CONSERVATION INNOVATION GRANTS

Final Report

Project Title:
Energy*A*Syst Comprehensive Farmstead Energy Self-Assessment Tool Kit: Continuation and Expansion

Agreement Number: NRCS 69-3A75-7-141

Grantee Name: Board of Regents of the University of Wisconsin System

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Deliverables

A. During the period of award, the grantee is required to attend at least one meeting hosted by NRCS. The meeting will provide a forum for technical feedback among grantees and NRCS.
B. National on-line self-assessment tools for energy efficiency.
C. National on-line self assessment tools for renewable energy production.
D. National on-line self-assessment tools for Greenhouse gas emissions
E. Verification of self assessment tools with detailed farm audits
F. National training in the use of these tools for cooperating state contacts.

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Executive Summary

The NRCS has been given the task of aiding farmers and growers in making their operations more energy efficient. This is outside of the traditional soil and water focus of the agency and they generally lack technical expertise in this area. This project, the Energy Self Assessment toolkit (ESA), provides education and tools to help NRCS carry out their great work. The objective of the project was to build on the work begun under Agreement 68-3A75-6-150 to develop web based energy education and assessment tools to aid farmers and the general public in learning what energy efficiency and renewable energy options are available. The assessment tools estimate the energy use and savings from different operations and processes on a variety of agricultural enterprises based on user inputs. The project also developed tools to aid in determining the energy generation potential from renewable energy sources. The existing energy self assessment tools have been expanded and refined to include tools covering lighting, ventilation, dairy farms, irrigation, grain drying, potato storage, greenhouses, maple syrup production, solar PV, solar water heating, biomass combustion, biogas (anaerobic digestion), wind and wind-solar water pumping. The greenhouse gas calculations have been incorporated into each tool so the affect of different processes and fuel types can be associated with the corresponding greenhouse gas generation or savings. In conjunction with the project, 91 on-farm energy audits were done to get user feedback and to assess the differences between a professional audit and a farmer using the energy self assessment for their farms. Training and introduction to the tools were done in conjunction with several professional meeting.

Comparisons with other tool provided reasonably close results although it varies by tool and often differs because of assumption or default values. Evaluations with farmers found that many were computer challenged and often didn't enter correct data compared to a professional audit. The tools strive to provide education about the different energy technologies that can either save or produce energy and provides an energy calculator with a modest number of inputs. At the end of each assessment is a link to a resource page with additional references for the person who wishes to learn more about an energy efficiency or renewable energy option or process. The tools are available at www.ruralenergy.wisc.edu.

Introduction

The USDA has been given the task of aiding farmers and growers in making their operations more energy efficient in the 2002 Farm Bill. This was the first time the USDA was given energy-related responsibilities which is outside of the traditional soil and water focus of the agency. They generally lack the technical expertise in this area so this project is very helpful in providing information to the agency as well as farmers and the general public. Prior to 2006 there were very limited options for agricultural producers to estimate the energy savings for a new process or technology. USDA-NRCS had developed some Energy Estimation tools that include dairy, poultry, swine, irrigation, and tillage. These tools help provide understanding of the relative savings for different technologies but make lots of assumptions in order to limit the number of inputs needed. The results aren't always relevant to the user's situation although it provides an estimate of the magnitude of the savings for different energy efficient technologies. Some utilities have offered some simple web-based tools but these seldom take into account interactions between different technologies.

In 2006 the development on the Energy Self Assessment web tools were started with tools for dairy, grain drying, irrigation, greenhouses and others for the upper Midwest region. The current project expands the 2006 tools developed under 2006 CIG Agreement 68-3A75-6-150 to be applicable to the entire U.S. and adds additional tools. The tools are meant to provide the user with information about energy efficiency technologies or renewable energy and estimates of the potential energy savings or energy production that is based on data input about their operation. The tools are designed to be simple yet provide lots of information with fewer assumptions than the USDA-NRCS Energy Estimator tools.

Background

Energy efficiency is not a high priority for many farms. This is often because the cost of direct energy in many production systems is low compared to other costs. For example, the electric, propane, natural gas or heating oil cost for a dairy farm is typically less that 2% of the overall cost of production. A greenhouse operator may be more likely to have a higher concern about energy costs because energy is typically 15% of the cost of production. There is also a lack of publications about energy efficiency in agriculture. There were many bulletins on energy efficiency published in the late 1970's and early 80's after the oil embargos of the mid 1970's but many of those publication are out of print or very out-dated. There is also a lack of priority and a consistent message about the importance of energy efficiency and renewable energy from leaders at the national, state and local levels which leads the general public in not making energy use reduction a personal priority.

The economic return from energy efficiency investments is also a concern of many farmers. A walk-thru audit for a moderate size farm may cost $200-$300 while a full farm audit may cost $1000-$2000 depending on the size of the enterprise. In many cases farmers don't think they will see a return on the investment for an energy audit. On-line web-base tools can be used as a first pass for a farmer to see if there is energy saving opportunities which may help rationalize having a professional do an on-site audit. It may also provide enough information for the farmer to act without further assistance or financial incentives.

Review of methods

The web base tools were developed by first identifying pre-existing studies of the energy characteristics, industry standards for energy calculation and potential energy saving technologies or processes. In many cases we used existing tools that were developed for the State of Wisconsin's energy conservation program, Focus on Energy (FOE). Using the available information, models were developed or modified using a spreadsheet program to organize the input data required, perform the calculations, make adjustments for exceptions and output a summary format that the user could understand with estimated energy savings for each energy efficiency option. Greenhouse gas emission reductions (in pounds of CO_2 equivalents) are calculated based on energy saved and published emissions rates for various fuel types and incorporated into each tool. A value of 1.65 lb CO2 per kWh is used for electricity based on EPA data for the Midwest. The spreadsheet programs were tested and then programmed into a web-based format. A resource page was developed for each tool to provide links to other bulletins and articles with additional details or links to associations or companies that offer equipment and services pertaining to the enterprise or technology. Tools were developed that cover dairy farm milk harvesting and housing, grain drying, irrigation, greenhouses, potato storage ventilation, maple syrup production, lighting, ventilation, livestock housing, biogas, biomass, wind, solar electric, solar thermal, and solar/wind water pumping.

Discussion of quality assurance

The goal of the Energy Self Assessment Tools was to provide an estimate of energy savings that would be within plus or minus 15% of the actual savings. The project provided energy audits to farms to help test the on-line tools against other existing audit tools but did not track if farmers installed any of the energy efficiency recommendations or the savings of such equipment. The energy audits did compare farmer's results from the on-line tools with a professional audit. The auditor with the Wisconsin Focus on Energy program and GDS Associates (Madison, WI) collaborated on this project to provide the field energy audits and the comparisons with the professional tools used by the auditors. The professional tools used were also developed by the University of Wisconsin and independently reviewed by the FOE evaluation group. The energy auditor did the comparisons between the two tools and compiled the data into a spreadsheet.

