Agricultural Energy Management Plan

John Doe
Any Farm
1234 Any Road,
Anytown, DE
XXXXX
Any County
XXX-XXX-XXXX
UTM Coords.: XXS XXXXXX.XXXXXXXXXXX.XX

Enterprise: Poultry
Acres: 36
Site Visit: Friday, June 5, 2020
Data Collector: Getda Info
Plan Delivered: Friday, July 24, 2020

Report Prepared by:
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Field Code Changed

I, Chantal L. Beliveau, P.E. TSP #17-21940, as the Certified Technical Service Provider employed under TSP Business EnSave, Inc., TSP# B-09-845, have reviewed this Plan and certify that it meets all applicable requirements according to NRCS Standards and Specifications.

I confirm that this Plan correctly lists the farm identifying information, addresses the primary farm enterprise under my control, adequately represents the baseline conditions of the farm enterprise, adequately represents the concerns and objectives, and that I have received a final copy of the Plan.

I have administratively reviewed this Agricultural Energy Management Plan, and the Plan meets all criteria of Conservation Activity Plan 128.

Reviewed by:____________________________ (John Doe/ date)

NRCS Acceptance: __________________________ ([NRCS REP]/ date)

Thursday, July 23, 2020

John Doe
Any Farm
1234 Any Road,
Anytown, DE XXXXX

Dear Mr. Doe,

Enclosed is your completed Agricultural Energy Management Plan (plan). This plan has been developed in accordance with Conservation Activity Plan Code 128 (CAP 128) of the U.S. Department of Agriculture's Natural Resources Conservation Service (USDA NRCS).

This plan is organized into several sections. The first section summarizes the overall energy savings recommendations. The second section provides background and site information. The third section contains an overview of the current energy use based on 12 months of usage. The fourth section provides a description of the current equipment evaluated and recommendations for energy efficiency.

CAP 128 requires a discussion of all energy-using equipment at the facility, even if no cost-effective recommendations are found, therefore, your plan may contain details about systems analyzed that did not result in energy savings opportunities. Finally, this plan includes information sheets with more detail about calculations, equipment, and recommended technologies, as well as links to various internet resources about funding sources.

This plan will help you determine the best way for you to increase your facility's energy efficiency and reduce your energy costs. Even if you are not able to implement all the recommendations immediately, this plan will serve as a guide for future decisions and improvements. Before moving forward with any recommendations, we encourage you to contact us regarding eligibility for various state, federal, and utility funding opportunities. More information about these opportunities is included in the *Quick Start Guide to Saving Money on your Energy Projects* flyer included with this audit.

To determine eligibility for funding available through the NRCS Environmental Quality Incentives Program (EQIP), you may contact your local USDA NRCS office (Georgetown Service Center at 302-856-3990).

On behalf of all of us at EnSave we want to thank you for the opportunity to help you evaluate your facility's energy use and energy saving opportunities. We will be calling you in a few weeks to discuss the plan with you. In the meantime, please feel free to contact me if you have any questions.

Sincerely,

Chantal L. Beliveau, P.E.
Senior Engineer
EnSave
Direct: (802) 434-1838
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1 Summary Report of Energy Practices

1.1 Summary of Recommendations

This plan prioritizes the opportunities for Any Farm to improve its energy efficiency. Energy systems supporting the major activities at the facility were evaluated for adequacy relative to the Appendix of *Minimum Standard Recommendations* and operational needs. If the existing systems are deemed adequate, the energy and cost savings calculations are based on a "one-for-one" replacement. If the existing systems are below minimum standard recommendations the energy and cost savings calculations compare the existing system to a replacement system that would meet minimum standard recommendations and operational needs.

Integrator requirements specific to this farm are not included in this analysis unless specifically requested. Integrator standards that are widespread in use and are considered industry standards are included in this plan as a check for adequacy. If we used integrator preferences, it is noted in the specific section.

During our conversations, you expressed an interest in ceiling insulation and tunnel fan covers (bonnets or doors), and we included these measures in our evaluations for cost effective opportunities to improve energy efficiency. Efficiency measures were reviewed and those found to be cost effective can be found in Table 1. The recommendations identified are for ceiling insulation, light emitting diode (LED) bulbs, sealing air leaks, insulated brood curtains, insulated tunnel doors, and insulated exhaust fan covers. The total annual energy cost savings of the recommended energy efficient measures is approximately $13,657 and represents approximately 24% savings of the baseline annual energy costs of $56,592.

Tables 1 and 2 summarize the benefits for all recommended measures. See the appendices for a detailed listing of Resources, Minimum Standard Recommendations, Calculations, Details, and Estimated Annual Energy Efficiency Improvements.

Table 1. Summary of Energy Efficiency Improvements

		Estimated Annual Reduction in Energy Use			Estimated Costs, Savings, Payback, and Prioritization for Implementation			
Map ID	**Recommended Measure**	**Electric Savings (kWh)**	**Propane Savings (gal)**	**Energy Savings (MMBtu)**	**Installed Cost [a], $**	**Energy Cost Savings [b], $/yr.**	**Payback in Years [a / b], yr.**	**Est. Life in Years**
A	Office Area Lights	68	0	0.23	$4	$8	0.5	10.0
B	Houses 1-4 Security Lights	4,495	0	15.34	$938	$505	1.9	10.0
C	Control Rooms 1-2 Lights	37	0	0.13	$8	$4	2.0	10.0
D	Houses 1-4: Seal Air Leaks	0	2,136	195.08	$9,920	$2,910	3.4	10.0
E	House 2 Security Light	166	0	0.57	$80	$19	4.2	10.0
F	Generator Area Lights	27	0	0.09	$16	$3	5.3	10.0
G	Houses 1-4: Brood Curtains	0	722	65.92	$9,538	$983	9.7	10.0
H	Houses 1-4: Tunnel Intakes	0	2,369	216.39	$32,211	$3,228	10.0	20.0
I	Houses 1-4: Ceiling Insulation	0	3,608	329.53	$67,061	$4,916	13.6	20.0
J	Houses 1-4: Exhaust Ventilation Fan Covers (doors/bonnets)	0	817/635.6	74.63/58.05	$15,960/$1,680	$1,113/$866	14.3/1.9	20.0/5.0
Totals		**4,793**	**9,652**	**897.91**	**$135,735**	**$13,690**	**9.9**	**N/A**

*Values for exhaust fan doors are used in the totals

Table 2. Estimated Annual Reduction of Emissions

Environmental Benefits*							
			Greenhouse Gases			Air Pollutant Co-Benefits	
Map ID	Recommended Measure	Energy Savings (MMBtu)	Estimated CO_2 (lbs)	Estimated N_2O (lbs)	Estimated CH_4 (lbs)	Estimated SO_2 (lbs)	Estimated NO_x (lbs)
A	Office Area Lights	0.23	58.37	<0.01	0.01	0.13	0.06
B	Houses 1-4 Security Lights	15.34	3,833.49	0.05	0.34	8.75	3.80
C	Control Rooms 1-2 Lights	0.13	31.43	<0.01	<0.01	0.07	0.03
D	Houses 1-4: Seal Air Leaks	195.08	26,698.93	1.92	0.43	0.21	27.77
E	House 2 Security Light	0.57	141.57	<0.01	0.01	0.32	0.14
F	Generator Area Lights	0.09	22.71	<0.01	<0.01	0.05	0.02
G	Houses 1-4: Brood Curtains	65.92	9,021.47	0.65	0.14	0.07	9.38
H	Houses 1-4: Tunnel Intakes	216.39	29,615.69	2.13	0.47	0.24	30.80
I	Houses 1-4: Ceiling Insulation	329.53	45,100.52	3.25	0.72	0.36	46.90
J	**Houses 1-4: Exhaust Ventilation Fan Covers (doors/bonnets)	74.63/58.05	10,214.52/7,945	0.74/0.57	0.16/0.13	0.08/0.06	10.62/8.26
Totals		**897.91**	**124,738.70**	**8.74**	**2.29**	**10.29**	**129.53**

*Emissions information is based on the EIA E-Grid 2015 values

** Values for exhaust fan doors are used in the totals

The measures recommended are based on energy savings analyses, related energy cost savings, and the estimated cost to implement. Estimated costs to implement energy saving measures are based on market research and include labor, materials, and equipment, and are identified in each specific section. Market research includes averages of material costs sourced from research, averages of material and labor costs from estimates and invoices from installed efficiency upgrades, and discussions with contractors and equipment suppliers. Routine operation and maintenance of all equipment is necessary to ensure that efficiencies and adequacies are maintained over time.

