BPA On-site Agricultural Energy Audit Measure Guidance

In general, BPA requires that incentivized on-site agricultural energy audits adhere to the ANSI/ASABE S612 JUL2009 for performing on-farm energy audits. This document can be found in the BPA Document Library. Additionally, please refer to Appendix A for information on major energy using activities to audit based on the farm type and operations.

Specifically, the Agricultural on-site energy audits must include the following minimum information and analysis to receive incentive payment for the Agricultural Energy Audit measure.

1) **A description of the agricultural production site**
    a. General details - facility layout, general construction and condition details, purpose of facility, etc.
    b. For buildings to be audited (if applicable) include:
        i. square footage, and space/zone descriptions, space usage descriptions
        ii. Envelope – Construction type and materials, layers, R-values/U-values, and condition.
    c. For energy using systems or processes to be audited:
        i. Describe with sufficient detail to understand major energy using systems or processes to be audited.
        ii. Include system age, condition, type, controls, areas, or purpose served, operating schedules and sequences, current capabilities, and limitations, and significant known or suspected issues.

Example

The dairy milks its cows 2 times per day in an 8-unit pipeline, including a 10 horsepower (hp) single-speed vacuum pump. Each milking lasts about 2 hours and clean-up is an additional 45 minutes. On average, the farm is milking around 93 animals and produces around 8,900 pounds of milk per day (approximately 95.7 pounds of milk/cow/day). Milk is cooled to 38˚F in 1 bulk tank and is picked up every 2 days. Hot water is supplied via an LP Gas water heater and refrigeration heat recovery unit. Hot water temperature is set at 172 degrees. Due to the performance of the refrigeration heat recovery uni water-heating load has been minimized for the farm's hot water needs. A complete list of equipment is

- Water Heating: The farm currently uses one AO Smith BTH 120 101 LP gas water heater that is 4 years old to heat water.
- Refrigeration: One 2,000 gallon bulk tank, BouMatic® Dari-Kool model DFK 2000, for milk storage. The bulk tank is cooled with an older 4 hp reciprocating compressor, Tecumseh® brand, model AG122ET-020, connected to refrigeration heat recovery. The bulk tank compressor is estimated to have an energy efficiency ratio (EER) of 7.00.
- Milk Harvesting: The farm milks using a pipeline milking system. Eight milking units are driven by a BouMatic® model GAEHDPA0040 blower-style vacuum system with a single-phase WEG® electric model 01018ES1DFD215T motor (efficiency is not labeled on motor nameplate).
- Other Motors/Pumps: Milk is transferred to the bulk tank using a 1.0 hp Magnetek®-(model worn off nameplate) receiver jar pump.
- Lighting: Currently, the farm utilizes a combination of lighting.

2) **Energy consumption profile:**
    a. Provide two to three years of utility data for facility, including all electricity and fossil fuel usage and cost for all meters (if available and if appropriate).
    b. Provide estimated or measured energy use of systems or processes to be audited (such as irrigation systems or harvesting equipment) including how they were derived/calculated (i.e. typical end-use splits, datalogging, energy model, etc.).
        i. For a targeted system or process analysis, data logging may be used to supplement or in lieu of full historic data, (as appropriate and depending on available measured data).

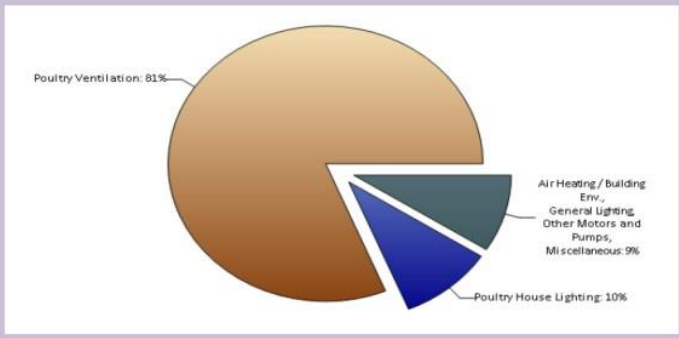
Example

Fuel	Current Usage/year
Electricity (KWh)	170,900
Propane (gallons)	1,000

-OR-

During a recent 12-month period, John Doe Farms used 170,900 Kilowatthours (kWh) of electricity with a total cost of $17,090, for an average cost of $0.10 per kWh. The farm also used a total of 1,000 gallons of propane with a total cost of $1,550, for an average cost per gallon of $1.55.

