Thank you for participating in PorkBridge 2011-12.
To start the presentation, advance one slide by pressing “enter” or the down arrow or right arrow key.

Energy efficient fans for swine production (pdf)
Energy fundamentals for farm lighting (pdf)
Sizing minimum ventilation to save energy in swine housing (pdf)

Why is Energy Important?
2006-2010 average from: www.finbin.umn.edu

- **Wean to Finish**
  - Fuel & Oil $1.22 per head
  - Utilities $0.99 per head ** (2010 only)
- **Finishing**
  - Fuel & Oil $0.92 per head
  - Utilities $0.69 per head
- **Sow Farm**
  - Fuel & Oil $0.58 per pig produced
  - Utilities $0.28 per pig produced

Energy is Important
- Energy is a significant part of expenditures that you CAN do something about
- Many energy savings can be implemented with very little expense and some with NO additional expense.

But isn’t that so small I shouldn’t worry about it?
- **Wean to Finish** Energy/Utilities $2.21/pig
  - 2.3% of total expenses
  - 8.1% of non-feed expenses
- **Finishing** Energy/Utilities $1.61/pig
  - 2.1% of total expenses
  - 6.7% of non-feed expenses
- **Sow Farm** Energy/Utilities $0.86/pig
  - 2.9% of total expenses
  - 4.5% of non-feed expenses

Where Do You Start?
- To know **WHERE** you can save, you have to know **HOW MUCH** you use......

You receive your energy bills. You read information about the importance of saving energy. You follow the tips to reduce energy use and costs. But how do you really measure your efforts? You might want to consider using an energy log. This is an easy and inexpensive method of tracking your energy use, studying costs, and comparing use and costs from month to month. We have provided a simple form (energy log) that you can download for use with Excel**®, or simply print the log and enter by hand.
If you were asked to do an energy audit........

• What would you look at?
  – Electricity
    – Lights?
    – Fans?
    – Heat Lamps?
    – Hidden Uses?
  – Propane
    – Heaters?
    – Insulation?
    – Management of Ventilation System?

Annual Benchmarks

• Benchmarks are not well documented. Based on small data set from cooperators.
• Sow Farms
  – Electricity: ~240-300 kWh/sow
  – LP: ~2-3 gal/sow
• Wean-Finish
  – Electricity:
    • ~ 25-30 kWh/pig space (tunnel)
    • ~ 15-20 kWh/pig space (curtain)
  – LP: ~ 2 gal/pig space

Lighting Terminology

• Lumens:
  – Quantity of light output (lm)
• Average Rated Life:
  – Number of hours for half of the bulbs to burn out in a laboratory setting.
• Efficiency:
  – Lumens/Watt
    • 1200 lm/20W = 60

Indoor Lighting Choices

<table>
<thead>
<tr>
<th>Lamp Type</th>
<th>Example</th>
<th>Typical Lamp watt (W)</th>
<th>Lumens</th>
<th>Average Rated Life (hrs)</th>
<th>Initial</th>
<th>Initial cost</th>
<th>Rotation</th>
<th>Typical Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incandescent</td>
<td>25-100</td>
<td>25-35</td>
<td>1,000-4,000</td>
<td>1,000</td>
<td>~250</td>
<td>$8</td>
<td>5</td>
<td>incandescent</td>
</tr>
<tr>
<td>Compact Fluorescent</td>
<td>5-27</td>
<td>50-90</td>
<td>6,000-12,000</td>
<td>9</td>
<td>Yes</td>
<td>15</td>
<td>incandescent</td>
<td></td>
</tr>
<tr>
<td>Cool Cobalt Compact Fluorescent</td>
<td>5-16</td>
<td>41-49</td>
<td>18,000-26,000</td>
<td>16</td>
<td>Internal</td>
<td>55</td>
<td>incandescent</td>
<td></td>
</tr>
<tr>
<td>LED</td>
<td>6-20</td>
<td>4-100</td>
<td>15,000-26,000</td>
<td>8</td>
<td>Yes</td>
<td>55</td>
<td>incandescent</td>
<td></td>
</tr>
<tr>
<td>T1 Fluorescent</td>
<td>12-25</td>
<td>34-84</td>
<td>5,000-24,000</td>
<td>0</td>
<td>Yes</td>
<td>55</td>
<td>incandescent</td>
<td></td>
</tr>
<tr>
<td>T5 Fluorescent</td>
<td>15-34</td>
<td>58-98</td>
<td>5,000-24,000</td>
<td>0</td>
<td>Yes</td>
<td>55</td>
<td>incandescent</td>
<td></td>
</tr>
<tr>
<td>T8 Fluorescent</td>
<td>44-68</td>
<td>42-98</td>
<td>1,500-38,000</td>
<td>50</td>
<td>Yes</td>
<td>5</td>
<td>incandescent</td>
<td></td>
</tr>
</tbody>
</table>