Specifications of existing equipment are sourced from name plate information stamped or printed on the equipment or records of installation available at the location. We make reasonable efforts to obtain manufacturer and model names of current equipment; however, in certain cases this is not possible. If specifications are not available on the equipment due to age or wear and no other records are available, EnSave estimates the size and efficiency of the existing equipment based on accumulated knowledge and records from previous energy audits and from market research.

Information on operational schedules and run times is based on either information you provided or is estimated based on typical uses of similar facilities and equipment. Note that savings calculations are based on conditions at the time of the site visit. Changes to equipment or operations that may have occurred following the site visit are not reflected.

Recommended measures are listed in priority order based on the estimated payback period in years. The estimated payback period is equal to the estimated cost to install ($) divided by the estimated energy cost savings ($/year) and is expressed in years. When the payback period is less than or equal to the expected useful life (EUL) of the measure in years, the measure is recommended. This method does not account for more complex financial considerations such as loan interest and fees, tax rates, depreciation, or any other potential cost impacts.

The installation of some measures can affect the savings achievable by other measures. For instance, an increase in thermal insulation can decrease the savings achievable by installing more efficient heating equipment and vice versa. Consequently, it is important to re-evaluate your overall savings potential once you have identified which measures you plan to install.

We were unable to obtain any information on any known health and safety, fire, or building code violations on your farm. A limited visual inspection for fire and safety code violations (only what can be seen) was performed during our site visit and none were identified. We recommend that you consult with a licensed electrician or code enforcement officer to properly evaluate your facility.

There may be other factors to consider when making decisions to implement recommended measures. These may include aspects such as equipment operational performance, equipment operation and maintenance costs, productivity, installation costs, and permitting, etc.

Any recommended equipment should be properly reviewed for site-specific needs, concerns, and applicability.

2 Background and Site Information

2.1 Facility Description

EnSave conducted a site visit at Any Farm on Friday, June 5, 2020. This plan covers the major activities identified for your location and provides recommendations to increase your facility's energy efficiency.

Any Farm has opportunities for energy efficiency improvements. Existing energy efficient equipment at your facility includes radiant heaters, solid side walls, and LED lighting.

Poultry (Broilers) is the only enterprise at your location. Any Farm is approximately 12 years old and raises approximately 630,000 birds a year in 4 buildings on 36 acres. For a more in-depth description of the equipment and associated schedules for your facility, refer to Table BS.1 and the relevant sections throughout this report and appendices. Refer to Figures BS.2 and BS.3 for the orientation and the location of your facility in relation to nearby roads, towns, streams, etc.

Flocks of young birds are delivered to your poultry houses by the integrator. Lighting, feeding, and heating schedules are used to encourage growth and bird health. Ventilation is used to control temperature and air quality. The building envelope enables climate control within your facility. The lighting, ventilation, and heating systems work together using building automation controls to provide an optimum climate for bird growth.

You expressed an interest in ceiling insulation and exhaust fan covers during our conversations. Adding ceiling insulation and fan covers are evaluated in the *Air Heating and Building Environment* section of this report. Both measures have been recommended.

Table BS.1 provides general construction and schedule information for the facility.

Table BS.1. Total Days Animals in House / Group

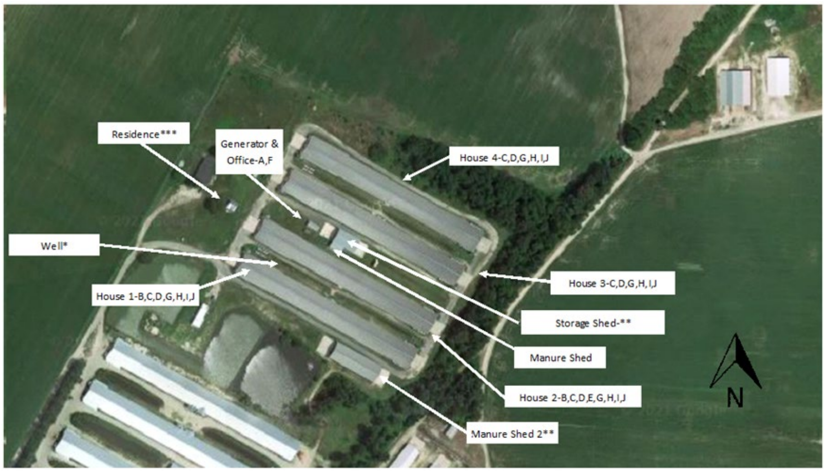
House Group	# Houses	Length (ft)	Width (ft)	Year Built	Sidewall Type	Ceiling Type	Tunnel Ventilated	# Groups / Year	Target Animal Weight (lb)	# Animals / Group / House	Total Days Animals in House / Group
Houses 1-4	4	560	60	2008	Solid	Dropped	Yes	4.5	7	35,000	59

2.2 Facility Location

Figure BS.2 provides an overall site location map and Figure BS.3 provides a labeled view of the location with map identifiers related to the recommendations from Tables 1 and 2.

Figure BS.2. Overall Site Map - **[REDACTED]**

Figure BS.3. Location and Recommendation View - **[REDACTED]**



* Approximate location
** No Energy use
*** Not Evaluated as part of this plan.

3 Baseline Energy Use

An average electricity cost of $0.11 per kilowatt-hour (kWh) and an average cost of $1.36 per gallon (gal) of propane, were used in this analysis based on energy use records provided for the twelve-month period ending February 2020. If Any Farm's actual costs are different from these documented values, the energy cost savings will vary accordingly.

All existing equipment specific information, including the amount of energy used for this analysis, determination of adequacy, the evaluated replacement equipment, and the recommendations are inventoried in the individual major activity sections.

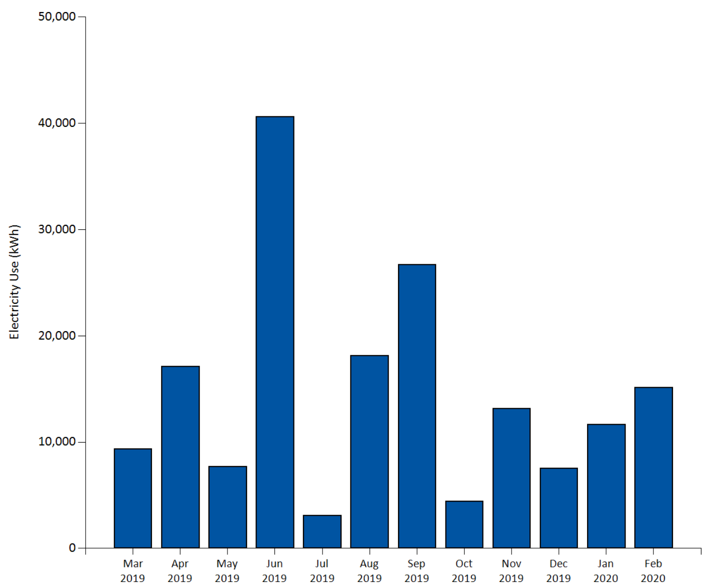
3.1 Electricity Use

During the twelve-month period evaluated, Any Farm used approximately 175,018 kWh of electricity. The total cost of electricity was $19,446. Any Farm is serviced by a single-phase power source.

The peak months typically coincide with hot weather and are the result of increased ventilation loads. Differences between electricity usage month-to-month can also be impacted by the downtime between flocks of birds.

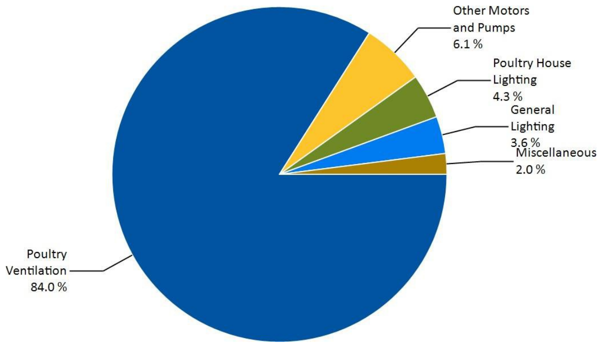
Figure EU.1 summarizes electricity use from March 2019 through February 2020.