The tools and educational information were reviewed by multiple persons on the development team for accuracy, clarity and for calculation errors. When the tools were nearing completion as a website, the links to the tools were sent to other experts for review and comment. As part of the project, 60 farm energy audits were done to compare the on-line tools to auditor findings. This was in addition to the 30 farms audited during the Phase I project. During or before the farm visit, the farmers were asked to try the Energy Self Assessment website and share their comments and troubles in navigating the site, entering the require data and understanding the results. All comments were incorporated into improving the website.

Findings

Field audits

Observation from the audit staff during on-farm visits indicated that a large majority of the farmers were technically challenged when it comes to computer use. The Farm Computer Usage and Ownership survey released by USDA in August 2011 would bear out our observations. While 63% of farms own or lease a computer, only 37% use it for farm business and 12-14% use if to purchase inputs or conduct marketing activities. The survey reported that 35% use the computer to conduct business on non-agricultural websites. This could indicate that the spouse and children use the computer but few farmers use it regularly.

Farmer evaluations and feedback were important for working to make input needs and output tables more intuitive. Some of the output data is difficult to format in a way that would be understandable for many people and required a written explanation to help the user understand the meaning of the data. Even with these additions, some folks will have trouble deciphering what the data means when there are competing technologies being used together.

Dairy Tool

The dairy tool has been the most widely used of the tools. It was designed to minimize inputs by making some assumption about the amount of water used for washing the milk pipeline and bulk tanks. Some farmers have commented that they had trouble understanding the summary output table for the refrigeration heat recovery unit, well water precooler and water heater. The refrigeration heat recovery unit and well water precooler are competing technologies and they affect the quantity of water heating and therefore need to be considered together along with water heating because of the interactions between them. The summary table was redesigned several times and includes several links to help explain the summary results for different options.

- Rakow Dairy, Wisconsin, 35 cows, milk 2 times per day. Already has a refrigeration heat recovery unit. This farm was chosen for comparison because it has a unique vacuum pump set-up: pulleys are used to reduce the overall capacity of the vacuum pump system. The farm has a 10HP vacuum pump which would normally result in a 100 cubic feet minute (cfm) output but the capacity has been reduced to 70 cfm of vacuum by using different pulleys to slow to revolutions per minute of the pump. Therefore, variable speed vacuum pump savings were expected to be different between the two tools. Vacuum pump baseline energy was the same but the variable speed drive vacuum pump savings were 7% different between the tools. The Energy Self Assessment (ESA) tool estimates the hot water usage for washing the milk pipeline based on its diameter, number of milking stalls and accessory while the tool developed for the Wisconsin Focus on Energy (FOE) audits has inputs for the size of the wash vat or gallons of water used. The tools reported a difference of 2 gallons per day difference of hot water used resulting in a baseline difference of less than 1%. The difference in energy savings from installing a more efficient hot water heater was 13% difference. This difference was due to the assumptions used in the ESA tool for reducing inputs versus the inputs the auditor chose from an on-farm audit. The ESA tool showed a savings from a precooler of 3233 kWh while the FOE audit tool shows no savings because the farm doesn't have enough heat in the milk to meet 50% of the water heating needs. It is typically to more cost effective to use refrigeration heat recovery to displace water heating than use precooling to reduce refrigeration energy use. The estimate for using a scroll compressor was the same for both tools. Cumulative baseline energy usage on the farm differed by 3%. The electric water heating seemed to be the reason for the discrepancy in baseline energy reports between the ESA and Focus tools.

- DADS Dairy, Wisconsin, 525 cows, milk 3 times per day, Already an efficient farm with refrigeration heat recovery, precooler, variable speed vacuum pump, scroll compressors and variable speed milk pump. The baseline energy estimates are 2% different with the ESA tool estimating the same energy for milk cooling, 2.6% higher for water heating and vacuum pump energy use 3% higher than the FOE tool. Both tools estimate that an additional 6110 kWh per year could be saved if the precooler could reduce the milk temperature an additional 4°F which would bring the milk temperature down to within 3-4°F of the well water temperature with is the practical maximum cooling.

- Double T Acres, California, 300 cows, milked 2 times per day. Currently has well water precooler and variable speed vacuum pump. The baseline energy use for milk cooling, vacuum system and water heating vary by 23%. This difference was largely due to a 32% difference in the amount of hot water used and the auditor over-rode the default compressor EER default value to a more efficient value. The ESA tool estimated 56 gallons per day more hot water use than was reported by the on-farm audit. It appears the milk pipeline wash system is using substantially less water than would typically be recommended for the size of the milking system. The water heating baseline differs by 31% due to the difference in hot water use. A refrigeration heat recovery unit was recommended and the energy savings difference between the tools was 40% which was due to the amount of water used and the auditor chose an 80 gallon refrigeration heat recovery unit while the ESA tool assumes a 120 gallon unit. The well water precooler is cooling the milk 18°F out of a potential 33°F. Adding variable speed milk pump was recommended to increase the efficiency of the precooler. The difference in the estimated savings was 40% do to the auditor over-riding the default compressor EER.

Irrigation Tool

The irrigation tool can be used to model almost any type of irrigation system including center pivot, linear-move, solid-set, hand-move, side-roll, traveling gun, flood, furrow or drip/micro irrigation. The program calculates the energy savings from reducing the system pressure to 30 psi (if possible – depends on system type), reducing irrigation events through irrigation scheduling and management, and increasing pumping plant efficiency by 5%. The program also helps the farm evaluate fuel switching by calculating the equivalent cost of other fuel sources. We did not have any growers officially evaluate this tool but we did have one grower get part way and gave up and got some feedback from on-line users. There is lots of information to enter which increases the likelihood of a mistake. It may not always be obvious when there is an incorrect entry or missing data.

The program does error check for a minimum amount of input data but it can't check for many inputs because of the variety of system configurations.

- O'Brien Farms – Wisconsin - Center pivot irrigation powered by a diesel engine that covers 130 acres. The baseline energy use between the FOE and ESA tools differed by 1.3%. Reducing the system pressure to 30 psi will result in a savings of 844 gallons of diesel fuel for the ESA tool while the FOE tool estimated a savings of 820 gallons or a difference of 3%. Using the tools to predict the energy savings from one less irrigation event resulted in no difference between the tools. Increasing the pumping efficiency by 5%, the CIG tool estimated a 290 gallon of diesel fuel saving and the FOE tool estimated a 266 gallons saved or a 9% difference. The ESA tool also estimated cost savings of $8175 if the power unit for the pump was changed from Diesel to Electric. Fuel switching resulted in a small increase in greenhouse gas emissions. Since this audit was done, the grower did install a new well powered by an electric motor.