-AND-



3) **Descriptions of existing energy-using equipment and proposed energy efficiency measures (EEM).** Include all available information applicable to current BPA Unit Energy Savings (UES) measure list (Appendix B) and possible custom projects.
   a. Existing Conditions: Provide a complete description of the existing condition that includes a summary of all critical monitoring and measurement results.
      i. Equipment information (nameplate or observed data, etc.) must be provided, as well as a citation of data sources for each critical value and condition.
   b. Proposed Energy Efficiency Measures: Provide a complete description for each proposed EEM that explains the purpose of the measure and how it will save energy.
      i. Outline non-energy impacts including how measure impacts any O&M measures or procedures, existing equipment life, as well as non-energy benefits (such as water or labor savings), especially improvements to health, safety, and environment.

Examples

- Water Heating: The farm currently uses one AO Smith BTH 120 101 LP gas water heater that is 4 years old to heat water.
- Refrigeration: One 2,000 gallon bulk tank, BouMatic® Dari-Kool model DFK 2000, for milk storage. The bulk tank is cooled with an older 4 hp reciprocating compressor, Tecumseh® brand, model AG122ET-020, connected to refrigeration heat recovery. The bulk tank compressor is estimated to have an energy efficiency ratio (EER) of 7.00.
- Milk Harvesting: The farm milks using a pipeline milking system. Eight milking units are driven by a BouMatic® model GAEHDPA0040 blower-style vacuum system with a single-phase WEG® electric model 01018ES1DFD215T motor (efficiency is not labeled on motor nameplate).
- Other Motors/Pumps: Milk is transferred to the bulk tank using a 1.0 hp Magnetek®-(model worn off nameplate) receiver jar pump.
- Lighting: Currently, the farm utilizes a combination of lighting.

Good Recommendation Statement (It is clear in what is recommended and includes how the savings will be determined, raising the R value)

Insulate Brood Curtain: Insulating the brood curtain will reduce the amount of energy lost through the curtain to the other parts of the house. This can be done by installing a second curtain with an inch of air space between the two curtains. This will increase the R-value from R-1 to R-2, and although this is a small increase, this will reduce the energy lost by 100 percent. Also ensure you have good seals at the ceiling, walls, and floor to reduce energy cost.

4) **Energy Efficiency Measure (EEM) detailed cost estimates**:
   a. Provide line-item details for labor, materials, equipment, disposal costs, design, engineering, commissioning, etc. for the EEM.
   b. Reference any sources for costs estimates.

Examples

Good cost estimate explanation. Anyone could verify the numbers used in this estimate. What could make this estimate better is if the savings percentages came from an industry flyer or perhaps an Extension reference.

Major Activity – Pumps

A variable feed drive (VFD) on the vacuum pump is estimated to save the farm $1,124 (8,644 kWh) annually, when compared to the baseline use of 15,800 kWh. The savings for the VFD can vary from 30 to 80 percent, but more typically between 50 to 60 percent.

Good cost estimate explanation. Anyone could verify the numbers used in this estimate. What could make this estimate better is if the savings percentages came from an industry flyer or perhaps an Extension reference. But like the above example, it is acceptable.

Major Activity – Heating

The use of aspirated thermostats placed near the plant canopy in locations representative of the greenhouse temperature (not near side walls, end walls or openings). Aspirated thermostats can save 2 to 3 percent of the total fuel bill by improving fan and heater operation.

Poor cost estimate explanation. There is no definitive wattage light recommended that would allow a person to calculated the electricity savings. Also, the number of fixtures to be replaced is not discussed. This would be unacceptable documentation of energy savings.

Major Activity – Lighting

Replacing the barn lighting with lower wattage and more efficient LED fixtures could save the landowner $1000 to $2000 a year in electricity costs.

5) Energy Savings Calculations and Assumptions:
   a. Use the BPA UES measure savings list (Appendix B) for prescriptive type measures.
   b. Provide detailed calculations and methodology for each custom EEM and summarize how the custom project saves energy.
   c. Must include documentation of assumptions, identification of key values, and ensure accuracy of values.
   d. Required for Rural Energy for America Program (REAP) Grant and Loan guarantee applications:

Include sample equipment product information for new or replacement equipment used in savings calculations.

6) **Provide a summary of all recommended EEMs at the beginning of the audit report.**

For each measure, provide:

1. Annual energy savings
2. Estimated installed cost
3. Energy cost savings (use current utility rates)
4. Annual operations & maintenance savings
5. Simple payback in years.
6. Available utility incentive
7. Overall simple payback in years.

