Review Guidance – ASABE On-Farm Energy Audits S612

This guidance is intended to assist in the review of an energy audit developed by an outside source intended to support the installation of a conservation practice through a USDA-NRCS financial assistance program, such as the Environmental Quality Incentives Program (EQIP).

An On-Farm Energy Audit needs to be developed so that (1) the farmer/rancher can understand the results, and (2) NRCS can make a judgment as to whether the proposed changes will have the intended impact. The American Society of Agricultural and Biological Engineers (ASABE) have developed a standard, On-Farm Energy Audits S612, which defines what needs to be discussed and included in an energy audit. If this standard is followed by the consultant or technical service provider (TSP) the two criteria for an audit mentioned above will be met.

The ASABE S612 standard provides for two types of audits, Type 1 and Type 2. A Type 2 audit involves more detail and is required for application of National Conservation Practice Standards (CPS) Code 670, Lighting System Improvement; and 672, Building Envelope Improvement, and is recommended for all financial assistance.

Following is a step-by-step guide for reviewing a submitted energy audit to ensure it meets the requirements contained in ASABE S612 standard:

PART A - Documentation of the existing operation (base-line condition)

STEP 1: Ensure the audit is identifiable. The following information should be shown on the first page of the report:

- *"ON-FARM ENERGY AUDIT"*
- *OWNER/OPERATOR NAME*
- *LOCATON*
- *ENTERPRISE TYPE*

There is certain information that needs to be documented about the farm/ranch enterprise in order to evaluate changes. When we refer to enterprise, we are focusing on the primary farm type (e.g., dairy operation, cash grain, field crop, swine operation, beef operation, etc.). Many farms may have more than one enterprise, but NRCS only requires as a minimum that the audit address one primary enterprise. The audit could include more.

The reason NRCS requires the audit to address only one primary enterprise is twofold: first, for the sake of keeping the energy audits from becoming too large in scale; and second, to keep the focus on the big benefit items which are assumed to come out of the primary enterprise of the farm/ranch. The original purpose of the audits was to show the farmer/rancher the benefits (dollar savings) of looking at their energy consumption. It is hoped that once a landowner sees that changes to their operation save money, they will pursue further audits.

Examples:

John Doe Farm	*John Doe Dairy Farm*	*Jack Gypsum*
On-Farm Energy Audit	*On-Farm Energy Audit*	*Cash Grain Farm*
County Road 1, City, State	*County Road 1, City, State*	*County Road, City, State*
Dairy Farm		*On-Farm Energy Audit*

STEP 1A: Ensure audit report has a signatures page.

It is important that the person that develops the audit certifies that this report meets the requirements of ASABE "On-Farm Energy Audit S612" standard. Also, there should be a certification that the auditor has presented the audit report to the landowner and that the landowner reviewed and understands what is recommended.

Examples:

I certify that this energy audit has been developed in accordance with the Type 2 audit requirements contained in the American Society of Agricultural and Biological Engineers (ASABE) standard "On-Farm Energy Audits S612."

John Doe Energy Auditor /s/, PE, CEM _____ *Date*

And

This On-Farm Energy Audit report has been reviewed with me and I understand the recommendations presented within.

Joe Doe Farmer _____ *Date*

STEP 2: Ensure the audit report has a summary of the operation:

The audit report should contain a summary overview that describes the operation. This allows anyone reviewing the audit report to make judgments about the scope of the proposed recommendations, it is necessary to understand how the farm enterprise operates and the size of that enterprise.

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 unit water-heating load has been minimized for the farm's hot water needs. A complete list of equipment is

included at the end of the report and only that recommended for upgrading or replacement are discussed within the body of the audit.

STEP 3: Ensure that the audit report documents the annual energy resource consumption of the enterprise:

In order to understand what the audit is suggesting as energy saving actions, it is necessary to be able to compare the proposed action's energy consumption with the current enterprise's energy usage. The audit report should contain a breakdown by energy resource (fuel type - electricity, propane, diesel, gasoline, etc.), of current annual energy consumption. For most enterprises electricity and propane or natural gas will be the only energy resources evaluated. The energy usage should be broken down for each of the major activities of the operation (see Appendix A). Generally, if only one meter exists that covers all the equipment on farm, an estimation of the percentage of the total used by each activity should be shown (this is usually a pie chart of some kind).