<u>Grain Drying Tool</u>
This tool compares the grower's dryer to all other major types of grain dryers used for corn drying. The potential energy savings is shown for the dryer only and for each option that could possibly be used with the dryer such as stirring in bin dryers or heat recovery or dryeration for high temperature dryers.

- Mark Gunn, Wisconsin, 200,000 bushels dried annually, continuous cross flow dryer with suction cooling heat recovery. Mixed Flow Grain drying with dryeration resulted as the most energy-saving recommendation according to the ESA tool. When compared to the FOE tool, the ESA tool reported energy and cost savings that were identical to the FOE tool.

- Jeremy Fikkema, Illinois, 700,000 bushels dried annually, continuous cross-flow dryer operated in a heat/cool mode with no heat recovery. The recommendation by the auditor was to convert to combination drying using the current high temperature followed by low temperature bin drying. The auditor rated the current dryer as being more efficient than default value used in the ESA tool so there is a 17% difference in the baseline energy use. The difference in energy savings was 33% comparing the FOE and ESA tools for converting to combination drying. Had the auditor chose the efficiency value recommend by the FOE tool the difference would have been identical.

- Greg Turnbaugh, Illinois, 32,000 bushels dried annually in a high temperature bin dryer. The proposal was to change the drying process to combination drying. The drying baseline energy use was identical while the energy savings difference between the tools was 1.5% difference.

<u>Greenhouse Tool</u>
This tool can model almost any type of heated greenhouse, even a greenhouse that shares a wall with a heated building where it would be assumed to be no heat loss. Many greenhouse operators have numerous greenhouses and some that can be very similar but use different growing environments based on crops grown. The tool does not allow a

grower to start over without having to enter all of the input data due to restrictions on the use of cookies by USDA. We will be looking to see if there is another way to start over without the need to re-enter all of the input data under the maintenance contract.

- Clesen Wholesale, Evanston, IL

This grower has a number of greenhouses but only one was selected for the comparison. The greenhouse is a 6 bay gutter-connected greenhouse that covers 25,380 square feet with glass glazing on the roof and 2 sides. The other 2 sides adjoin a heated building so no heat loss is assumed. The baseline heating varies between the FOE and ESA tools by 10% due to the use of different types of solar radiation data. The solar data is being standardized so they will be identical in the future. The tools estimated a thermal curtain savings within 1.2% difference and the energy savings from changing the glazing to double wall polycarbonate within 8%. This difference was partially due to the recommendation by the ESA tool to use 16mm double wall polycarbonate versus the auditor had recommended 8mm double wall polycarbonate. Upgrading the heating system to a 90% efficient heating unit showed a difference of 9.7% and switching to under-bench or in-floor heating indicated a difference of 16%. These were both due to the use of different solar data. Air infiltration is a very subjective measure and can not be accurately determine without testing. The ESA tool uses a 20% reduction while the auditor that did this audit estimated a reduction of 0.5 air changes per hour which is a 12.5% difference. Cost difference between the estimates was 42% or about $1200 for a greenhouse that is estimated to use $42,000 per year in natural gas. Once the solar data is standardize on the Wisconsin Focus on Energy tools, most of the values will be identical.

- Kinsch Greenhouses – Palatine, IL

The greenhouse used for comparison is 21,000 square foot, glass glazing on the roof and one side with one end wall constructed of polycarbonate and the other end wall framed and covered with plywood without insulation. One wall of the greenhouse is common with a heated building so no heat loss is assumed. The baseline energy use difference between the ESA and the FOE tool was 4%. The estimated savings difference between the tools was 8% for thermal curtains, 11% for changing glazing materials and adding insulation to the plywood wall, identical for adding perimeter insulation, 4% for increasing the heating system efficiency to 90%, and 71% for decreasing the infiltration rate. In this case the auditor estimated a 75% reduction in infiltration versus the ESA tool uses a 20% reduction.

<u>Lighting Tool</u>

The lighting tool allows the user to select from a list of typical fixtures and lamp configurations that are typically used in agricultural enterprises. The tool compares the lumen output from the current lamps to a typical efficiency for the type of lamps that would typically be used as replacements to estimate the energy use to provide the same light level.

- D A D S Farms, Wisconsin, 525 cows in freestall housing. Currently the farm uses twenty-six 400-watt metal halide lamps in the freestall barn and is considering replacing them with 6-lamp T8 fixtures. The auditor proposed switching metal halide fixtures one for one with 6-lamp T8 fixtures. Baseline energy costs and energy estimates were exactly the same for both the ESA and FOE tools. The T8 lighting savings differed by 24% between the ESA tool and the professional audit tool. This comparison is common but it results in 31% less lumens of light output. A 400-w MH lamps emits 23500 lumens and the T8 emits 16260 per fixture. The ESA tool matches the lumen output therefore if the lumen output is matched it will require thirty seven of the 6-lamp T8 fixtures. The efficiency for the 6-lamp fixture offer on the market is lower than for typical T8 lamp. If the T8 efficiency is adjusted and the number of fixtures increased the savings difference is less than 1%.

<u>Ventilation Tool</u>

The ventilation tool estimates the reduction in electrical use for replacing standard efficiency exhaust fans with high efficiency fans and/or the electrical savings from switching from high-speed stirring fans to high-volume low-speed (HVLS) over-head large diameter paddle fans. The tool assumes that the standard efficiency is the same as the average efficiency of the 75% least efficient fans that have been tested by BESS Lab that the University of Illinois. High efficiency fans are those in the top 25% of the fans tested by BESS Lab.

- D A D S Farms, Wisconsin, 525 cows, 500’ by 116’ freestall housing which currently uses 40, 48” - high speed circulation fans. Baseline energy use differed by less than 1%. Energy savings were reported to be less than 4% different between the ESA tool and FOE audit tools.

<u>Potato Storage Ventilation Tool</u>

The potato storage energy savings estimate is base on a research study done at the University of Wisconsin and uses an empirical equation based on length of storage and fan motor size.

Justin Bula, Wisconsin – Potatoes are stored in 3 sheds, two sheds with one 5 HP fan each and the third with a 3 HP fan. Standard efficiency motors were assumed. The combined baseline and energy savings for the sheds with 5 HP fans was 29148 kWh and 21555 kWh, respectively, based on the FOE audit tools with a difference of 1.5% on the baseline energy use and 12% on the energy savings between the ESA and FOE tools. The storage shed with the 3 HP fan had a baseline and energy savings of 8955 kWh and 6868 kWh, respectively, based on the FOE audit tools with a difference of 3% on the baseline energy use and 14% on the energy savings between the tools. The FOE tool allows different hours of operation based on the stage of storage while the ESA tool uses an average hours of operation over the storage period for non-variable speed fans and uses empirical data for the variable speed energy savings.