Figure EU.1. Twelve Month Electricity Use



The electricity use by measure is depicted in Figure EU.2.

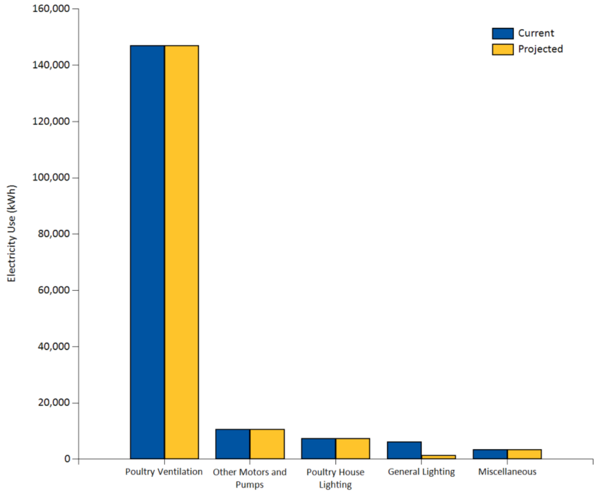
Figure EU.2. Electricity Use Breakdown



The *Miscellaneous* electric use represents shop tools, electronics, and other miscellaneous consumption. A detailed listing of equipment associated with each category can be found in the relevant sections of this plan.

Figure EU.3 provides a comparison of the estimated current and projected energy use of all recommended measures.

Figure EU.3. Comparison of Annual Current and Projected Electricity Use



Your facility may also have opportunities to implement a demand management strategy by re-evaluating the schedule of operations of your facility and the time-of-use of your larger energy-using systems. Electricity service is often provided under electric tariffs that include charges for the peak electrical demand and/or that differentiate electricity prices based on time of use, or peak and off-peak hours during the billing period. If you are interested in exploring how to avoid additional utility charges please contact us for more information about both peak usage times, as well as energy demand, and any related charges.

3.2 Propane Use

During the twelve-month period evaluated, Any Farm purchased approximately 27,260 gal of propane. The total cost of propane was $37,146. Monthly propane deliveries may not reflect actual monthly propane usage.

Propane is only used for *Air Heating and Building Environment* at this location. Therefore, the amount delivered for the year was allocated to the heating system of the houses.

Figure PU.1 summarizes propane delivered from March 2019 through February 2020.

Figure PU.1. Twelve Month Propane Deliveries

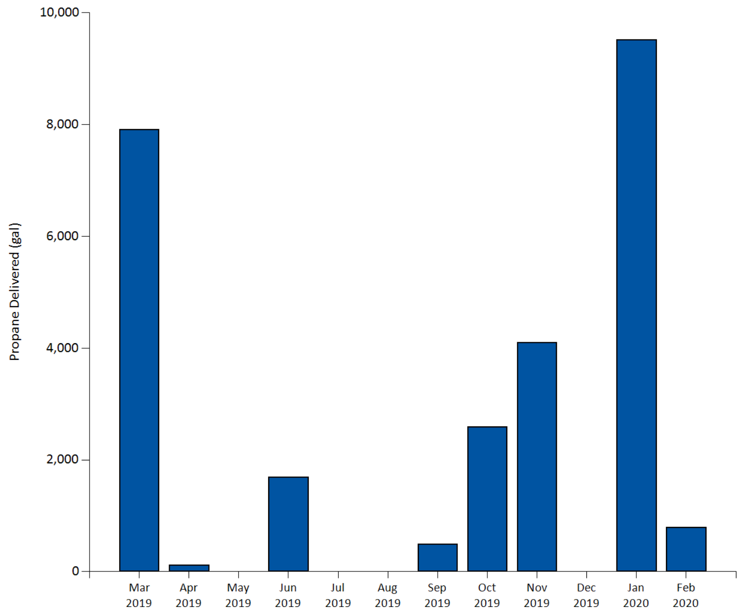
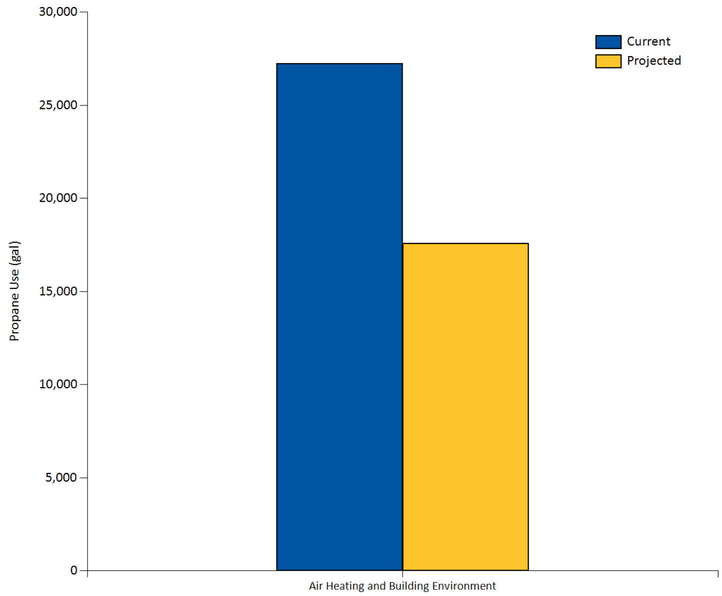


Figure PU.2 provides a comparison of the estimated current and potential energy use after the installation of all recommended measures.

Figure PU.2. Comparison of Annual Current and Projected Propane Use



3.3 On-Site Energy Generation

Any Farm currently operates a diesel generator for back up and emergency purposes, which is only run otherwise for testing, upkeep, and maintenance. The generator serves as an emergency power supply and was not in operation for a significant time during the twelve-month period evaluated. The generator was not evaluated for energy saving opportunities due to low run-time. Energy generated by the on-site generator during the testing and upkeep and minimal power outage uses is not included in the overall electricity used in this analysis. Energy saving measures are calculated based on the purchased electricity cost only.

No concerns were identified in our conversations relating to the adequacy of the generator for Any Farm, and we typically assess for 20-25 kWh per poultry house for meeting the minimum adequacy. We encourage you to use proper O&M practices including periodic and scheduled maintenance to prevent unnecessary problems during power outages.

Table EGEN.1 contains the existing generator details.

Table EGEN.1. Current Generator Inventory

Description	Manufacturer / Model	Year Installed	# Generators	Resource Type	Output (kW)	Annual Run Time (Hours)
Generator	State line	2008	1	Diesel	200	52

4 Current Equipment and Recommended Energy Improvements

4.1 Lighting

We evaluate replacing lighting systems with LED bulbs because they are significantly more efficient than other types of lighting and have been demonstrated effective in agricultural operations. Price decreases in recent years have made LEDs cost-effective replacements for most applications.

Fluorescent lights are regulated under the Resource Conservation and Recovery Act. It is illegal to dispose of these lights in the trash. Please contact your local waste district regarding the proper disposal of fluorescent lamps. Additional information is provided in the Appendix of *Resources.*

A lighting schedule was not available at your facility, therefore, savings calculations are based on a typical poultry lighting schedule for similar facilities in your area to determine the number of annual run hours for each light and existing versus recommended light wattages. The lighting schedule used can be found in the Appendix of *Details.*

When evaluating for light level adequacy in lux, the calculations include reductions for the lamp lumen depreciation (LLD), ballast factor (BF), luminaire dirt depreciation (LDD), and room surface dirt depreciation (RSDD) factors. The value also considers the coefficient of utilization (CU) which is determined by room void ratios and wall, floor, and ceiling reflectance factors. The initial light levels when installing brand new bulbs may be adequate but over time this will diminish.