Example

Summary of EEM Costs, Savings, Payback & Prioritization for Implementation										
		Annual				Annual				
Measure No.	EEM Description	Electrical Savings kWh	Natural Gas Savings therms	Propane Savings Gallons	Estimated Installed Cost (a) $	Energy Cost Savings (b) $	O&M Cost Savings (c) $	Simple Payback (a/(b+c)) Yrs.	Utility Incentive (d) $	Overall Simple Payback ((a-d)/(b+c)) Yrs.
1	Lighting Upgrade	50,000			18,000	3,000	500	5.1	3,000	4.3
2	Irrigation System Conversion	150,000			35,000	2,100	1,000	11.3	7,500	8.9
3	Irrigation Pump VFD's	100,000			20,000	6,000	-	3.3	10,000	1.7
4	Irrigation Hardware Upgrades	60,000			10,500	3,600	500	2.6	1,400	2.2

Appendix A

Suggested Components within Major Activities by Farm Enterprises for Ag Energy Audit

		Farm Enterprises							
Major Activity	Components	Dairy	Swine	Poultry	Beef/ veal	Field crops	Fruit/ vegetables	Aquaculture	Nursery/ Greenhouse
Lighting[1,7,10]	lamps, timers, sensors	X[6]	x	x	x		x	x	X
Ventilation[2,7,10,11]	fans, control system, variable drives, humidity control	x[6]	x	x	x		x	X(aeration)	x[8,9]
Refrigeration[5,7,10]	compressor, evaporator/chiller, motor, insulation	milk, products[6]		eggs			commodity	x	Veg/cut flowers
Milk harvesting[7,10]	pumps, motors, controllers	x[6]							
Controllers[7,10]	master system automation	x	x	x				x	x
Other motors/ pumps[3,4,7,10]	Types, compressors	X[6]	x	x	x	x	x	x	x
Water heating[7,10,12]	heater, energy source, insulation, recovery, waterers	x[6]	x	x	x				
Air Heating/ Bldg environment[10]	heater, energy source, insulation, recovery, variable drives	x	x	x	x		x		x[8,9]
Drying[10]	energy source, airflow (motors/fans), handling equipment					x			
Waste handling	collection and dispersal equipment/methods	x	x	x	x			x	
Air Cooling	energy source, airflow (motors/fans), control systems, evaporative	x	x	x	x				x[8,9]
Cultural Practices	planting, tilling, harvesting, engine driven equipment					x	x		
Crop/feed Storage					x	x	x	x	x
Water management	wells, reservoir, recycled	x	x	x	x	x	x	x	x
Material handling[7,10]	equipment, motors, pumps	x[6]	x	x	x	x	x	x	x
Irrigation[10]	motors/engines, pumps, power source					x	x		x

Footnotes:

Listed references are guidance documents or tools useful for assessing the energy use and/or efficiency associated with various major activities and/or farm enterprise. Not included here are the numerous planning guides that address the design of farm enterprise systems and the major activities involved because most do not directly assess energy conservation or efficiency. These planning and design guides provide a reference for understanding elements of efficient production systems, but do not specifically address energy use or efficiency as is the intent of this standard. These are by no means the only guides and tools that can be used in performing these audits.

1. ASABE Standards. 2009. EP344.3: Lighting systems for agricultural facilities. St. Joseph, Mich.: ASABE.
2. ASABE Standards. 2008. EP566.1: Guidelines for selection of energy efficient agricultural ventilation. St. Joseph, Mich.: ASABE.
3. Srivastava, Ajit K., Carroll E. Goering, Roger P. Rohrbach, and Dennis R. Buckmaster. 2006. Chapter 3: Electrical power for agricultural machines. In *Engineering Principles of Agricultural Machines*, 2nd ed., 45–64. St. Joseph, Mich.: ASABE.
4. Gustafson, Robert J., and Mark T. Morgan. 2004. Chapter 8. Electric motors. In *Fundamentals of Electricity for Agriculture*, 3rd edition, 205–248. St. Joseph, Mich.: ASAE.
5. Peebles, R.W., D. J. Reinemann, R. J. Straub. 1994. Analysis, of milking center energy use. *Applied Engineering in Agriculture* 10(6): 831–839.
6. Go, A. and Surbrook, T. 2009. Michigan dairy farm energy audit guide. East Lansing, Mich.: Michigan State University, Departments of Biosystems & Agricultural Engineering, Food & Resource Economics. Available at: http://web5.anr.msu.edu/fa/farm%20energy%20calculators.html.
7. UW-Madison. 2009. Farm energy assessment toolkit. Madison, Wisc.: University of WI-Madison and Wisconsin Focus on Energy. Available at: http://www.soils.wisc.edu/foe/login?resource=%2Ffoe%2Flogin%20.
8. ASABE Standards. 2009. EP460: Commercial greenhouse design and layout. St. Joseph, Mich.: ASABE.
9. ASABE Standards. 2008. EP406.4: Heating, Ventilating, and Cooling Greenhouses. St. Joseph, Mich.: ASABE.
10. Sanford, S., et al. 2009. Energy Self Assessment tools, University of Wisconsin-Madison, Available at: http://www.ruralenergy.wisc.edu/.
11. UI-Urbana-Champaign. 2009. Agricultural Ventilation Fans—Performance and Efficiencies, Bioenvironmental and Structural Systems Laboratory (BESS Lab), University of Illinois-Urbana-Champaign. Available at: http://www.bess.uiuc.edu/.
12. Directory of Certified Product Performance. 2008. Gas Appliance Manufacturers Association, Available at: http://www.ahridirectory.org/ahridirectory/pages/home.aspx.