<u>Maple Syrup Tool</u>

The only publicly available tool that calculates the cost of evaporation is on Cornell University’s Sugar Maple Research & Extension Program website. The excel spreadsheet was authored by Chuck Winship and is not very user friendly. It includes some evaporation systems that were experimental and never commercialized. It was used for comparison to the ESA tool.

Duane Boon, WI – Produces 350 gallons of maple syrup in an open-pan wood fired arch. He estimated the use of 20 cords of wood at a cost of $60 per cord for fuel.
The baseline energy use varies by 16% between the tools but this can be attributed to the use of a lower energy content for a cord of wood, 20 MBtu, used for the ESA tool versus 23 MBtu used in the Cornell tool. A lower value was used because of the common use of mixed and soft wood versus all hardwood. If the wood energy content was set the same, the difference would be about 1%. Adding a preheater to the existing arch is estimated to save about $100 in fuel and a difference between the tools of 16%. A SteamAway is estimated to save $325 to $379 or a 16% difference. Adding a reverse Osmosis system to dewater the sap could reduce cost by $521 to $577 and had a difference between the tools of 11%.

Renewable Energy Tools Evaluation

The renewable tools were developed later during the project and were much harder to get farmers interested in using. The general lack of technical competence with computer use by farmers or general disinterest renewable energy may be some reasons for the low number of trials. There were 5 farmers that tried at least one of the renewable tools and all were used at least once – Solar PV – 1, Solar Thermal – 2, Biomass Heating – 2, Biogas – 2, Wind – 3 and solar/wind water pumping – 1.

Online renewable energy tools were compared to RETScreen renewable energy calculators (Developed by Ministry of Natural Resources – Canada). If there was a second tool available, it was also used for comparison. The following reports discrepancy differences between tools.

<u>Wind Tool</u>
Accuracy of the online calculator compared to the RETScreen module depends highly on the capacity factor input to RETScreen. The online tool is within 4.3% accuracy when considering kWh production from inputting kW. This is based on a 40% capacity factor on a 65kW turbine, which is high according to the typical range that RETScreen recommends. A more in-depth analysis which allows the user to input power curve data from a wind turbine was used for analysis. Power curve data was used for a used 65-kW turbine. The wind curve data just made the capacity factor low, around 22%. When RETScreen considers a capacity factor around 20-22% for a 65kW turbine, then the accuracy of the ESA tool goes down considerably. The ESA tool produces a kWh result that is almost double the RETScreen module output for a 60 kW turbine. For smaller turbines (12-30 kW rated capacity), the RETScreen module was closer to the ESA tool at 20% capacity factor. For RETScreen module turbines over 30 kW, then a higher capacity factor allowed the tools to be close together in their kWh outputs.

Seventh Generation Energy System (SGES), Madison, WI has developed a spreadsheet tool that is used by the Wisconsin Focus on Energy (FOE) renewable energy program to predict the energy output of specific turbines based on their power curves, tower height, turbulence index and wind speed distribution (Weilbull coefficient). For the first comparison an ARE442 wind turbine mount at a height of 30 m that is rated at 10 kW was compared to the Energy Self Assessment (ESA) tool. The estimated output is 15,464 kWh for the ESA tool and 9000 kWh per year for the SGES tool for a difference of 6464 kWh or 42%. Choosing a Bergey Excel-S which is also rated at 10 kW also mounted on a 30 m tower, the difference is 1332 kWh per year or 12%. A Northwind 100 is rated at 100 kW the SGES tool estimates the energy output at 120,511 kWh while the ESA tool estimates 167,192 kWh per year or a 39% difference. The tool provides an order of magnitude estimated which is likely as close as one can get unless a specific wind turbine model is selected. Turbine ratings are not done at a set wind speed so two turbines that are advertised as 10 kW may have different capacities if a set wind speed is used for comparison. For example, the ARE442 has a rating of 10.3 kW at a wind speed of 11 m/s while the Bergey Excel-S is rated at 8 kW.

Solar Electric (PV) Tool

The RETScreen tool allows entry of the power capacity of the PV system, as well as efficiency for system components. It also allows a user to choose the type of solar collector (choices include mono-Si, poly-Si, a-Si, etc.). For this comparison, mono-Si was chosen with a 45-degree angle on the collector with a zero-degree azimuth. Also, 10% miscellaneous were input as losses for the PV collector system and 10% misc. losses for the inverter. The RETscreen tool was input with 8.29 kW capacity panel, which is the output of the ESA tool when estimated the PV panel capacity to produce 10,000 kWh. The RETScreen calculator estimated production of 10,457 kWh for the 8.29 kW panels for Madison, WI. The RETScreen model also calculates tons of CO2 displaced, and reports values that are about 25% less than what the ESA tool reports.

The Solar Electric tool uses energy data from PVWatts, a solar PV modeling tool developed by the National Renewable Energy Laboratory. The ESA tool estimates it would require a 14 kW capacity system to produce 20,000 kWh per year for a solar PV system located in Wichita, KS. The PVWatts calculator estimates a 14 kW system could produce 19611 kWh per year, a 2% difference.

Solar Water Heating Tool

The ESA Solar Water Heating tool assumes a glazed flat plate collector. The differences between the ESA and RETScreen tools were 18% for glazed flat plate collectors.

The Texas State Energy Conservation Office (TSECO) has a simple calculator that was also used for comparison (http://www.infinitepower.org/calc_waterheating.htm). Inputs were for 100 gallons of hot water use per day using natural gas costing $1.00 per Therm. The water inlet temperature was estimated at 70°F from a ground water temperature map (Austin, TX) and the heated water temperature was assumed to be 130°F. It was assumed that the solar system would replace 50% of the water heating needs. The ESA tool estimated the cost for heating water at $365 per year and the TSECO tool, using a water heater energy factor of 0.5 (same as assumed in the ESA tool), estimated the baseline energy use at $297 per year, a 23% difference. The ESA tool estimated a $182 yearly savings and a system cost of $4960 based on a cost of $155 per square foot for a glazed flat plate collector. The TSECO tool displays a payback (years) based on an inputted capital cost. Using $5000 system cost, the calculated annual energy savings was $133 per year from solar water heating, a 36% difference.

