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Energy Efficiency for Florida Aquaculture Facilities: Energy Audits[1]

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Introduction

The energy consumption on aquaculture facilities can account for a large portion of on-farm operational costs. Energy associated with keeping aquatic plants and animals alive contributes to the total cost of operation. Even on a moderately sized farm, excessive energy consumption can be a limiting factor in the success of an aquaculture business. When farms use recirculating aquaculture systems and indoor climate-controlled production methods, the cost of energy consumption can be as large as the costs of labor and feed. Reducing total energy use can help lower overall operational costs and increase profitability. Energy audits are required to evaluate energy use and identify energy-saving opportunities. This article is one in a series that details techniques for reducing energy consumption and associated costs on aquaculture farms.

Energy Audits

Energy audits are performed to characterize the energy use on a facility and identify ways to reduce energy consumption and related costs. These audits are assessments that explore how facilities use energy and look for potential savings opportunities. Professional energy-auditing services can be found through utility providers and government agencies such as the Natural Resource Conservation Service (NRCS). The American Society of Biological Engineers (ASABE) has established a standard that serves as a guide for auditing aquacultural operations. Each audit will vary based on the methods used and can be categorized as a type one or type two audit. Type one audits are general and report only on major activities. Type two audits are the most comprehensive and provide detailed assessments of major activities and their components. A major activity is an individual system that heavily impacts energy consumption, for example, a greenhouse HVAC system. A component is an individual part of a major activity, for example a HVAC blower motor. Energy audits for aquacultural facilities should include but are not limited to assessments of the major activities and some of their components listed in Table 1.

Energy audits start with a visual walk-through to quickly assess the condition and major activities of the operation. Walk-throughs identify obvious inefficiencies but are not detailed enough to uncover all energy saving opportunities. A review of past utility bills of at least the prior 12 consecutive months helps establish an energy-use baseline. This baseline of energy consumption per square foot (kWh/sqft) is used to compare similar operations and assess the impact of future improvements. If there are multiple utility meters on a facility, past utility bills can be assessed to show energy use for the metered area. Utility bills show monthly energy use measured at each meter but cannot extract the demand of individual components. More comprehensive audits will include evaluations of key components and management

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practices. Taking inventory of components and individually evaluating them helps pinpoint features of a facility that are energy intensive and warrant further analysis.

The purpose of an energy audit is to provide a report that describes how energy is used on a facility, reveals energy saving opportunities, and indicates the steps the operators should take to make improvements. Audit reports should include enough information to allow facility operators to make informed decisions around implementing energy-efficient measures. Depending on the scope and complexity of an energy audit, the report should include at least some the following topics:

- Summary of basic facility information (type, size, number of meters, etc.)
- Summary of energy use by type (electricity, natural gas, propane, etc.)
- Summary of energy use by major activity
- Energy-use benchmarks and comparison to industry norms (kWh/sqft)
- Compilation of historic utility records and energy-use trends
- Energy-saving opportunity recommendations
- Explanation of priority energy-efficient improvements
- Estimates of cost savings associated with reduced energy use
- Inventory of systems components (motors, pumps, fans, blowers, etc.)
- Component details (hp, voltage, efficiency, etc.)

Measuring Energy Use

Once an audit has identified specific areas where changes can have impact, determining energy use of individual processes or components is often necessary. For example, it may be beneficial to evaluate a recirculating aquaculture system by recording the power consumption of one or more specific pumps operating in the system. Submeters can be used to measure the consumption of specific components. There are various submetering devices available to measure and record energy use, but most operate on the same premise. Each device measures voltage and current of the desired circuit or circuits. Some basic submetering devices sold for 110VAC-120VAC circuits, often branded as electricity-use monitors, can be plugged in directly between the outlet and the electrical device. These monitors are simple but helpful to establish baseline power consumption of components such as appliances, heaters, and small pumps. More sophisticated submetering equipment is installed in or alongside electrical panels. These units offer more features and include data-analysis tools. Retrieving data from these units usually requires a computer or tablet. Additionally, some advanced submetering equipment can be connected to the internet to view historical and live data remotely. Electrical voltage, current load, phase, and phase configuration(s) should be identified before selecting any energy-monitoring equipment.

Energy savings at the Tropical Aquaculture Laboratory

In 2017, an energy-efficiency project at the UF/IFAS Tropical Aquaculture Laboratory (TAL) was initiated. The primary objective was to develop and demonstrate energy-efficient improvements and strategies viable for implementation on Florida's ornamental fish farms. This process began with commissioning a commercial energy audit. The audit, performed by the Tampa Electric Company (TECO), recommended upgrading lighting systems with LEDs and timers, adding variable drives to electric pump motors, and servicing some existing infrastructure. Using the audit's recommendations and further investigation to make improvements to the energy efficiency of water pumps, aeration blowers, and lighting systems. the overall energy consumption at TAL was reduced by approximately 20%. By implementing energy-efficient changes at their aquaculture facility, producers can increase the profitability of their business.

The Tropical Aquaculture Laboratory is an aquaculture research facility, located on 6.5 acres. It includes 48 ornamental fishponds, five greenhouses, and 5000 square feet of indoor space used for ornamental fish production. It serves as a commercial-scale aquaculture research facility, demonstrating how energy-efficient changes may affect commercial aquaculture farms in Florida.

Conclusion

Possible energy-saving opportunities on aquaculture facilities include changes to water delivery systems, pumps, aeration components, heating, ventilation, air conditioning, and insulation. Improving the energy efficiency of lighting systems often includes the addition of timers, occupancy sensors, and LED bulbs. Adding insulation, installing automation controls, changing maintenance schedules, and adding fans are all measures used to increase efficiency of HVAC systems. Fitting aeration and water systems with proper pumps, pipes, and other components also helps ensure energy is not being used unnecessarily. System

components and management practices should work together to create efficient systems that reduce energy consumption and cost. Implementing energy-efficient changes and management practices on aquaculture farms can reduce operational costs, promote business sustainability, and increase business profitability.

References and Recommended Reading

Bankston Jr., J.D., and F.E. Baker.1994. "Selecting the Proper Pump." USDA Southern Regional Aquaculture Center Publication No. 372.

Bankston Jr., J.D., and F. E. Baker. 1995. "Powering Aquaculture Equipment." USDA Southern Regional Aquaculture Center Publication No. 375.

ABABE Standard S612, Performing On-farm Energy Audits

ANSI/ASHRAE/ACCA Standard 211, Standard for Commercial Buildings Energy Audits

NRCS, New Jersey, Energy Conservation Series: Conducting an Energy Audit

Table 1. Major activities and components commonly found on aquaculture facilities.

Major activities	**Components**
Aeration	Blowers, blower motors, air delivery systems
Air cooling	Blowers, fans, evaporators, compressor
Automation controls	Timers, occupancy sensors, automation
Heating	Heater, energy source(s), insulation
Lighting	Fixtures, bulbs
Refrigeration	Chiller, evaporator, compressor, insulation
Ventilation	Fans, fan motors, control systems
Water management	Pumps, piping, fittings