Appendix B

BPA UES Measure Savings List

End Use	Category	UES Measure Name/Description	Measure Unit	Annual kWh Savings per unit
HVAC	HVAC System Controls	Thermostatically Controlled Outlets Heating Zone 1	Outlet	707.80
HVAC	HVAC System Controls	Thermostatically Controlled Outlets Heating Zone 2	Outlet	639.80
HVAC	HVAC System Controls	Thermostatically Controlled Outlets Heating Zone 3	Outlet	639.80
Irrigation	Irrigation Hardware Maintenance	Gasket Replacement Replace Leaking Drain Gaskets with New Gaskets Wheel-line, Hand-line, Lateral Move or Center Pivot Systems	Gasket	11.89
Irrigation	Irrigation Hardware Maintenance	Gasket Replacement Replace Pipe Section Gasket Wheel-lines, Hand-lines, Riser or Portable Main Line	Gasket	16.19
Irrigation	Irrigation Hardware Maintenance	Hub Replacement Replace Thunderbird Wheel Line Hubs Wheel Line System	Hub	16.19
Irrigation	Irrigation Hardware Maintenance	Leveler Rebuild Rebuild or Replace Leaking or Malfunctioning Leveler with New or Rebuilt Leveler Wheel Line System	Leveler	4.40
Irrigation	Irrigation Hardware Maintenance	Sprinkler Replacements Replace Leaking Impact Sprinkler with New or Rebuilt Impact Sprinkler Wheel-line, Hand-line, Lateral Move or Center Pivot Systems	Sprinkler	2.31
Irrigation	Irrigation Hardware Upgrade	Nozzle Replacement Replace Nozzle Wheel-line or Hand-line System	Drop	26.06
Irrigation	Irrigation System Conversion	Sprinkler Upgrade Irrigation System Conversion to MESA from high pressure Center Pivot or Lateral Move System	Drop	48.48
Irrigation	Irrigation Hardware Upgrade	Sprinkler Package Replacements High Pressure Sprinkler Package Center Pivot or Lateral Move System	Drop	59.70
Irrigation	Irrigation Hardware Upgrade	Sprinkler Package Replacements MESA Sprinkler Package Center Pivot or Lateral Move System	Drop	29.85
Irrigation	Irrigation System Conversion	Sprinkler Upgrade Irrigation System Conversion to LESA/LEPA/MDI from high pressure Wheel-line, Hand-line, Lateral Move or Center Pivot Systems	Drop	53.97
Irrigation	Irrigation System Conversion	Sprinkler Upgrade Irrigation System Conversion to LESA/LEPA/MDI from MESA Wheel-line, Hand-line, Lateral Move or Center Pivot Systems	Drop	33.98
Irrigation	Irrigation Hardware Upgrade	Sprinkler Package Replacements LESA/LEPA/MDI Sprinkler Package Center Pivot or Lateral Move System	Drop	14.92
Irrigation	Irrigation System Conversion	Sprinkler Upgrade Irrigation System Conversion to low pressure from high pressure Wheel-line or Hand-line System	Drop	47.00
Irrigation	Pumps	Pump Efficiency Upgrade New Efficient Pump 20 to 500 horsepower Bronze or Stainless Steel impeller	hp	200.00
Motors/Drives	Motors/Drives Controls	Motors/Drives Control Improvements (VFD) On Irrigation Turbine Pump 7.5 to 1000 horsepower	hp	250.00
Motors/Drives	Motors/Drives Controls	Motors/Drives Control Improvements (VFD) On Irrigation Centrifugal Pump 7.5 to 1000 horsepower	hp	175.00
Process Loads	Livestock Tanks	Freeze Resistant Stock Tanks - Heating Zone 1	Tank	376.00
Process Loads	Livestock Tanks	Freeze Resistant Stock Tanks - Heating Zone 2	Tank	774.00
Process Loads	Livestock Tanks	Freeze Resistant Stock Tanks - Heating Zone 3	Tank	2,378.00
Process Loads	Process Loads System Improvements	Interactive Process Loads System Improvements Generator Block Heater Stationary Less than 3 kW	kW	1,000.00
Process Loads	Process Loads System Improvements	Interactive Process Loads System Improvements Generator Block Heater Stationary Greater than or equal to 3 kW	kW	14,000.00