Energy Efficiency Case Study
Car Min Vu Dairy Farm

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Background

Car Min Vu is a grade A dairy and crop farm on 2,000 acres in Webberville, Michigan. Their milking herd is composed of Holstein cows. At any given time, approximately 1,000 cows are in lactation, 75 are dry, 600 are heifers, and 60 are calves. The farm produces an average of 85 pounds of milk per day per cow. Car Min Vu also grows corn, hay, alfalfa and wheat, all of which is used as feed for the cows. The operation runs 24/7, performs milking three times per day, and the owners host 150-200 people annually.

When the owner of Car Min Vu was approached by Michigan State University with the potential for a lighting energy efficiency project to be conducted on their property, he jumped at the opportunity. From the spring of 2017 through the fall of 2019, a LED long day lighting engineering project was designed and implemented at Car Min Vu to realize energy savings among other economic and environmental benefits.

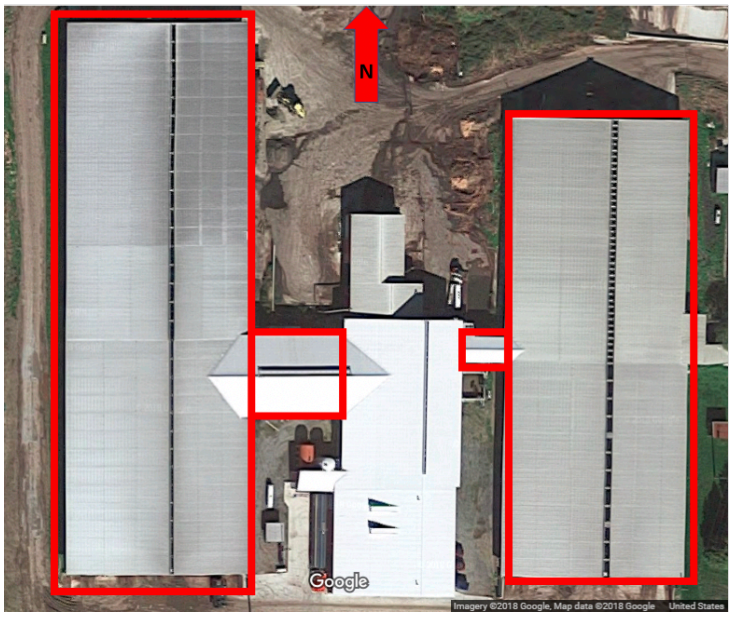

Figure 1: Aerial view of Car Min Vu Farm. Long day lighting was implemented in the areas outlined in red.

System Implementation

All luminaires were purchased from Everlast Lighting in Jackson, Michigan and the control system was purchased from Synapse in Huntsville, Alabama. The two types of LED luminaries used for this study were 150-Watt high-bays and 60-Watt canopies. In order to use dynamic controls, a Synapse DIM-250 control module was installed inside each dimmable high-bay luminaire.

The Synapse daylight harvesting (DLH) capability utilized an open loop system. The system works by monitoring the light levels just outside of the barns and adjusting the light levels inside based on these outdoor measurements.

Figure 2: Daylight sensor connected directly to a box that houses a control module.

Installation took place between May and September of 2018, and installation costs were paid for by the farm owner. Since the electrical infrastructure was outdated in both barns, the electrician started by installing new circuit breaker panels specifically for the new lighting system. Once all of the luminaires were installed, bird spikes were added to the top of the high-bays since they had ample space for bird nesting.

All the Synapse light and sensor controllers wirelessly communicate with a gateway controller. This device communicates with the farm's router through an ethernet cable. This ethernet cable also connects to the data acquisition systems which monitors total energy usage and measures actual light levels inside the barns. The control system was programmed to simulate sunrise in the morning and sunset at night using sequentially higher and lower brightnesses throughout the barns, respectively. These 15 minute dimming periods prevent the luminaires from changing from 0% to 100% output abruptly, startling the cows. The daylight harvesting system takes over control of all dimmable luminaires during the day and dims them to

save energy. On a sunny day, it is common for all of the high-bay luminaires to be dimmed to only 10%, which saves energy while still maintaining appropriate light levels for the cows.