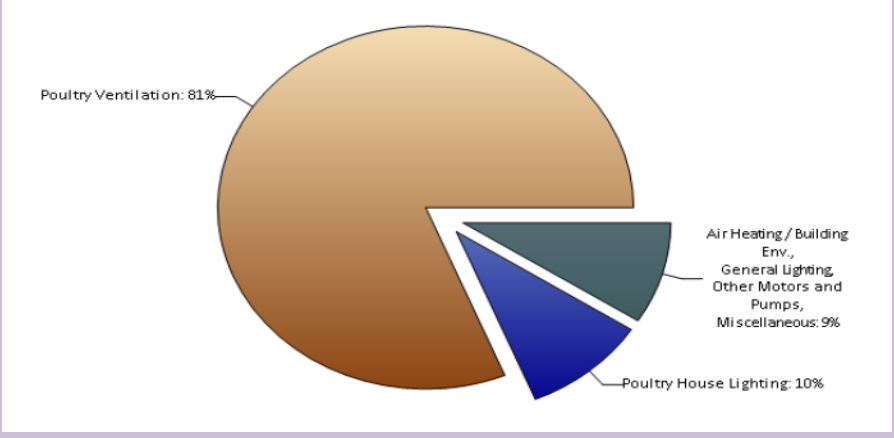
Examples:

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-



STEP 4: Check to see that the audit documentation contains a listing of equipment/components:

In order to verify that existing equipment and components of major activities should be evaluated by the audit or assumed adequate or irrelevant requires that someone can determine what specific equipment currently is in place. All of the components and equipment that are covered by the major activities need to be identified by brand and model, as appropriate.

As stated above, focus is on the activities associated with the primary enterprise of the operation. For each farm enterprise type certain activities are typically found. ASABE S612 refers to these as "Major Activities." To ensure that audits address what is important to the enterprise, ASABE S612 requires that certain major activities be addressed in each audit. This is required in the interest of ensuring the most likely big-ticket savings are captured in the audit. For example: it is assumed that most dairy operations have some type of refrigeration equipment for collected milk. Therefore, it was concluded that this major activity "refrigeration" would be an important audit focus. See Appendix A, Table 1, attached at the end of this guide for the major activities required by ASABE S612 for each farm/ranch enterprise type.

From Appendix A, Table 1, the major activities identified for Dairy Enterprises are: lighting, ventilation, refrigeration, milk harvesting, controllers, other motors/pumps, water heating, air heating, waste handling, air cooling, water management, and material handling. Somewhere in the audit documentation should be either a discussion or listing of all the components (brand and model) that are utilized on the farm associated with these activities. Again, we are looking at the big-ticket items. So if there are a lot of components the audit could focus on, generally those that utilize a lot of energy would be analyzed, not necessarily all the components in these major activities. Professional judgment needs to be exercised. Quite often this listing is included in the appendix of the audit report and only components that will be replaced or upgraded discussed within the body of the report.

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.

PART B - Assessments and Recommendation

This section specifies how recommendations shall be presented and minimum information needed to be provided consistent with a Type 2 energy audit.

STEP 5: Check to see if recommended energy savings actions are shown in the audit report. Savings should be delineated by major activity, components and actions discussed, and compared to base-line condition.

As discussed previously, the audit documentation needs to address each of the major activities identified for the enterprise. In performing the audit, an energy professional can often determine that some of these major activities either do not apply to the specific operation or know that the current components being used are energy efficient enough that replacement would garner only minor efficiency gains. In these situations the auditor is still required to address each major activity in their audit report, but may just state their reasons for not recommending changes to these components or activities without showing any specific documentation to support it. Addressing the major activities that the auditor does not have recommendations for is the most common omission in audit reports. If the auditor states that some of this equipment does not merit replacement or upgrading we accept their justification. However, because the audit report documents what is on site (step 4), it would be possible to verify the auditor's findings at a later date.

For each activity that the auditor identifies as having a potential for significantly impacting energy use and merits a recommended change, you must show an anticipated energy savings compared to the current consumption (baseline condition step 3). Quite often this step gets grouped with steps 7 and 8 for the components that are being recommended.

Examples:

Acceptable disqualifying statement as long as the list of existing components under step 4 are complete. The idea is that if we were to check out the components listed in step 4 there would be enough information in the report to validate this statement.

Major Activities Ventilation, Refrigeration and Harvesting
Most of the equipment on-farm has been upgraded in the last few years and is operating at industry considered high efficiency levels. These components were not analyzed for potential savings.

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.

Good Disqualifying Statement (Energy impact is very low, 0.4%, and is comprised of many components):

Major Activity--Other motors/pumps
There is an electric single phase Campbell Hausfeld 7.5 hp air compressor operating a mister in the germination room. Other intermittent loads include shop tools, domestic refrigerators and office loads. Other motors/pumps consume approximately 5,800 kWh per year, comprising 4 percent of the electrical usage and 0.40 percent of the total energy cost.