Biomass Combustion Tool
The RETScreen biomass module is much more technical than the Energy Self Assessment tool. Overall, the differences between the results were very minimal, about 5%. A Canadian bioenergy project called "green heat initiative" (GHI) has a simple calculator to estimate the cost savings and equipment cost for wood pellets or wood chips (http://www.greenheatinitiative.com/Biomass_Calculator.aspx). Using an estimate of 1000 gallons of propane use for space heating at $2.00 per gallon and an 80,000 Btu/hr heater requirement, the GHI tools estimated the fuel need at 5.3 bone dry tons per year or 5.7 tons at 8% moisture and estimate the boiler/furnace cost at $7600. The ESA tool estimated the fuel requirement at 6.4 tons assuming a boiler/furnace efficiency of 78% and 8000 Btu per dry pound, a 12% difference. There is variation in the energy content of pellets and there are pellet boilers with efficiencies over 90% now which could be the reason for the difference in the fuel estimate. The ESA tool's assumptions can be changed to match most situations. The assumptions for the GHI tool wasn't stated.

Biogas Tool
The RETScreen module allows a user to enter the kW capacity of the electric generator. Therefore, the kWh production based on the kW capacity closely matches between the two tools. The cubic feet of biogas consumed in the RETScreen module closely matched our proprietary calculator. The volume of gas consumed in the RETScreen calculator is based on the generator capacity input in kW. Although, there is a discrepancy between RETScreen's volume of biogas production versus the ESA tool, the amount of volatile solids differs by source, and the ESA tool uses figures derived from actual, on-farm dairy production.

Producer Evaluations

As part of the evaluation of the web site, we asked farmers that were participating in the farm audits, to try the on-line tools and provide us feedback on ease of use, understanding of the information presented, data collection, etc. A group of 28 farmers were contacted about participating in this study of which 13 farmers used 7 of the 16 tools and 11 didn't use the tools for various reasons from no-computer to too busy.

Producers who tried the tools gave positive reactions about the tools they used. Dairy, lighting and grain drying were the three most used conservation tools. Biogas was the most used renewable tool. Most producers felt that the tools were easy to use and that they would recommend their use to others producers.

The summary (see Appendix B) indicates that the suite of farm energy tools has potential for assisting producers to assess their energy use. Some data from the user surveys suggested that the tools had helped producers prepare for the professional audit making them aware of the information that would be required. In addition, data from some user surveys indicated that these tools have value in building awareness of energy conservation considerations as well as learning about renewable energy options.

The difference between the farmer's results using the Energy Self Assessment Dairy tool and a professional audit varied widely. Much of it was caused by incorrect inputs by the farmer. It was observed that farmers often didn't change pre-filled values to match there own operations perimeters, for example the electric cost per kWh was defaulted to $ 0.10 but this of course varies by utility and region. There seemed to be a larger error percentage for the dairy tools than the other tools but the dairy tool was also the most widely used tool.

Audit Comparisons

There were over 90 audits done as part of the project to compare the Energy Self Assessment tools (ESA) to professional audit tools used by Wisconsin's Focus on Energy (FOE) Program. Audits were done in 9 states including California, Florida, Illinois, Massachusetts, Minnesota, Ohio, Oregon, Pennsylvania and Wisconsin. Dairy farm audits were done on 63 farms, 10 with grain drying facilities, 9 had both dairy and grain drying, 6 greenhouse audits, 5 on livestock farms and 2 each for potato storage and maple syrup production. The dairy farms averaged 215 cows with a range from 16 to 2000 cows per farm. Grain drying operations averaged 165,000 bushels per year dried with a range from 9500 to 700,000 bushels. The greenhouse operations averaged about 40,000 square feet of covered area Table 1 below shows the distribution of audits by state and enterprise type audited. Sixty one farms were from the upper Midwest and 41 farms were from California, Florida, Massachusetts, Oregon and Pennsylvania.

There was an average of 3.16 energy efficiency recommendations per farm for an average savings of 546 MMBtu with an energy savings potential for all farms of 46,954 MMBtu. Table 2 lists the technologies and estimated average payback for all farms audited. The dairy farms audited averaged 3.2 recommendations with a potential energy savings of 174 MMBtu per farm and paybacks ranging from 2.1 to 22.9 year. The greenhouse operations averaged 4 recommendations per grower and a potential energy savings of 3555 MMBtu each. Excluding perimeter insulation (25.5 year payback), paybacks ranged from 0.6 to 6.9 years.

Web Programming

This part of the work turned out to be challenging because of the restriction placed on web development by USDA because of not allowing the use of cookies. This limits the ability to allow users to start over on a tool without re-entering all of the data and doesn't allow data from a previous assessment to be provided or to track and remind users which assessment they have finished and which they haven't yet done. We received complaints on assessment with many inputs (greenhouse and irrigation) because if the user wanted to look at different energy efficient options or had systems of similar sizes, they have to re-enter all of the data for each run they wanted to try instead of just changing a few inputs.

Table 1: Audits by State and Enterprise Type

	Number of Farms By State	Grain	Dairy	Dairy and Grain	Greenhouse	Livestock	Potato	Maple Syrup
California	7		7					
Florida	3		3					
Illinois	15	4	4	4	3			
Massachusetts	3		2		1			
Minnesota	7		7					
Ohio	7	1	4	2				
Oregon	7		7					
Pennsylvania	20		18		2			
Wisconsin	28	5	11	3		5	2	2
	97	10	63	9	6	5	2	2

Table 2: Payback per Recommended Technology:

	Payback per Technology does not include all recommended technologies, as some did not have an accurate cost associated with them to determine payback.	
	No. Farms Recommended this Measure*	Average Payback (years)
Greenhouse Reduce Infiltration	3	0.6
Greenhouse Heating System Upgrade	6	5.4
Greenhouse Temperature Set Point Change	4	n/a
Greenhouse Perimeter Insulation	3	25.5
Greenhouse Thermal Curtain	5	6.9
Greenhouse Glazing	5	1.8
Crop Storage VFD	1	0.8
Livestock Waterer	9	2.1
Ventilation	7	6.6
Water Heating Upgrade	21	9.5
Variable Speed Vacuum Pump	28	10.3
Milk PreCooling	32	22.9
Scroll Compressor	35	21.2
Refrigeration Heat Recovery	47	9.4
Lighting	51	4.4
Grain Dryer Upgrade	15	12.3

*Farms could have more than one of the mentioned technology per farm. For instance, a farm was counted as "one" even though they were recommended to replace three livestock waterers.

Maintenance of this site will be important to keep it viable in the future because links will need to be fixed and there is some time sensitive material in some areas of the web site. The current federal incentives for renewable energy technologies are set to end on December 31, 2016. The renewable tools will need to be updated depending on changes to the incentives programs.