Lighting Example

• Incandescent (long life)
  – 75 W
  – 1065 lumens
  – 1500 hr rated life (assume 750)
  – 84 cent initial cost
  
  Operating 8 hrs per day all year (2920 hours)
  
  • 219 kWh or $21.90/yr
  • Need 3.89 bulbs/yr = $3.27
  • Total cost = $25.17/yr

• Compact Fluorescent
  – 20 W
  – 1250 lumens
  – 12,000 hr rated life (assume 6000)
  – $1.79 initial cost
  
  Operating 8 hrs per day all year (2920 hours)
  
  • 58 kWh or $5.80/yr
  • Need 0.49 bulbs/yr = $0.87
  • Total cost = $6.67/yr

$18.50 Saving per year per bulb
Magnitude of Savings

- Example of a 900 head gestation barn
  - Assume:
    - 150 bulbs
    - On 8 hours/day
  - 75 W incandescent bulbs >>> 32,850 kWh/yr
  - 20 W CFL bulbs >>> 8760 kWh/yr
  - @ 10 cent/kWh >>> Energy savings of $2400/yr

Fan Selection Matters

- 24” fans @ 0.10” H₂O (7600 hrs per year)
- Most efficient
  - 17.1 cfm/W, 6980 cfm
  - $310 per year
- Least efficient
  - 8.2 cfm/W, 5790 cfm
  - $537 per year

Dirty Fans and Shutters

- 1/8 inch of dirt/dust can cause up to a 40% reduction in fan and shutter airflow.
  - Triggers next ventilation stage sooner costing more energy.
- Excessively high static pressure has same impact.

Cross-Sectional Area of Transition

\[ \text{sq. ft.} = \frac{\text{fan capacity (cfm)}}{400 \text{ fpm}} \]

- Ideally NEEDS at least 15 Square Feet
- 30” x 1.67 sq ft
- Very High Static Pressure Loss

Fan Transition from Pit

- Fan running 100%
- 1 ft minimum
- Pit Fans Need Inlets

Rebates available: Example: Alliant Energy offers $75 if over 13.0 cfm/W for 24 inch fans

Is it a Restriction?
Energy-efficient 175W lamp vs. conventional 250W lamp - Xin Study

- Annual energy saving of $36 per unit or $5,500 per 1,000 sows
- Improved livability, 284 extra pigs per 1,000 sows per year
- Reduced lamp failure rate, 50%
- Slightly higher ADG of piglets
- More uniform resting pattern of piglets under the lamp

Lamp or Mat Control

Variable output allows the creep temperature to be managed while saving energy
Rheostats do not do the same thing. They “chop” voltage… only reducing output, not input.

Lamp or Mat Control

Variable output allows the creep temperature to be managed while saving energy
Rheostats do not do the same thing. They “chop” voltage… only reducing output, not input.

Insulation

- Sample: 1000 head barn, 41 x 200
  - Assume:
    - 50 lb pigs @ 3 cfm/head
    - $1.75/gallon LP
    - Mason City, IA
  - Questions:
    - Does adding ceiling insulation pay?
    - Does perimeter insulation pay?

Insulation - Attic

<table>
<thead>
<tr>
<th>Current Insulation Depth (in)</th>
<th>Adding 6” - Savings/yr</th>
<th>Adding 6” - Payback (yrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2”</td>
<td>$4200</td>
<td>0.5</td>
</tr>
<tr>
<td>4”</td>
<td>$1600</td>
<td>1.3</td>
</tr>
<tr>
<td>6”</td>
<td>$900</td>
<td>2.4</td>
</tr>
<tr>
<td>8”</td>
<td>$500</td>
<td>3.7</td>
</tr>
<tr>
<td>10”</td>
<td>$400</td>
<td>5.4</td>
</tr>
</tbody>
</table>

- If existing is < 6”, may be justifiable.
- Building longevity important consideration.

Insulation - Attic

<table>
<thead>
<tr>
<th>Current Insulation Depth (in)</th>
<th>Adding 6” - Savings/yr</th>
<th>Adding 6” - Payback (yrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2”</td>
<td>$4200</td>
<td>0.5</td>
</tr>
<tr>
<td>4”</td>
<td>$1600</td>
<td>1.3</td>
</tr>
<tr>
<td>6”</td>
<td>$900</td>
<td>2.4</td>
</tr>
<tr>
<td>8”</td>
<td>$500</td>
<td>3.7</td>
</tr>
<tr>
<td>10”</td>
<td>$400</td>
<td>5.4</td>
</tr>
</tbody>
</table>

- If existing is < 6”, may be justifiable.
- Building longevity important consideration.
Effect of Cold Surfaces on Growing Pigs

<table>
<thead>
<tr>
<th>Air to Wall Gradient $\theta_F$</th>
<th>Change in Effective Temperature $\theta_F$</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>-13</td>
</tr>
<tr>
<td>6</td>
<td>-3</td>
</tr>
<tr>
<td>2</td>
<td>-1</td>
</tr>
</tbody>
</table>

Mount, 1975

Proper Temperature?