The lumen output of existing bulbs is determined by the stamped ratings on the bulb or specifications sourced from the manufacturer. If neither source is available, they are determined by using typical lumen outputs for the given type and wattage of bulb using online research and research based on information gathered from previous EnSave energy audits and data collections. The details for adequacy determination can be found in the Appendix of *Minimum Standard Recommendations*.

In the sections and tables below, lm stands for lumens, CFL stands for compact fluorescent, HPS stands for high pressure sodium, INC stands for incandescent, and W stands for watts.

4.1.1 Poultry House Lighting

When purchasing LED bulbs, it is recommended that you select models that have been designed for the poultry industry. Some considerations include selecting bulbs that have a color temperature in the range of 3,500-6,400 Kelvin and have been tested by an independent third party to perform well in poultry houses. We also recommend selecting bulbs that are fully dimmable, protect against the intrusion of dust and moisture, and come with a warranty (a three-year warranty is typical).

Table PL.1 provides the equipment inventory. Table PL.2 summarizes a review of the adequacy relative to applicable standards.

Table PL.1. Current Poultry House Lighting Inventory

Description	Manufacturer / Model	Total # Fixtures All Locations	Fixture Type	# Bulbs / Fixture	Bulb Wattage (W)	Lumens per Bulb (lm)	Annual Run Time (Hours)	Total Fixture Wattage (W)	Est. Annual Use (kWh)	Schedule
Houses 1-4 Brood Area Lights	Overdrive/L10WA19Dlm/50k	120	LED	1	10	1,000	2,463	10	2,956	Brood
Houses 1-4 Brood Area Lights	Overdrive/L10WA19Dlm/50k	60	LED	1	10	1,000	2,463	10	1,478	Brood
Houses 1-4 Non-Brood Area 1 Lights	LED Lamp/YGA03A00	22	LED	1	10	900	1,635	10	360	Grow Out 1
Houses 1-4 Non-Brood Area 2 Lights	LED Lamp/YGA03A00	22	LED	1	10	900	825	10	182	Grow Out 2
Houses 1-4 Non-Brood Area 1 Lights	Overdrive/L10WA19Dlm/50k	19	LED	1	10	1,000	1,635	10	311	Grow Out 1
Houses 1-4 Non-Brood Area 2 Lights	Overdrive/L10WA19Dlm/50k	19	LED	1	10	1,000	825	10	157	Grow Out 2
Houses 1-4 Non-Brood Area 1 Lights	LED Lamp/YGA03A00	46	LED	1	10	900	1,635	10	752	Grow Out 1
Houses 1-4 Non-Brood Area 2 Lights	LED Lamp/YGA03A00	46	LED	1	10	900	825	10	380	Grow Out 2
Houses 1-4 Non-Brood Area 1 Lights	Overdrive/L10WA19Dlm/50k	38	LED	1	10	1,000	1,635	10	621	Grow Out 1
Houses 1-4 Non-Brood Area 2 Lights	Overdrive/L10WA19Dlm/50k	38	LED	1	10	1,000	825	10	314	Grow Out 2

Table PL.2. Current Poultry House Lighting Adequacy Review

Description	Min. Rec. Light Level (lux)	Calculated Light Level (lux)	Light Level Adequate?
Houses 1-4 Brood Area Lights	30	13	No
Houses 1-4 Non-Brood Area 1 Lights	5	12	Yes
Houses 1-4 Non-Brood Area 2 Lights	5	14	Yes

The existing LED lights listed in Table PL.1 are considered energy efficient and were not evaluated for replacement. The houses are equipped with Pro-Tech Inc. 2K Green Rimmir Dimmers which are considered efficient and were not evaluated for replacement.

Based on available information, the calculated illuminance of the existing lights does not meet the recommended minimum light level in the Brood areas of houses 1-4. These areas require either an increase in bulb count and/or bulbs with a higher wattage, which will increase electricity use. Thus, there are no energy efficiency recommendations. We suggest you discuss the minimum illuminance requirements with your integrator before making any changes.

4.1.2 General Lighting

For exterior and linear fluorescent light evaluations, we include replacement of the entire fixture. This will ensure that the light will not fail prematurely due to degraded existing fixture components or compatibility issues.

The existing LED lights listed in Table GL.1 are considered energy efficient and were not evaluated for replacement. Table GL.1 provides the equipment inventory.

Table GL.1. Current General Lighting Inventory

Description	Manufacturer / Model	Total # Fixtures All Locations	Fixture Type	# Bulbs / Fixture	Bulb Wattage (W)	Lumens per Bulb (lm)	Annual Run Time (Hours)	Total Fixture Wattage (W)	Est. Annual Use (kWh)
Houses 1-4 Security Lights	Not Available	7	HPS	1	150	15,000	4,368	188	5,748
House 2 Security Light	Not Available	1	CFL	1	65	550	4,368	65	284
Manure Shed Light	Not Available	1	HPS	1	150	15,000	210	188	39
Control Rooms 3-4 Lights	Overdrive/L10WA19Dlm	4	LED	1	10	1,000	392	10	16
Control Rooms 1-2 Lights	GE/Proline	2	INC	1	57	760	392	57	45
Control Rooms 1-2 Lights	LED Lamp/YGA03A00	2	LED	1	10	900	392	10	8
Office Area Lights	LED Lamp/YGA03A00	1	LED	1	10	900	1,456	10	15
Office Area Lights	GE/Proline	1	INC	1	57	760	1,456	57	83
Generator Area Lights	Harmony lighting/SSS42-30	4	CFL	1	42	2,650	208	42	35

Table GL.2 summarizes a review of the adequacy relative to applicable standards.

Table GL.2. Current General Lighting Adequacy Review

Description	Min. Rec. Light Level (lux)	Calculated Light Level (lux)	Light Level Adequate?
Houses 1-4 Security Lights	2	352	Yes
House 2 Security Light	2	15	Yes
Manure Shed Light	50	85	Yes
Control Rooms 3-4 Lights	100	152	Yes
Control Rooms 1-2 Lights	100	126	Yes
Office Area Lights	100	118	Yes
Generator Area Lights	50	148	Yes

Table GL.3 provides an analysis of energy savings associated with the recommendations and Table GL.4 summarizes equipment that was evaluated but not recommended. We analyzed the energy and cost saving benefits for replacing the existing lights listed in Table GL.3 with LED lights. We recommend these energy saving measures.

Table GL.3. General Lighting: Recommended Energy Saving Measures

Description	Current Equipment	Recommended Equipment	Est. Annual Electricity Savings (kWh)	Est. Annual Cost Savings ($)	Est. Cost to Install ($)	Est. Payback (Years)	EUL (Years)
Office Area Lights	(1) 57W INC light	(1) 10W, 1,100 lumen LED light	68	$8	$4	0.5	10.0
Houses 1-4 Security Lights	(7) 150W HPS lights	(7) 41W Dusk-Dawn 4,700 lumen LED lights	4,495	$505	$938	1.9	10.0
Control Rooms 1-2 Lights	(2) 57W INC lights	(2) 10W, 1,100 lumen LED lights	37	$4	$8	2.0	10.0
House 2 Security Light	(1) 65W CFL light	(1) 27W Dusk-Dawn 2,247 lumen LED light	166	$19	$80	4.2	10.0
Generator Area Lights	(4) 42W CFL lights	(4) 10W 1,100 lumen LED lights	27	$3	$16	5.3	10.0
Totals			**4,793**	**$539**	**$1,046**	**1.9**	**N/A**

We analyzed the energy and cost saving benefits for replacing the light listed in Table GL.4 with an LED light. We do not recommend this measure because of the long payback period. Although not recommended for early replacement, consider choosing LEDs for your existing general lighting bulbs when replacing them at the end of their useful life.

Table GL.4. General Lighting: Evaluated Measures Not Recommended

Description	Current Equipment	Evaluated Measure	Est. Annual Electricity Savings (kWh)	Est. Annual Cost Savings ($)	Est. Cost to Install ($)	Est. Payback (Years)	EUL (Years)
Manure Shed Light	(1) 150W HPS light	(1) 41W Dusk-Dawn 4,700 lumen LED lights	31	$3	$134	44.7	10.0

4.2 Ventilation

There are two ratings to consider when replacing exhaust fans. A ventilation efficiency ratio (VER) in cfm/watt, which is the cubic feet per minute of air moved per watt of power rating at a specific static pressure, and an air flow ratio, which gives an indication of the fan's ability to provide a constant air flow as wind speed and static pressure varies. Fans with higher VERs will use electricity more efficiently and fans with a higher air flow ratio are better performing fans as conditions vary.