Training

Presentations on the use of the tools were made at multiple meeting and events. In 2008 presentations were made at the Midwest Rural Energy Council Annual meeting, Wisconsin Potato & Vegetable Growers meeting, ASABE Annual meeting in 2008, and the ACEEE Forum on Energy Efficiency in Agriculture. In July 2009 a presentation was made at the SWCS meeting in Detroit and in February 2010 a workshop was held at the ACEEE meeting in Madison, WI. Presentation titles and dates are listed in Appendix C.

Conclusions and recommendations

None of the models can estimate energy savings with 100% accuracy for every situation. The Energy Self Assessment tools will provide a "Best Available Estimate" at a low cost and with minimal time commitment. In some cases the Energy Self Assessment Tools will provide enough information to encourage investment in energy efficiency without an independent audit or financial incentives and grants. For some, the tools will provide the confidence that an independent energy audit will provide some financial return. With timely maintenance to fix broken links and update time sensitive materials, the Energy Self Assessment site should aid farmers in determining what and where to invest in energy efficiency and renewable energy for many years. The Energy Self Assessment website does needs to be incorporated into the NRCS suite of web-based Energy tools so more people are exposed to it and it become a central location for finding information.

<u>Future</u>

This tool could be expanded in the future to include poultry and swine production. This could involve developing an energy model to simulate the heating and ventilation of barns based on typical weather data and animal loading to provide baseline energy values to aid in determining if the barn is being over ventilated, poorly insulated or heaters are operating inefficiently. The current greenhouse tool is only calculates heating needs. In the southern US ventilation and cooling energy use is a higher energy use than heating. Incorporating ventilation and cooling in to the greenhouse model would increase its use in the southern US.

The USDA-NRCS has developed a draft of a tool (spreadsheet) to assess the energy usage for field crop production. This tool allows one to estimated energy use from different cultivation practices, tillage operations, crop rotations and fertilizer inputs. The tool can be used to assess the cultivation and harvest of almost any crop. This type of tool could be incorporated into the Energy Self Assessment website to allow farmers easy access to this tool.

Incorporating the use of cookies into the Energy Self Assessment tools would allow users to easily come back to the tools to re-run options without having to reenter all data. This could have the option for a user to not use permanent cookies but the disadvantage would be that all data would need to be reentered. Cookies would eliminate some of the complaints received about the use of some tools. Cookies are stored on the user's computer and are only the input data for the tools. They would not contain any information that could link them any closer than a zip code area. The website never asks for any names or addresses. None of the data would be stored on a USDA server.

Appendix A - Evaluation report

Evaluation Feedback: NRCS Web-based Farm Energy Self-Assessment Tools

INTRODUCTION

This report presents results of efforts to evaluate a suite of energy self-assessment tools developed for The Natural Resources Conservation Service (NRCS), United States Department of Agriculture, funded by a Conservation Innovation Grant (CIG). The suite of web-based tools was developed so farmers could independently assess their energy use and identify ways to reduce energy consumption or produce renewable energy for various agricultural enterprises. Developers were Scott Sanford, Biological Systems Engineering, University of Wisconsin-Madison, Jennifer Brinker and Joe Schultz, GDS Associates, Inc., Madison, Wisconsin. See http://www.ruralenergy.wisc.edu/ for detailed information about the suite of tools.

Janice Kepka, Web and Technical Support Manager, Environmental Resources Center (ERC) provided on-going evaluation consultation and was responsible for evaluation efforts. Assisting her was Jacob Blasczyk, ERC Evaluation Specialist. This report primarily focuses on results of efforts to collect information about the tools from users. Another more extensive quantitative evaluation took place over the life of the development effort which included developers critiquing each tool and validating the data outputs of the various on-line assessment tools. As a result of on-going critique and review, numerous modifications were made to the tools.

The user focused evaluation occurred during the last twenty months of the project. Developers initially identified questions to investigate listed below.

- Overall impressions of the tools?
- Are the reports understandable and/or meaningful?
- Is the information presented useful and/or meaningful?
- Would users recommend these tools to others?

The intended evaluation design called for collecting information from various users of the tools and that would address the above four questions. Doing so proved to be challenging. Factors contributing to the challenge included, (a) continual refinement of the suite of tools meant that not until late in the project were there final versions of the tools available for an evaluation, (b) number of tools (total of 16) developed and (c) the variety of different types of users.

Various feedback methods were considered or attempted, including focus groups with different types of users, and rejected because of factors listed above. An on-line user survey, part of the web site providing access to the tools, was developed and implemented. This survey was used primarily by field auditors to send back information about the operations and functionality of the tools. The survey did not yield significant quantities of data from independent users. Capturing number of hits and use of the web site tracked by typical on-line tools was also attempted. Distinguishing data from actual users and use of the website by developers to refine tools was impossible.

Finally, interviews were planned with those who attended a session at the American Council for an Energy Efficient Economy (ACEEE) Forum held in Madison, WI in February 2009 about the tools and who were likely to use any of the tools. Volunteers were recruited during the session. E-mails were sent to the five volunteers and to date one indicated he did not use any of the tools as planned and four never responded.

USER FEEDBACK SURVEY

The sole data collection method was a survey (see Appendix A, PDF files), along with an optional informal interview, that Wisconsin based auditors administered in conjunction with field audits they had with producers. Administration began during the summer of 2009. Producers received a packet of information in advance of the auditor's visit. The packet of materials introduced the development project and asked the producer to use the online tools prior to the field visit. Producers were encouraged to try at least one conservation tool and one renewable tool. The seven question survey included in the packet was to be completed before the actual audit with responses written on the survey. During the farm visit, auditors were also encouraged to interview producers about their use of any on-line tools following a prepared protocol.

Three auditors were involved in the data collection process and twenty-eight (28) surveys from producers were returned and available for analysis. Another four were returned after analysis was completed. Producers were from California, Pennsylvania and Wisconsin. Data for the surveys were entered into SPSS, a statistical software package. Essentially, analysis involved developing inferences based on tendencies, trends, and patterns within the data. Further reflection and study of inferences resulted in findings. The four surveys received after data analysis were reviewed for additional insights

Specific findings according to user survey and auditor informal interviews are now presented.

User Survey Data

Question response totals reflect that some producers did not respond to all questions.

Data Collection Forms Fairly Easily to Use

Respondents were asked which statements best described their experience using the data collection forms they received for the onsite visit. Twelve (12 or 42.9%) of the 23 respondents described their experience as "easy to use" while another 39% or 11 felt their experience was "somewhat easy to use." In contrast, only one respondent (3.6%) described their experience as "somewhat difficult to use" and no respondents found it "difficult to use."