- Are you using the proper temperature?
- How can you tell?
- How much does using an improper temperature cost?

Zone Heating

- Transfer of heat to a surface without direct contact
- 30-50% of total heat loss
- Main component:
  - Pig’s surface area exposed to other surfaces
  - Difference in temperature between pig & surface ($\Delta\theta$)
- Less expensive to zone heat than heat the entire building
Zone Heating
• The benefit comes in being able to lower the room temperature.
• Zone heating without lowering the room temperature is pointless.

Proper Temperature
Example: 1000 head curtain sided barn in Iowa. 50 lb pigs – ANNUALIZED results

<table>
<thead>
<tr>
<th>Setpoint</th>
<th>Annualized LP</th>
<th>Cost @ $1.75 LP</th>
<th>Different from Base</th>
</tr>
</thead>
<tbody>
<tr>
<td>64 F</td>
<td>1800 gallons</td>
<td>$2290</td>
<td>-35%</td>
</tr>
<tr>
<td>66 F</td>
<td>1600 gallons</td>
<td>$2850</td>
<td>-20%</td>
</tr>
<tr>
<td>68 F</td>
<td>2000 gallons</td>
<td>$3480</td>
<td>Base</td>
</tr>
<tr>
<td>71 F</td>
<td>2700 gallons</td>
<td>$4740</td>
<td>+35%</td>
</tr>
<tr>
<td>73 F</td>
<td>3300 gallons</td>
<td>$5820</td>
<td>+65%</td>
</tr>
</tbody>
</table>

Ventilation
• FAR and AWAY the biggest potential for wasted energy
• 80 to 90% of heating energy lost through ventilation when done properly
• A good “target” for LP usage is 2 gallons/space/yr for wean to finish

Proper Ventilation Rate?
• Sample: 1000 head barn, 41 x 200
  – Assume:
    • 50 lb pigs @ 3 cfm/head & 68 F setpoint
    • Mason City, IA
  – Questions:
    • How much does over-ventilating cost?

Annual LP Usage Estimate

Ventilation
• Even slight over-ventilation
  – For given case:
    • 10% over – 460 gal LP increase (23%)
    • 20% over – 920 gal LP increase (46%)
    • 30% over - 1430 gal LP increase (72%)
    • 40% over – 1980 gal LP increase (99%)
    • 50% over – 2510 gal LP increase (126%)
    • 59% over – 2960 gal LP increase (148%)
• Virtually NO investment... only management
Why is Proper Rate so Difficult?

- Variable speed fans make delivering a prescribed minimum rate difficult.
- So WHY use them???

Why do we use variable-speed fans?

- Example: 24-crate farrowing room
  - Needs 480 cfm for minimum
  - Smallest fan available is about 1,000 cfm
- Example: 1200-head, wean-to-finish barn
  - Needs ~ 1,800 cfm for minimum
  - 24” fan = 6,000 cfm

Why are Variable Speed Fans Complicated?

How Does Your Controller Work with Your Variable-Speed Fans?

Motor curve recommendations for various fan sizes using Aerotech controller.

Motor curve recommendations for various fans using Airstream controller.
Generally, minimum speed is ~50% of voltage.
**Other Management**

- Curtains
  - Overlap 3”
- Pumps
  - Are there recycling pumps being used?
  - Could they be converted to 3 phase?
  - Do lines need cleaning?
- Emergency thermostat setup
  - Set so they do not control the fans/heaters

**Summary**

- Begin by tracking your energy usage
- Ventilation Management is critical to energy management
  - Can amount to several $1000
- Controller Settings are an important part of efficient operation.
  - No investment in many cases .. Only management
- Proper Temperature

**Summary**

- Insulation may be helpful if there is little currently, may have animal comfort and building longevity issues.
  - Attic ~$1000 if less than 6” exists
  - Perimeter ~$1300 if no perimeter insulation
- Lighting
  - Lighting is an easy savings, but small impact
  - <$1000, quick payback

**Thank you for your time!**

**What questions do you have?**

**ISU Extension Farm Energy Initiative**
Farmenergy.exnet.iastate.edu

**ABE**

IOWA STATE UNIVERSITY