STEP 6: Identify the cost of recommended replacements and upgrades.

This is an important part of the audit, as it is used to determine whether the improvements are feasible and cost effective. Although many improvements may prove to be cost effective when compared to savings over a long period of time, the bottom line to most farmers and ranchers is whether or not they have the capital to afford the cost of the recommendations; therefore, this information should be clearly stated. The recommendation needs to not only suggest new equipment or action and the cost, it also needs to provide the information the auditor used to arrive at the cost. This information will be important when energy savings are determined in step 7.

There are various brands and models available, each with its own costs and efficiencies. Without the exact brand and model of the proposed recommendation component it would be difficult for the landowner to shop around for a similar performing unit for a similar price.

Examples:

Good cost estimate explanation. The landowner could easily get a contractor to give them an estimate based on this information that could be compared to the auditor's estimate.

Major Activity - Heating
The star barns need insulation applied on the ceiling, walls, and doors. Insulation to be installed should be at least an R-6 to reach the savings documented in this audit. Exact Energy recommends installing spray-foam insulation in the walls, ceiling and door of all Star barns currently used on this farm. The estimated cost to remove the exterior walls then install new spray-foam insulation in the walls, ceiling, and rear compartment of the barn and reinstall metal on the walls, ceiling, and doors of the barn would be approximately $2,400 per barn.

Fair cost estimate explanation. The statement does state a cost and hp for the recommended improvement, but without a brand and model or efficiency rating of the motors it would not be easy for the landowner to find exactly what he needed to secure both energy savings and the cost of the component. The statement would have been better if it had included an assumed efficiency rating of the motor.

Major Activity - Ventilation
The factory installed single-phase 10 hp and 7.5 hp electric motors installed in these curing barns should be replaced with energy efficient National Electrical Manufacturers Association

(NEMA) Premium® efficiency electric motors. It would cost approximately $800 for one 7.5 hp, and $1,000 for one 10 hp (including parts and labor).

Good cost estimate. Easy-to-price fixtures with the information provided. Lighting is one area where brand name is not as important in determining a cost because of the standardization in the industry.

Major Activity – Lighting

The best practice installation for a high-bay lighting system for the free-stall barn would be the installation of T8, 6 bulbs by 4 feet, fluorescent lighting in a sealed and gasketed fixture. The price of these fixtures can range from $160 to $200 per fixture.

STEP 7: Estimated savings in energy and energy cost, including appropriate assumptions and documentation.

Similar to the cost of a component, it is important to have sufficient information to be able to recalculate the estimated energy and cost savings presented by the auditor. However, it is sometimes difficult for the auditor to express exact figures, as much of what they provided is based on experience and exact estimates are not always something that can be calculated. Therefore, it is important that the auditor state their assumptions to the point that someone else can recreate the numbers they used. The more an assumption can be based on a documented reference, the better. If the auditor were to reference a university extension document that supported their assumption is more solid that stating they believe a certain savings can be achieved. Regardless, the assumptions made need to be documented in the report.

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.

STEP 8: Estimate simple payback period in years for each recommendation.

Each recommendation in the energy audit report needs to be represented by a simple payback period to show how quickly the landowner will recoup their capital cost of the new equipment from energy savings. This is a simple exercise to compute and is very helpful to the landowner in making decisions on whether to pursue a recommended improvement. Some components pay for themselves rather quickly, 2 to 5 years, however, many require greater lengths of time. Technology advancements often dictate whether the risk of payback periods greater than 8 years are worth taking. This is the landowner's decision, often made with the assistance of a lending source. It should be also noted that once a new component has paid for itself the subsequent savings thereafter further reduce the landowner's overall operating cost.

Generally, the representation of payback period will be shown in a table that depicts the energy savings value, energy savings cost (component), and simple payback period in years.

Example:

	Costs, Savings, Payback & Prioritization for Implementation				
Recommended Measure	Electrical Savings (kWh)	Natural Gas Savings (therms)	Installed Cost [a]	Energy Cost Savings [b]	Payback in Years [a/b]
Insulation - Seal Air Leaks	0	2,500	$1,500	$2,000	0.75
Heating Controls Upgrade	0	3,500	$8,075	$2,800	2.88
Lighting Upgrade	10,530	0	$6,023	$910	6.62

Table 1 – Suggested Components within Major Activities by Farm Enterprises for Audit Assessment

		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[6,7,10]	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.