Seven of the Sixteen Tools Were Used

Respondents reported which online energy assessment tools they used. Thirteen (13 or 54.2%) of the 24 respondents had used at least one tool and the remaining (45.8% or 11) had not. Reasons for not using the tools included no access to computer or internet and no money for upgrades. Seven of the 16 tools were used and these were:

- Dairy – 66.7% or 14
- Grain Drying – 16.7% or 4

- Lighting – 13.0% or 3
- Irrigation – 5.0% or 1
- Ventilation – 5.0% or 1
- Solar PV (Electric) – 5.0% or 1
- Solar Water Heating – 5.0% or 1

Time Spent Using a Tool Varied

Fifty-seven percent (57% or 13) of the 23 respondents spent less than one hour using the online assessment tools. Two respondents (8.7%) spent about one hour and one respondent (4.3%) spent 1-2 hours. The remaining (30.4% or 7) did not use any of the tools.

Most Felt Using the Online Assessment Tools Was Easy

Respondents were asked which statement best describes their experience using the online assessment tools. Seven (7 or 31.8%) of the 22 respondents described the tools as “easy to use” and 5 or 22.7% found the tools “somewhat easy to use.” In contrast, 13.6% or 3 respondents described the tools as “somewhat difficult to use.” The remaining (7 or 31.8%) did not use any of the tools.

Using Tools May Have Somewhat Influenced Considering Energy Efficient Practices

Respondents were asked if they were considering applying energy efficiency practices on their operation as a result of using the online assessment tools. Fifty-two percent (52% or 11) of the 21 respondents “may consider new practices but are not sure when.” Two (2 or 9.5%) are “not considering changes” and one respondent each “may apply practices within the next six months” or “within the next year or two.” The remaining (6 or 28.6%) did not use online tools.

Those Who Answered the Question Would Recommend Tools

Sixty percent (60% or 12) of the 20 respondents who answered the question would recommend the online assessment tools to other producers. The remaining (40% or 8) did not use online tools

Relatively Few Other Comments Offered

A portion of the survey was left for any other comments about the online assessment tools. Comments were relatively few and these included:

- “Had some issues with an error that came up when we tried to fill out the grain form for a cross flow batch dryer, but resolved it when we check combo high/low temperature dryer”
- “Sheets provided were easy to fill out, but was uncomfortable with the online tool”
- “Wonder if the tool takes into account the extreme years in corn moisture”

Auditor Informal Interviews

In addition, auditors were encouraged to interview producers, if at all possible. Not all auditors were able to interview producers that they visited. Data from records were entered into SPSS and open-ended notes were aggregated into a Word file. These data resulted in the following findings.

Nine Used Tools Prior to Visit

Auditors again asked respondents if they had an opportunity to try any of the on-line tools. Nine (9 or 69%) of the 13 respondents stated they had used online tools and filled out the required survey form. The remaining (4 or 31%) had not used online tools but were willing to do so in the next week and complete the form.

Six Tools Used

If online tools were used, auditors asked respondents to identify them. The following were used:

- Dairy – thirteen (13) producers
- Lighting – six (6) producers
- Grain Drying – four (4) producers
- Irrigation – two (2) producers
- Waterer/Water Fountain – one (1) producer
- Biogas – one (1) producer

Using Online Tools Aided Preparation for Site Visit

Respondents were asked if the online tools helped to prepare for the on-site audit visit. Eighty-five percent (85% or 17) of the 20 respondents felt that the online tools helped them prepare for the visit. A common shared sentiment, as expressed by one producer was that using the online tools "gave a heads up for what was coming." Another common message was that using the online tools helped collect the needed information for the audit itself. Those who did not use the online tools prior to the onsite visit seemed to have forgotten to do so or felt no need to do so.

Most Would Recommended Using Tools

Eighty-two percent (82% or 14) of the 17 respondents would recommend the online tools used to another producer. Among frequently mentioned reasons for a recommendation were the tools gave ideas for energy savings and the ease of using the tools. The three who would not recommend felt were difficult to, results were confusing, and another was still unsure how much was gained from using the tools.

Relatively Few Suggestions for Improvement Were Offered

Respondents had an opportunity to give suggestions for improving online tools that were used. Relatively few suggestions were made. One respondent felt that the tools used seemed "set up more for Midwest states (especially irrigations)." Specific suggestions included: more clarification, do something to lessen confusion in filling out information, and “Get the bugs out with dairy, otherwise questions were pretty simple, can get through ok.”

SUMMARY AND OBSERVATIONS

In summary, producers were positive in their reactions about the tools they had used. Dairy, lighting and grain drying were the three most used conservation tools. Biogas was the most used renewable tool. Most producers felt that the tools were easy to use and that they would recommend their use to others producers.

The above summary indicates that the suite of farm energy tools has potential for assisting producers to assess their energy use. However, the extent producers can use the tools independently from a professional audit would require further evaluation and one not linked to the audit. In the meantime, some data from the user surveys suggested that the tools had helped producers prepare for the professional audit. In addition, data from some user surveys indicated that these tools have value in building awareness of energy conservation considerations as well as learning about renewable energy options.

To conclude, findings reported here point to how a convenient sample of producers used the tools and their overall positive reactions to this experience. A convenient sample is one assembled based on the availability of its members and using one presents limitations. A limitation in this case is the inability to say much about the merit or worth of the suite of tools under conditions when a producer independently uses the tools without any scheduled professional audit.

Submitted on August 18, 2010 by Janice Kepka, Web and Technical Support Manager, and Jacob Blasczyk, Evaluation Specialist, Environmental Resources Center, University of Wisconsin-Madison.

Appendix B - Field Audit Report

Summary of Farm Energy Audits

No.	City	State	Enterprise Type	Measures recommended per Farm *	Energy savings /farm MMBtu *
1	Livingston	WI	Grain	1	124.4
2	Gratiot	WI	Grain	1	2583.7
3	Seymour	WI	Dairy	1	35.2
4	Sugarcreek	OH	Dairy	3	134.5
5	New Philedelphia	OH	Dairy	3	124.9
6	Millersburg	OH	Dairy	3	128
7	Howard	OH	Dairy and Grain	4	340.2
8	Mt. Gilead	OH	Dairy	4	97.9
9	Cardington	OH	Grain	1	1134.3
10	Kewaunee	WI	Dairy	4	981.5051
11	Oconomowoc	WI	Dairy and Grain	4	182.67
12	Mosinee	WI	Dairy		
13	Marathon	WI	Livestock	1	14.6
14	Edgar	WI	Dairy	1	30
15	Auburndale	WI	Livestock		
16	Marathon	WI	Dairy	3	41.688
17	Beaver Dam	WI	Grain	1	1126.5
18	Arkansaw	WI	Grain	1	71.1
19	Plum City	WI	Grain		
20	Edgar	WI	Dairy	1	45.4336
21	Auburndale	WI	Dairy	3	80.78458
22	Warrens	WI	Livestock	1	2.59312
23	Pearl City	IL	Dairy and Grain	6	473.4285
24	Pearl City	IL	Dairy and Grain	6	384.4523
25	Pearl City	IL	Dairy and Grain	4	113.8101
26	Arena	WI	Potato	1	494.2418
27	Arkansaw	WI	Dairy	4	44.9258
28	Mindoro	WI	Dairy	2	3.152688
29	Marshfield	WI	Dairy		
30	Neillsville	WI	Dairy	4	21.7242
31	Palatine	IL	Greenhouse	6	6263.9
32	Mundelein	IL	Greenhouse	5	2879.3
33	Evanston	IL	Greenhouse	4	9476.9

