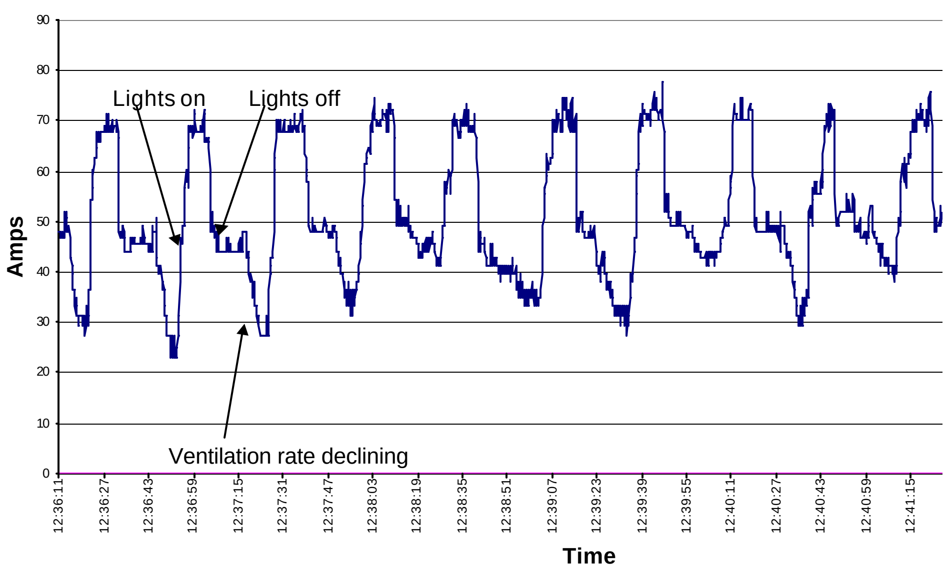
Suppliers may offer lower energy (kWh) rates to operate specific large loads such as a feed mill during off-peak times (typically weekends and from 11PM to 8AM).

Interruptible

The supplier offers low rates for loads such as heat (usually hot water based) but has the right, with notice, to turn that load off (but not any other regular rate loads). A back up boiler, usually propane, is required.

Figure 2 shows the electrical energy load profile for a finisher operation. This profile is very useful in a deregulated market. It allows a producer to determine if an electricity retail supplier may give a break or penalty; and what opportunities are present. In the figure, ventilation loads and light loads are easily distinguished. In this case, a retrofit to energy efficient fluorescent lighting became an obvious choice.

Figure 2. Finisher unit load profile.



Single vs. 3 phase power

The belief that using 3 phase instead of single phase power is advantageous is not always the case. Before choosing 3 phase, consider:

Power supplier's rate structure

3 phase can cost more until a monthly minimum use milestone is passed.

Application

Fractional motors are not more efficient, due to a loss in output when a 230 V motor is connected across 208 V.

Operating Time

Large 3 phase motors make sense under virtually continuous operation where efficiencies of 90% or more are possible.

▪ Conclusion

Energy efficiency is an important part of swine production. In many cases, use of energy efficiency as a criterion in selection and design of housing and ventilation systems can enhance production and well being of pigs while also reducing costs.