For adequacy review, the 'maximum' required ventilation capacity for the houses is calculated to ensure that during hot weather, the air exchange is sufficient to keep the inside temperature only slightly warmer than the outside temperature. The design temperature used in this review is the summer dry bulb 2 ½% value for the city closest to your location as provided in *'U.S. Climatic Data' of the ANSI/ASHRAE/IESNA Standard 90.1 'ASHRAE Standard Energy Standard for Buildings Except Low-Rise Residential Buildings/Appendix D1'*. Refer to the *Air-Cooling* section for further information on cooling incoming ventilation air. The facility has a minimum ventilation schedule used during cold weather that cycles existing exhaust fans on and off to manage moisture and air quality in the houses. The facility has the capacity to meet minimum ventilation requirements.

Table V.1 provides an inventory of the existing ventilation fans and estimated run times at the facility. Table V.2 summarizes a review of the adequacy relative to applicable standards. The calculated existing cfm per house can be found in the Appendix of *Details.*

Table V.1. Current Exhaust Fan Inventory

Description	Fan Manufacturer / Model	Year Installed	Total # Fans	Diameter (in)	Location	Staging	Annual Run Time (Hours)	Airflow (cfm)	VER (cfm / Watt)	Est. Annual Use (kWh)
Exhaust Tunnel Fans 1-4	Hired Hand	2008	20	50 - 53	Sidewall/Tunnel	Stage I	2,370	27,700	20.0	65,649
Exhaust Tunnel Fans 1-4	Hired Hand	2008	20	50 - 53	Sidewall/Tunnel	Stage II	1,422	27,700	20.0	39,389
Exhaust Tunnel Fans 1-4	Hired Hand	2008	16	50 - 53	Sidewall/Tunnel	Stage III	474	27,700	20.0	10,504
Minimum Vent Fans 1-4	Hired Hand	2008	8	48 - 49	End wall	Stage II	1,594	23,100	18.7	15,756
Minimum Vent Fans 1-4	Hired Hand	2008	8	36	End wall	Stage II	3,394	10,270	17.7	15,756

Table V.2. Current Poultry Ventilation Adequacy Review

Description	Existing Airflow Capacity / House (cfm)	Max. Rec. Airflow Capacity / House (cfm)	Airflow Adequate?
Houses 1-4 Ventilation	387,800	280,714	Yes

We do not recommend replacing any of the ventilation fans because of the long payback periods.

Table V.3 summarizes equipment that was evaluated but not recommended.

Table V.3. Poultry Ventilation: Evaluated Measures Not Recommended

Description	Current Equipment	Evaluated Measure	Est. Annual Electricity Savings (kWh)	Est. Annual Cost Savings ($)	Est. Cost to Install ($)	Est. Payback (Years)	EUL (Years)
Exhaust Tunnel Fans 1-4	(20) exhaust fans (50 - 53" diameter, 27,700 cfm airflow, 20.0 VER), running 2,370 hours / year	(20) exhaust fans (50 - 53" diameter, 27,800 cfm airflow, 25.5 VER), running 2,370 hours / year	13,974	$1,569	$30,000	19.1	15.0
Exhaust Tunnel Fans 1-4	(20) exhaust fans (50 - 53" diameter, 27,700 cfm airflow, 20.0 VER), running 1,422 hours / year	(20) exhaust fans (50 - 53" diameter, 27,800 cfm airflow, 25.5 VER), running 1,422 hours / year	8,384	$942	$30,000	31.8	15.0
Minimum Vent Fans 1-4	(8) exhaust fans (36" diameter, 10,270 cfm airflow, 17.7 VER), running 3,394 hours / year	(8) exhaust fans (36" diameter, 10,500 cfm airflow, 20.2 VER), running 3,394 hours / year	1,641	$184	$7,200	39.1	15.0
Exhaust Tunnel Fans 1-4	(16) exhaust fans (50 - 53" diameter, 27,700 cfm airflow, 20.0 VER), running 474 hours / year	(16) exhaust fans (50 - 53" diameter, 27,800 cfm airflow, 25.5 VER), running 474 hours / year	2,236	$251	$24,000	95.6	15.0
Minimum Vent Fans 1-4	(8) exhaust fans (48 - 49" diameter, 23,100 cfm airflow, 18.7 VER), running 1,594 hours / year	(8) exhaust fans (48 - 49" diameter, 23,300 cfm airflow, 19.7 VER), running 1,594 hours / year	670	$75	$9,600	128	15.0

Regular maintenance and cleaning of ventilation fans is an important part of reducing energy costs. Poor maintenance can reduce a fan's efficiency significantly. We recommend you establish a periodic fan cleaning schedule of every one-to-three months which includes inspecting and replacing worn belts and pulleys. Also, straighten bent cones and repair shutters that are not closing properly. It is important to de-energize the fan motor using lockout and tagout procedures prior to performing any maintenance on a ventilation fan.

4.3 Refrigeration

There are no activities or equipment at your facility applicable to this section.

4.4 Controllers

Poultry houses have multiple environmental systems such as lighting, heating, and ventilation, that all interact. Electronic controls can be set so that the lights, fans, and cooling systems are turned on and off automatically based on pre-determined settings. Electronic controls will help increase productivity by minimizing the chance of human error. These systems create a more stable, controlled environment for the birds to grow.

Dimmers are used to control lighting levels. Dimmers were evaluated in the *Poultry House Lighting* section.

Thermostats are used so that ventilation fans, attic inlets, stir fans, heaters, refrigeration units, etc. can be turned on or off automatically based on pre-set temperatures and other settings. The calibration of all thermostats should be checked every three months. The controllers are set to automatically control the ventilation system to manage air temperature, animal temperature and air quality. Thermostats are used by the controllers to call for fans to be turned on in a staged manner to control the temperature of the houses. Air quality is managed by the controllers calling for the fans to be run at minimum intervals of time automatically.

Timers are used to set equipment with an on/off schedule and motion sensors can reduce unnecessary energy use.

The facility is equipped with controllers and all existing automated controls have manual overrides. We recommend scheduled maintenance for all controls.

4.5 Other Motors and Pumps

We evaluate for replacing the existing motors with National Electrical Manufacturers Association (NEMA) Premium® efficiency motors.

Savings calculations are based on estimated annual run times, and the difference of the calculated electricity usage using the existing equipment specifications and efficient replacement equipment. When existing motor efficiencies are not available, they are estimated based on market research of motor ratings using the existing motors size and application.

Table OM.1 provides the equipment inventory. In the tables below, TEFC stands for totally enclosed fan cooled, TENV stands for Totally Enclosed Non-Ventilated, and VFD stands for variable frequency drive.

Table OM.1. Current Other Motors and Pumps Inventory

Description	Manufacturer / Model	Year Installed	# Motors	Motor HP	RPM Rating	Casing Type	VFD?	Submersible ?	Annual Run Time (Hours)	Efficiency Rating (%)	Estimated Annual Use (kWh)
Houses 1-4 Feedline Motors	Grower Select/C63BXHLT-1421	Not Available	24	0.5	1500 - 2700	TEFC	No	No	532	76.20	5,310
Houses 1-4 Auger Motors	Grower Select/C63BXJH-1236	Not Available	8	0.75	1500 - 2700	TEFC	No	No	532	81.80	2,473
Houses 1-4 Vent Motors	Hired Hand	Not Available	2	0.33	1500 - 2700	TEFC	No	No	133	72.40	77
Houses 1-4 Vent Motors	Bluffton Motor Works/4511007401	2008	2	0.33	1500 - 2700	TEFC	No	No	133	72.40	77
Houses 1-4 Feed Line Winch Motors	Powertrek	Not Available	4	0.25	1500 - 2700	TEFC	No	No	133	68.50	123
Houses 1-4 Curtain Motors	Bluffton Motor Works/4511007401	2008	4	0.33	1500 - 2700	TEFC	No	No	67	72.40	77
Well Pump Motors	Not Available	Not Available	4	1	1500 - 2700	TENV	No	Yes	532	82.50	1,635
Houses 1-4 Fogger Pumps	Sta-right	Not Available	4	0.75	2700 +	TEFC	No	No	67	76.20	166
Houses 1-4 Cool Pad Pumps	Flotec	Not Available	4	0.75	2700 +	TENV	No	Yes	67	76.20	166
Houses 1-4 Cool Pad Pump	Pentair	Not Available	12	0.75	2700 +	TENV	No	Yes	67	76.20	498
Fuel Pump	GPI/CC110496	2012	1	0.25	0 - 1500	TEFC	No	No	312	62.20	79

NEMA currently does not have recommendations for submersible motors or motors less than 1 horsepower (hp), so no evaluation is made for replacing these motors.