No.	City	State	Enterprise Type	Measures recommended per Farm *	Energy savings /farm MMBtu *
34	Whately	MA	Greenhouse	5	4528.275
35	Middleboro	MA	Dairy	5	148.7194
36	Sterling	MA	Dairy	3	72.82645
37	Gerber	CA	Dairy	3	8.53
38	Modesto	CA	Dairy	4	93.85312
39	Eugene	OR	Dairy	3	126.3732
40	Coos Bay	OR	Dairy	3	59.74412
41	Cloverdale	OR	Dairy	1	23.74752
42	Yamhill	OR	Dairy	4	74.58632
43	Merced	CA	Dairy	4	250.0916
44	Stevinson	CA	Dairy	5	73.90392
45	Modesto	CA	Dairy	3	33.19876
46	Modesto	CA	Dairy	3	43.05944
47	Myrtle Point	OR	Dairy	3	122.1591
48	Myrtle Point	OR	Dairy	6	207.1835
49	Denair	CA	Dairy	1	3.71908
50	Tillamook	OR	Dairy	5	59.09888
51	Mifflinburg	PA	Dairy	3	7.91584
52	Chalfont	PA	Greenhouse	4	1251.18
53	Mercersburg	PA	Dairy	4	23.91812
54	Richfield	PA	Dairy	2	7.09696
55	Shippensburg	PA	Dairy	2	14.26216
56	Thompsontown	PA	Dairy	3	13.37504
57	Honey Grove	PA	Dairy	2	8.56412
58	Thompsontown	PA	Dairy	1	11.49844
59	West Grove	PA	Greenhouse	3	471.1904
60	Mifflin	PA	Dairy	3	27.32612
61	East Waterford	PA	Dairy	4	34.15704
62	Mt Pleasant Mills	PA	Dairy	1	3.27552
63	Elizabeth	IL	Dairy	4	57.94564
64	Chadwick	IL	Grain	2	108.1468
65	Mt. Carroll	IL	Grain	3	113.8781
66	Lanark	IL	Grain	3	3569.487
67	Mifflinburg	PA	Dairy	2	6.38044
68	Millmont	PA	Dairy	3	29.6844
69	Lewisburg	PA	Dairy		
70	Lewisburg	PA	Dairy	1	2.0472

No.	City	State	Enterprise Type		Measures recommended per Farm *	Energy savings /farm MMBtu *
71	Galena	IL	Dairy		5	134.2281
72	Elizabeth	IL	Dairy		4	88.97428
73	Savanna	IL	Dairy		5	149.5478
74	Elizabeth	IL	Dairy and Grain		4	1671.391
75	Chadwick	IL	Grain		1	73.88902
76	Granville Summit	PA	Dairy		2	33.19876
77	Lewisburg	PA	Dairy		3	15.75664
78	Gillett	PA	Dairy		1	13.68212
79	Gillett	PA	Dairy		2	18.52716
80	Bell	FL	Dairy		6	2143.801
81	Branford	FL	Dairy		6	1922.852
82	Gainesville	FL	Dairy		6	671.3528
83	Caledonia	MN	Dairy		6	187.2779
84	La Crescent	MN	Dairy		4	83.04648
85	Lake City	MN	Dairy		4	72.73236
86	Spring Grove	MN	Dairy		3	73.93804
87	Lewiston	MN	Dairy		4	70.50788
88	Rushford	MN	Dairy		3	129.0206
89	Lewiston	Mn	Dairy		5	62.30312
90	Springfield	OH	Livestock and Grain		3	139.6142
91	Greenwood	WI	Maple Syrup		1	72.3071
				AVERAGE	3.16	551.55

Online Evaluation only

No.	City	State	Enterprise Type
92	Stevens Point	WI	Dairy
93	Spooner	WI	Dairy
94	Neillsville	WI	Maple Syrup
95	Marengo	WI	Dairy
96	Crandon	WI	Potato storage
97	Denmark	WI	Renewable
98	Mischicot	WI	Wind
99	Gays Mills	WI	Biomass/wind
100	Mount Horeb	WI	Livestock

* Blanks indicate no recommendation were made for the enterprise and processes covered by this project. No-till crop production methods was often recommended but crop production was not included in this project.

Appendix C – Presentations

American Society of Agricultural and Biological Engineers 2008 Annual Meeting, Providence, RI, June 29-July2, 2008
The following presentations were made:
- Web-Based Energy Self Assessment Tool – Dairy (poster session)
- Web-Based Energy Self Assessment Tool for Irrigation
- Web-Based Energy Self Assessment Tool for Greenhouses
- Web-Based Energy Self Assessment Tools for Grain Drying

Midwest Rural Energy Council
La Crosse, WI February 28-29, 2008
- Lighting and Livestock Waterer On-line Energy Assessment Tools
- Irrigation-grain-drying, Energy Self Assessment Tools
- Greenhouse-potato-storage, Energy Self Assessment Tools
- The CIG Energy Self Assessment Tool Collaboration
- NRCS Energy Efficiency Tools: Dairy and Beef Operations

Wisconsin's Annual Potato Meeting – 2008
Stevens Point, WI, February 5-7, 2008
- Web Based Energy Assessment Tools for Growers

Soil and Water Conservation Society Annual Meeting
Detroit, MI, July 13, Conservation Innovation Grants Showcase
- Web-Based Energy Self Assessment Tools

American Council on Energy Efficient Economy
Profitability and Environmental Sustainability in the Dairy Industry
Madison, WI, February 7-10, 2010
- Audit Workshop: Self-Assessment Tools

Food and Energy from the Ground Up: Efficiency's Role in Sustainable Agriculture
Des Moines, IA, February 20-22, 2008
- Panel discussion – What tools are available for energy audit?
    Jennifer Brinker – On-line Farm Energy Assessment