The project was funded by DTE Energy via their E-Challenge for Colleges and Universities. The project expenses are outlined in Table 1 below. The total project budget was $112,463.

Table 1: Project Budget Breakdown

Expense Category	**Cost**
Personnel	$2,149.05
Training, Education, Conferences	$1,087.54
Travel	$820.22
Consultant Services	$4,500.00
Equipment	$67,865.16
Materials and Supplies	$16,489.73
University Administrative Fee	$19,551.33
Total	$112,463.03

System Impacts

There are currently 193 days of energy consumption data available spanning September 20, 2018 through March 31, 2019. Column 4 in Table 2 shows the actual energy consumption for the west and east barns. It also shows the energy consumption of the original T-8 fluorescent luminaires as well as two theoretical values - an identical LED layout using non-dimmable luminaires and an equivalent layout that utilizes HID luminaires. Figure 3 illustrates the power draw of the west barn over a 2-day period, along with the theoretical power draws of a featureless LED layout and HID layout, to demonstrate the energy savings of the daylight harvesting system.

Table 2: Energy Consumption

Barn	Original T-8 (kWh)	Theoretical HID (kWh)	Featureless LED (kWh)	Dimmable LED with DLH (kWh)
West	6114	53847	34893	19695
East	4864	35847	27242	14822

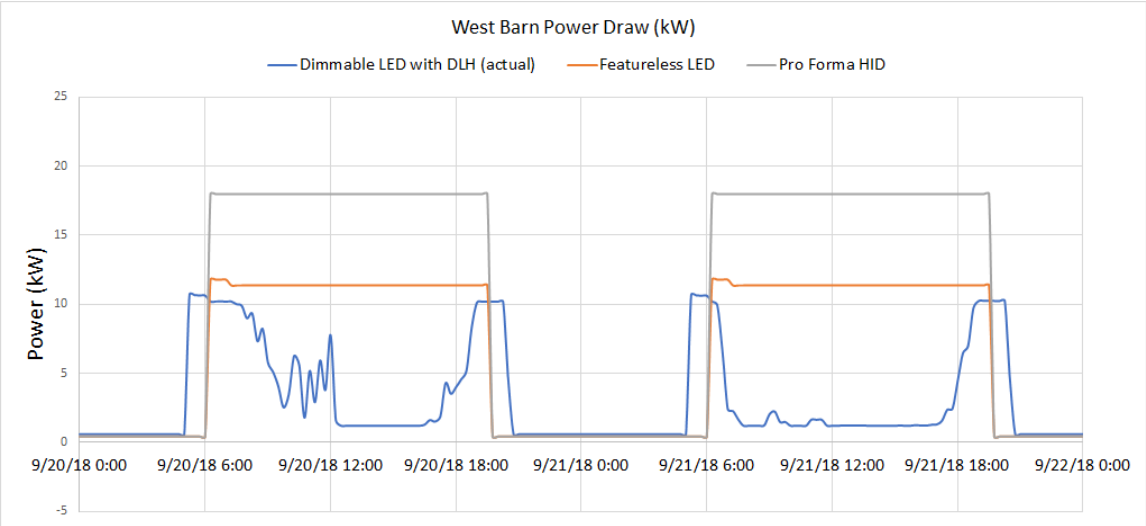

Figure 3: Power Draw Comparison

The presented energy data shows the difficulty in predicting energy usage of a long day lighting system that uses a dynamic control system, validating the need for this case study.

Conclusions

Before this technology is ready for widespread use, more energy and milk production data must be gathered to better understand the energy consumption of this system and quantify the increase in milk production for a large farm that milks three times per day. Once the data has been gathered and analyzed, Michigan State and the farm owner will work with the Michigan State University Extension Office to disseminate the data from this study to other large dairy farms that operate a three a day milking schedule.

The farm manager stated that the new system is very low maintenance and he is happy with the results. An additional benefit to the energy savings has been the even light distribution and higher light levels in the aisles. The manager exclaimed that his workers can maneuver around the barn a lot easier and safer, especially at night. He has also noticed that the barns have been a lot cleaner since the system has been operational.

The farm owners recommend other farms to conduct energy audits and are looking into additional energy conservation projects the future, such as looking into new, more energy efficient fans.