No concerns were identified during our conversations about the adequacy of the motors and pumps at Any Farm.

4.6 Water Heating

There are no activities or equipment at this site applicable to this section.

4.7 Air Heating and Building Environment

An effective thermal boundary is continuous and unbroken at the perimeter of a heated “conditioned” space. Insulation resistance to heat transmission is given as an R-value. The effectiveness of insulation depends on the choice of material, its density, and installation quality. Effective installations are absent of voids, completely fill any cavities, are installed at the correct densities, and are protected from air movement. A well-insulated and air-tight environment will prevent moisture and heating or cooling losses within a conditioned space. A vapor barrier is a necessary part of moisture management. Vapor barriers should be installed on the interior side of insulation, and as continuously as possible with seams, joints and penetrations sealed.

Savings explanations are outlined in each of the individual measure sections below.

4.7.1 Animal Housing

The existing heating equipment and adequacy review is described in Table H.1. Table H.2 summarizes existing and evaluated R-values and provides a review of the adequacy. Table H.3 provides information on other equipment in each house.

Table H.1. Heater Inventory

House Group	Description	Manufacturer / Model	Year Installed	# Heaters (All Houses)	Heater Type	Ignition Type	Input Rating (Btu/hr.)	Output Rating (Btu/hr.)	Chamber Length (ft)	Existing Output (Btu/hr. /sq. ft.)	Min. Rec. (Btu/hr. /sq. ft.)	Adequate?
Houses 1-4	Brood Heaters	LB White/Oval 80/AR80D2PD12 161S	2018	48	Radiant	Electronic	80,000	80,000	224	71	56	Yes
Houses 1-4	Non-Brood Heaters	Warnock Hersey/Comfort Zone-Easy Radiant/EZB-100	2008	16	Radiant	Electronic	100,000	100,000	336	45	34	Yes
		Warnock Hersey/Comfort Zone-Easy Radiant/EZB-125	2007	16	Radiant	Electronic	125,000	125,000				

Table H.2. R-Values Inventory and Adequacy Review

House Identifier	Area	Existing R-Value	Evaluated R-Value	Min. Rec. R-Value	Adequate?
Houses 1-4	Sidewall	13.53	18.37	7	Yes
Houses 1-4	Exposed Foundation Wall	1.33	1.33	N/A	-
Houses 1-4	End Wall	13.53	18.37	7	Yes
Houses 1-4	End Wall Doors	2.25	12	N/A	-
Houses 1-4	Ceiling	14.4	33.4	9	Yes
Houses 1-4	Brood Curtains	1	3	N/A	-

House Identifier	Area	Existing R-Value	Evaluated R-Value	Min. Rec. R-Value	Adequate?
Houses 1-4	Tunnel Intakes	1	7	N/A	-
Houses 1-4	Vent Boxes	1	1	N/A	-
Houses 1-4	Minimum Vent Fan Area	1	1	N/A	-
Houses 1-4	Exhaust Ventilation Fan Area	1	7/3	N/A	-

Table H.3. Other Equipment Table

House Identifier	# Attic Inlets / House	# Stir Fans / House	# Vent Boxes / House
Houses 1-4	0	0	71

4.7.2 House Wall Insulation

Savings calculations for adding insulation to the walls are based on installing new wall insulation above the curtain, below the curtain, in the end walls, and in other miscellaneous side wall areas with interior vapor barrier and interior plywood sheathing (either 1/2" fire-retardant treated plywood or 5/8" exterior type plywood). Though the evaluated insulation value is above the adequacy level of R-7 for walls, we evaluate for this R-value due to the size of the wall cavity and insulation material.

The exposed concrete foundation walls are uninsulated. Producers often use the concrete foundation as a guide when cleaning out the litter in the houses, and if insulation were to be installed, it would likely become damaged and ineffective from clean out processes, therefore, we do not evaluate for installing insulation on this surface.

We do not recommend installing new insulation to the side walls and end walls in Houses 1-4 because of the long payback period.

4.7.3 House Ceiling Insulation

Dropped ceilings are typically insulated with batt or blown insulation. The most common types of blown insulation are cellulose and fiberglass. Before adding additional insulation, the interior sheathing material should be patched of any holes and any loose strapping should be securely fixed to the trusses. The sheathing material should be an industry standard material type such as Tri-Ply, or similar. A wind barrier should also be installed in the eaves to prevent wind washing of insulation.

Savings calculations for adding insulation to the ceiling assume increasing the approximate R-value of the ceiling insulation by R-19. Though the evaluated insulation value is above the adequacy level of R-9 for ceilings, we evaluate for this R-value for increased energy savings.

We note that this was something you were interested in. We recommend this energy saving measure in Houses 1-4.

4.7.4 Insulated Tunnel Doors

Tunnel curtains can be a major source of heat loss in broiler houses. Insulated and gasketed tunnel inlet doors reduce conduction and infiltration losses and provide a more controlled environment. Tunnel doors also better direct the incoming cooled air upwards.

Savings calculations are based on reduced air infiltration and new doors with a minimum insulation value of R-7.

Houses 1-4 currently use curtains to cover the tunnel inlet. We recommend installing insulated tunnel doors in Houses 1-4.

4.7.5 Insulated Fan Covers

We noted that you were interested in the possibility of fan covers.

Exhaust fans, that are generally only used in the summer for the high heat and high humidity, can be a major source of heat loss in broiler houses in the colder months. Insulated exhaust fan covers, such as fan bonnets, or insulated and gasketed individual fan doors (similar to tunnel doors) can reduce heat losses when the fans are not in use.

We evaluate for installing either insulated fan doors R-value (R-7), or fan bonnets (R-3). If the fan doors meet the minimum payback criteria and are recommended, we use that information for the table totals.

Savings are based on both the increased R-value for the areas of the fan openings and eliminating the air leakage through the fan baffles. The estimated cost for insulated fan doors is $285 each, which is based on a quote provided for a recent project in Delaware. The estimated cost for fan bonnets is $30 each, which is based on a web search of available products.

Due to your interest in this measure we verified that both the fan doors and the fan bonnets meet the pay back criteria. The savings information for the exhaust fan doors are used in the table totals, however the insulated bonnets information is also provided.

We recommend installing insulated exhaust fan covers in Houses 1-4.

4.7.6 Insulated End Wall Doors

Insulated end wall doors reduce conduction and infiltration losses and provide a more controlled environment. Maintenance of the door tracks and seals, keeping them free of debris and clean, is important to the continued energy efficiency benefits.

Savings calculations for installing insulated end wall doors are based on reducing air infiltration and installing a manufactured insulated door with an insulation value of R-12.

We do not recommend installing insulated end wall doors on Houses 1-4 because of the long payback period.

4.7.7 Insulated Brood Curtains

We evaluate installing insulated brood curtains to reduce heat loss and air infiltration through the curtains during brooding periods.

Savings calculations for replacing the existing curtain are based on installing an insulated brood curtain with a value of R-3. Brood curtain dimensions are based on the cross-sectional area of the house.

We recommend replacing the existing brood curtains in Houses 1-4 with insulated brood curtains.

4.7.8 Seal Air Leaks

All broiler houses, even brand-new houses, should be checked for air leaks. Some common air leakage areas in poultry houses are wall sill plates, the ridgeline of open-ceiling construction, around fans, doors,

windows, and damaged areas of walls and ceilings. A tighter house provides a more controllable environment.
Savings calculations for sealing air leaks are based on reducing excessive and uncontrolled air leakage estimated as linear footage. The savings calculations use minimum ventilation requirements, existing fan information, estimated natural air changes, existing building conditions, and site-specific conditions.

