PURDUE EXTENSION | AGRICULTURAL AND BIOLOGICAL ENGINEERING

RE-11-W

Renewable Energy

Fueling and Feeding America Through Renewable Resources

A Guide to Prepare for a Grain Dryer Energy Audit

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EXPERT REVIEWED

Introduction

Seasonal grain drying using high-temperature, continuous-flow dryers is one of the largest energy budgets incurred in grain crop production in the Midwest. Most of the corn crop is dried using grain dryers, in some cases with as much as 10 percent moisture point removal. But many dryers on US farms are showing their age. Meanwhile, the USDA is emphasizing increased energy efficiency in agricultural production and a reduction in fossil energy usage.

USDA REAP grants and loans have provided farmers with opportunities to purchase newer, more energy-efficient grain drying technologies. However, to access USDA REAP funds, farmers are required to utilize the services of a reputable energy auditor who will conduct a comprehensive energy audit of their existing grain dryer system and provide a comparative analysis to the proposed new system.

Purdue University has a proven track record of conducting on-farm energy audits for the replacement of grain drying systems. To date, Purdue Renewable Energy and Energy Efficiency/Grain Post-Harvest Extension programs have conducted more than 450 such audits on US farms, primarily in the Midwest. Audits conducted since 2008 have been used primarily by farmers applying for USDA REAP grants and loans. Several farmers have been successful in using energy audit documents to acquire funding from utility rebate programs for electricity and for natural gas efficiency improvements.

This bulletin provides a step-by-step guide to prepare for a grain dryer energy audit. It also discusses how an energy audit — following procedures provided in an ASABE Standard, "Performing On-farm Energy Audits" (ANSI/ASABE S612 JUL2009) — is conducted.

What the producer needs to do

The energy audit begins with the farmer ("client") contacting the Purdue Renewable Energy and Energy Efficiency Program via the website, https://extension.purdue.edu/renewable-energy/on-farm-efficiency.shtml. The client is then connected with a Purdue Extension Specialist.

To initiate an audit, the client needs to take the following steps:

1. The client signs an agreement upon engagement, which describes the roles of the client and the auditor and stipulates that the information provided to the auditor is valid and accurate. Fees are discussed and agreed to; a site visit is scheduled.
2. The following field data information is required to be assembled by the client (farmer) and collected by the auditor during the scheduled on-farm site visit:
   a. Collect and copy previous three years of fuel — propane or natural gas — and electricity bills (ASABE Standard).
   b. Collect and copy documentation of grain production and drying quantity for previous three years (crop insurance records, logbook on farm, terminal dump tickets).
   c. Provide existing dryer owner's manual and insights on the operational performance of the dryer (over-drying, slower dryer capacity, possible burner, motor, sensor replacement, or maintenance issues). Additional feedback about the performance of the dryer (burner rate fluctuation, bushel per hour variance, etc.) will also be considered by the auditor.
   d. Determine typical moisture content removal average over the harvest period.
   e. New dryer make and model with project costs.
   f. The auditor takes pictures of the existing dryer, showing the overall condition and documenting the hours meter when available.

What the Purdue Auditor does with your data

1. The data is taken to campus with the following audit report creation activities:
   a. Summarize fuel bills, electric bills and bushels documentation.
   b. Calculate an average fuel cost (per gallon propane, or therm natural gas) and electricity cost per kWh based on bill history.
   c. Calculate the average bushels dried over the three years.
   d. Using the existing dryer specifications provided, create the parameters of the existing dryer within the grain dryer engineering analysis tool created by Purdue University Department of Agricultural and Biological Engineering.

   Variables used to create the simulation:
      i. Drying Mode (full heat, dry cool, mixed flow, dry, or vacuum cool)
      ii. Drying capacity
      iii. Cooling capacity
      iv. Airflow rate (CFM/BU)
      v. Fan motor horsepower
      vi. Cost per unit of fuel
      vii. Cost per unit of electricity
      viii. Plenum temperature
      ix. Ambient temperature
      x. Relative humidity
      xii. Moisture going in and moisture going out

e. When evaluating the proposed new dryer, the same parameters are used to simulate in the Purdue grain drying evaluation tool. When the Purdue tool is not equipped to evaluate various parameters, such as ambient air intake variables, ask the grain dryer manufacturer to provide assumptions for energy performance. The following parameters remain constant when comparing the existing dryer to the proposed new dryer:
   i. Cost per unit of fuel
   ii. Cost per unit of electricity
   iii. Plenum temperature
   iv. Ambient temperature
   v. Relative humidity
   vi. Moisture going in and moisture going out