Sealing the air leaks with an appropriate sealant material in Houses 1-4 is recommended.

4.7.9 Heaters

Rather than heating the air with forced hot air heaters (FHA), radiant heaters use radiant energy to heat the objects in a room. Radiant heaters also do a better job of heating the animals by providing concentric zones of temperature, with the hottest area in the center. This better enables them to find their own comfort zones.

When the existing heating system has adequate capacity, we evaluate for replacing the existing heating system total Btu/hr./sq. ft. with an electronic ignition radiant system with the same Btu/hr./sq. ft.

Savings calculations for replacing FHA heaters with electronic ignition radiant heaters are based on reduced heat losses during ventilation periods and the ability to provide thermal comfort at the defined temperatures in a more location-focused manner. Cost estimates are based on installing 125,000 Btu/hr. radiant tube heaters.

The Houses 1-4 currently have electronic ignition radiant heaters, which are considered energy efficient, therefore there are no efficiency recommendations for heaters.

4.7.10 Ceiling Stir Fans

During heating periods, the stack effect causes temperature stratifications within the house. Less dense hot air naturally rises towards the ceiling. Stir fans help circulate the heated air resulting in less heat loss through the ceiling, less temperature fluctuations and lower relative humidity.

Savings calculations are based on a reduced heat loss through the ceiling and account for an increased annual electricity usage. We evaluate for installing 1/15 HP 18" diameter cage fans rated at 3,500 cfm to attain 2 cfm per square foot.

We do not recommend installing stir fans in Houses 1-4 because adding stir fans would result in a net energy and cost increase.

4.7.11 Actuated Attic Inlets

Attic inlets enable warm attic air to be drawn into the house by utilizing the heat trapped above a dropped ceiling. When the attic temperature is at least 10 degrees higher than the desired temperature of the house, this can significantly reduce the heating fuel needed, especially during the first few weeks of a flock. Attic inlets are most effective in solid side wall houses that have been well sealed and that utilize tunnel ventilation.

Savings calculations are based on a reduction of fuel use by accounting for a warmer 'exterior' air being used for the first two weeks of the flocks. For our calculation purposes a 1.5 cfm/sq. ft. minimum standard using attic inlet of 2,000 cfm is considered in each house.

We do not recommend installing attic inlets in Houses 1-4 because of the long payback period.

4.7.12 Vent Box Doors

The vent box doors do not currently seal properly when closed and there is potential for energy savings associated with replacing with new units. Savings calculations are based on reducing excessive and uncontrolled air leakage associated with vent box doors that don't seal properly and is estimated as linear footage. The savings calculations use minimum ventilation requirements, existing fan information, estimated natural air changes, existing building conditions, and site-specific conditions.

We do not recommend replacing the existing vent box doors in Houses 1-4 with new units.

4.7.13 Air Heating and Building Environment Summary

Table HS.1 provides an analysis of energy savings associated with the *Air Heating and Building Environment* recommendations and Table HS.2 summarizes equipment that was evaluated but not recommended.

Table HS.1. Air Heating and Building Environment: Recommended Energy Saving Measures

Description	Current Equipment	Recommended Equipment	Est. Annual Electricity Savings (kWh)	Est. Annual Propane Savings (gal)	Est. Annual Cost Savings ($)	Est. Cost to Install ($)	Est. Payback (Years)	EUL (Years)
Houses 1-4: Seal Air Leaks	4 houses with moderate air sealing	Seal approximately 2,480 linear ft. per house in 4 houses to eliminate air leaks.	0	2,136	$2,910	$9,920	3.4	10.0
Houses 1-4: Brood Curtains	4 houses with (4) uninsulated brood curtains	Install (4) insulated brood curtains (approximately 1,987 ft² per house) in 4 houses.	0	722	$983	$9,538	9.7	10.0
Houses 1-4: Tunnel Intakes	4 houses with (2) uninsulated tunnel curtains	Install (2) insulated tunnel intake doors (approximately 894 ft² per house) in 4 houses.	0	2,369	$3,228	$32,211	10.0	20.0
Houses 1-4: Ceiling Insulation	4 houses with 33,531 ft² per house of blown fiberglass	Install 33,531 ft² per house of ceiling insulation in 4 houses.	0	3,608	$4,916	$67,061	13.6	20.0
Houses 1-4: Exhaust Ventilation Fan Covers	4 houses with 350 ft² per house of exhaust ventilation fans	Install (56) Insulated Fan Covers (Doors/Bonnets).	0	817/606	$1,113/$866	$15,960/$1,680	14.3/1.9	20.0/5.0
Totals			**0**	**9,652**	**$13,150**	**$134,690**	**10.2**	**N/A**

***Values for exhaust fan doors are used in the totals**

Table HS.2. Air Heating and Building Environment: Evaluated Measures Not Recommended

Description	Current Equipment	Evaluated Measure	Est. Annual Electricity Savings (kWh) (Increase)	Est. Annual Propane Savings (gal)	Est. Annual Cost Savings ($) (Increase)	Est. Cost to Install ($)	Est. Payback (Years)	EUL (Years)
Houses 1-4: Attic Inlets	4 houses with (0) attic inlets per house	Install (26) attic inlets per house in 4 houses.	0	669	$912	$16,640	18.2	10.0
Houses 1-4: Vent Boxes	4 houses with vent boxes with loose-fitting covers	Install replacement vent boxes (approximately 290 ft² per house) in 4 houses.	0	606	$826	$18,460	22.3	20.0
Houses 1-4: End Wall Doors	4 houses with (2) wood, uninsulated doors	Install (2) well-insulated end wall doors (approximately 192 ft² per house) in 4 houses.	0	258	$351	$8,448	24.1	20.0
Houses 1-4: End Walls	4 houses with 652 ft² per house of fiberglass batting	Install 652 ft² per house of wall insulation with interior plywood sheathing in 4 houses.	0	22	$30	$8,221	274	20.0
Houses 1-4: Sidewalls	4 houses with 5,454 ft² per house of fiberglass batting	Install 5,454 ft² per house of wall insulation with interior plywood sheathing in 4 houses.	0	304	$414	$114,760	277	20.0
Houses 1-4: Stir Fans	4 houses with (0) stir fans per house	Install (11) stir fans per house in 4 houses.	(12,602)	549	($667)	$6,600	N/A	10.0

4.8 Drying
There are no activities or equipment at this site that are applicable to this section.

4.9 Waste Handling
Using non-stationary equipment, the houses are de-caked, and litter is stored in a litter shed. Non-stationary equipment is not evaluated in this plan. The facility is currently using a composting system for mortality birds and litter. This system is considered energy efficient.

4.10 Air Cooling
The houses are cooled using a tunnel ventilation system with 6" wall mounted evaporator cells with recirculating water. Evaluations for installing tunnel doors are included in the *Tunnel Door* subsection in the *Air Heating and Building Environment* section. Evaluations for tunnel fans are included in the *Ventilation* section. Evaluations for pumps are included in the *Other Motors and Pumps* section.

4.11 Crop/Feed Storage
The facility stores feed on-site in grain bins. Electric motors used for crop/feed management are included in the *Other Motors and Pumps* section.

4.12 Water Management
The water sources used for agricultural purposes are wells. Electric motors used for water management are included in the *Other Motors and Pumps* section. We recommend you implement good conservation practices for water management, including checking and repairing any leaks and broken seals in a timely manner and instituting good maintenance practices for any evaporators.

The facility conserves water by recirculating the water used on the evaporator cells when cooling the flock.

You did not identify any adequacy concerns during our conversations regarding your farm's current source of water.