When considering in-bin drying strategies, the following parameters will be collected:

   i. Bin height and diameter
   ii. Drying strategy (constant heat, natural air, self-adapting variable heat, Stirrator system).
   iii. Airflow rate (cfm/bushel)
   iv. Moisture in and moisture out

f. The data from the simulation tool is then used to calculate total energy costs and BTU consumption for the existing dryer as well as the proposed new dryer. Spreadsheet inputs are:
   i. Cost per unit of fuel and electricity
   ii. Cost per bushel for fuel and electricity from the simulator
   iii. Total bushels dried in the existing dryer and new dryer (same bushels used to have consistent capacity comparison)
   iv. Conversion of both fuel and electricity units to BTUs
   v. Project cost

g. Outputs from the spreadsheet include:
   i. Total gallons or therms of fuel consumed annually (both existing and new dryer)
   ii. Total kWh consumed annually (both existing and new dryer)
   iii. BTUs of fuel consumed annually (both existing and new dryer)
   iv. BTUs of electricity consumed annually (both existing and new dryer)
   v. Cost of electricity and fuel annually (both existing and new dryer) **It should be noted that the actual energy consumption from the utility bills is used to place a ceiling on the total number of bushels dried that the client reported to be dried.**
   vi. BTU savings between existing and new dryer, and the percentage difference
   vii. Cost savings between existing and new dryer, and the percentage difference
   viii. Simple payback period, in years

h. This data is used to build a report that contains the following:
   i. Situational analysis, depiction of the existing dryer profile information and energy costs paid by the audit client.
   ii. Description of the improvements made with a new dryer and costs.
   iii. Technical analysis, which estimates the annual energy and energy costs savings from each improvement.
   iv. Calculations of all direct and attendant indirect costs of each improvement.

v. Ranking potential improvement measures by cost-effectiveness but only when there are more items than the grain dryer equipment alone.
vi. Potential improvement description with pictures of the existing dryer and aerial view of the location of the new dryer.

Your audit report

Once grain drying system comparison calculations are made between your existing and proposed drying system, the audit staff will create a cover letter with a summary of the results and a report of the background information used to come to the audit conclusions. The following will be provided in the cover letter summary:

a. Drying costs for the existing and proposed grain dryer, with moisture removal rates
b. Annual BTU savings
c. Annual percentage of cost savings
d. Annual BTUs of energy saved (combined electric and fuel)
e. Annual cost savings in dollars
f. Project cost for upgrade
g. Total bushels dried
h. Years to payback (simple)

Terminology and Definition of Units Used:

LP – Liquid Propane

NG – Natural Gas

1 bushel = 56 lb. at 15.5% moisture content, wet basis (w.b.)

1 BTU = 100,000 therms

1 gallon LP = 91,660 BTU

The report will include the following details:

a. Situation report — this will describe the farming operation, the existing system, the name of the auditor and date of the farm visit, crop records of grain dried and moisture removal, fuel and electricity use summary.
b. The potential improvements to be made with new dryer specifications.
c. Technical analysis of the improvements to be made, with the estimated annual energy savings based on engineering calculations and parameters of the same amount of grain dried and energy costs per unit as in previous years in the existing system, with payback period calculations.
d. Engineering calculation outputs from simulation for the existing and proposed new system.
e. Pictures of the existing system depicting its overall condition and hours meter.
f. BTUs of energy saved from making the improvements to the grain dryer system.
g. Cost effectiveness, description, benefits, project layout of the proposed improvements.
h. Description of the improvements and how the energy bills match up with the actual grain dried in the system. Because every point of moisture removed dries with more, or less, BTUs of energy for each pound of water removed, the adjustments are made to the bushels dried based upon utility bill records.

Post-audit monitoring after installation of new equipment

It is important to conduct post-audit monitoring of the installation and use of new equipment in order to verify that the actual savings incurred is within range of the savings predicted. Also, post-audit monitoring provides firsthand knowledge of how to set and run equipment to optimize throughput while minimizing energy usage. It also enables the farmer to determine best operating practices in the use of the equipment; examples include routine maintenance and cleaning during drying operations. Note that for post-audit monitoring to be useful, at least 5 years of data of the energy consumption, dried bushels and operating conditions of the dryer equipment need to be collected.

The following data need to be routinely collected during/after the drying equipment is installed in order to make a good post-audit analysis of drying equipment operations:

1. Bushels per hour variance on both 5 points and 10 points of moisture removed.
2. Consumption of fuel and electricity associated with the new grain dryer.
3. If more automation and computer data is collected on the dryer, analyze the data and maintain records.

References

ASABE. 2009. ANSI/ASABE S612 JUL2009 – Performing On-farm Energy Audits. ASABE Standards. St. Joseph, MI: ASABE.

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Sept. 2016