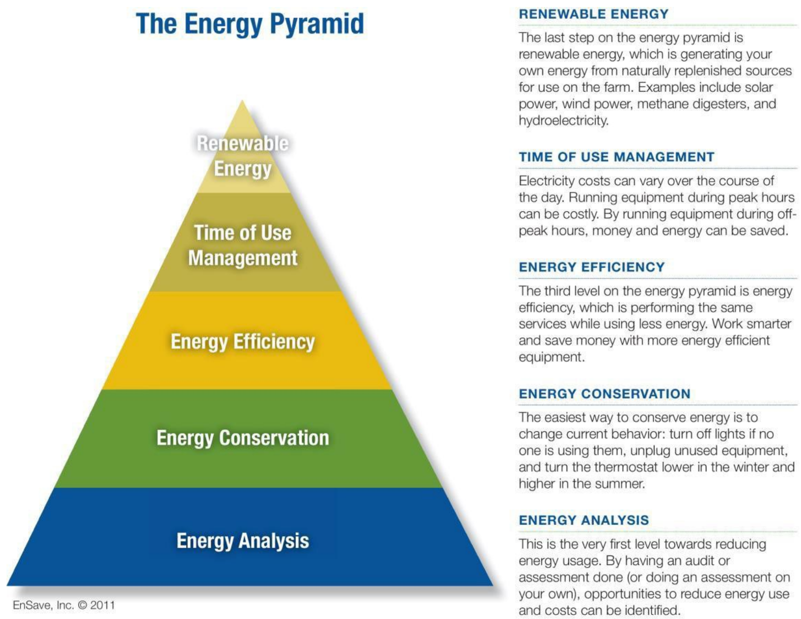
4.13 Material Handling

Stationary equipment used for material handling is included in other sections throughout this plan. Non-stationary equipment is not evaluated as part of this plan. There may be some opportunities to convert some or all of your non-stationary equipment to electric power, in order to save on the cost of fuel, however these are not evaluated as a part of this plan. We also recommend proper and continued maintenance to extend the expected useful life of the equipment.

5 Energy Pyramid

The energy pyramid describes a cost-effective approach to minimizing energy costs and achieving greater energy independence. In some cases, too much emphasis is placed on renewable energy to address energy concerns. Rather than being the first course of action, renewable energy should typically be considered only after addressing energy analysis, energy conservation, energy efficiency, and time of use management. This approach will minimize design and implementation costs associated with renewable energy technologies. The energy pyramid illustrates this approach to energy management, starting with building an understanding of opportunities through energy analysis and then pursuing the simplest and least expensive steps before progressing to the most complex and costly. Figure EP.1 shows the energy pyramid.

Figure EP.1. Energy Pyramid



The energy pyramid is a guide that serves as a road map to help facilities improve their efficiency and reduce their dependence on purchased energy.

The next step would be to review the recommended energy efficiency measures with your operation's needs and investigate funding resources.

6 Statements and Disclaimers

6.1 Liability

The intent of this energy evaluation is to estimate energy savings associated with recommended energy conservation measures. This plan is not intended to serve as a detailed engineering design document. Detailed design efforts may be required to implement several of the improvements evaluated.

Energy savings and equipment costs presented in this document are estimates and are based on information gathered during the process of developing this energy plan. Actual savings and costs may vary from estimates due to a variety of factors including changes in energy usage and energy costs, equipment costs, product availability, and geographic location.

EnSave is not liable if projected energy or cost savings are not actually achieved. All savings and cost estimates are for informational purposes and are not to be construed as a design document or as guarantees. The producer shall independently evaluate any advice or direction provided. EnSave is not liable for any failure to achieve a specified amount of energy savings, the operation of the customer's facilities, or any incidental or consequential damages of any kind in connection with this plan or the installation of recommended measures.

6.2 Vendor Neutrality

The goal of EnSave is to help our clients save energy and conserve natural resources. EnSave does not represent any equipment manufacturer or dealer. Any quotes or manufacturer literature included are intended as illustrations only.

The presence or absence of trade or company names should not be interpreted as a reflection on the quality of a company or its products.

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7 Appendix A: Resources

The following resources provide additional information about funding sources and energy information.

7.1 Funding Sources

1. NRCS Environmental Quality Incentives Program, https://www.nrcs.usda.gov/wps/portal/nrcs/main/[de]/programs/financial/eqip/
2. USDA RD Rural Energy for America Program (REAP) Information, https://www.rd.usda.gov/programs-services/rural-energy-america-program-renewable-energy-systems-energy-efficiency
3. Database of State Incentives for Renewables & Efficiency (DSIRE), http://www.dsireusa.org/
4. USDA Farm Service Agency, http://www.fsa.usda.gov

7.2 Energy Information

1. National Renewable Energy Laboratory, http://www.nrel.gov/
2. NEMA Premium® Motors, http://www.nema.org/Policy/Energy/Efficiency/Pages/NEMA-Premium-Motors.aspx
3. U.S. Energy Information Administration (EIA), http://www.eia.gov/tools/faqs/
4. EIA, AEO2016 National Energy Modeling System, https://www.eia.gov/outlooks/aeo/
5. EIA, Short-Term Energy Outlook, https://www.eia.gov/outlooks/steo/
6. R-Value database, http://www.coloradoenergy.org/
7. Lawrence Berkeley Laboratory (LBL) procedure https://www.energystar.gov/ia/home_improvement/home_sealing/ES_HS_Spec_v1_0b.pdf
8. Lamp Recycling, http://www.epa.gov/osw///hazard/wastetypes/universal/lamps/index.htm
9. CFL Recycling https://www.epa.gov/cfl
10. The DLC Qualified Product List, http://www.designlights.org/qpl
11. UD Lamp Interactive Tool, http://agdev.anr.udel.edu/dimmer/intro.php
12. Poultry House Light Dimming Issues, http://www.aces.edu/dept/poultryventilation/documents/Nwsltr-68LightDimmingIssues.pdf
13. Auburn University, Poultry Ventilation and Housing Newsletters, http://www.aces.edu/dept/poultryventilation/Newsletters.php
14. AU Minimum Ventilation Timer Calculator, http://www.aces.edu/poultryventilation/documents/MinVentTimerCalculator.pdf

15. University of Illinois at Urbana-Champaign's Bioenvironmental and Structural Systems Laboratory, uiuc.edu
16. Selecting Rated Ventilation Fans, https://extension.psu.edu/selecting-rated-ventilation-fans
17. UGA Tunnel House Heat Gain Analysis, https://www.poultryventilation.com/node/4074
18. AU Wintertime Broiler House Ventilation, http://www.aces.edu/dept/poultryventilation/documents/Nwsltr-15.pdf
19. AU Big Birds, Hot Weather and Maximum Comfort, Performance and Profit, http://www.aces.edu/poultryventilation/documents/Nwsltr-42_BigBirds_Hot_Weather.pdf
20. University of Georgia Poultry Housing Tips, https://www.poultryventilation.com/housing-tips
21. Six Top Tips for Best Tunnel Cooling, http://www.aces.edu/dept/poultryventilation/documents/Nwsltr-72TipsonTunnel.pdf
22. Improving Gas Heat System Efficiency, http://www.aces.edu/dept/poultryventilation/documents/Nwsltr-69ImprovingGasHeatSystemEfficiency.pdf
23. Keys to Top Evaporative Cooling Performance, http://www.aces.edu/dept/poultryventilation/documents/Nwsltr-41EvapCooling.pdf
24. Stir fan options, http://www.envirofan.com/Documents/Auburn%20Univ%20Stir%20Fan%20Report.pdf
25. Reduce Energy Costs in Poultry Houses, http://www.poultry.msstate.edu/pdf/extension/energy_costs.pdf
26. Insulation, https://www1.eere.energy.gov/library/pdfs/insulation_fact_sheet.pdf

7.3 Equipment and Productivity Attachments

The following resources describe the equipment and productivity benefits. They include explanations of how each piece of equipment saves energy and how each process improvement helps increase production and are attached separately.

1. *Best Practices Guide Energy Savings for Poultry*, published by EnSave, Inc.
2. *Brooding Curtains*, published by EnSave, Inc.
3. *Exterior LED Lighting,* published by EnSave, Inc.
4. *Efficient LED General Lighting*, published by EnSave, Inc.
5. *Insulated Tunnel Doors*, published by EnSave, Inc.
6. *Tunnel Ventilation Fans*, published by EnSave, Inc.

7.4 Equipment Product Data Sheets for Recommended Measures-Attachments

The following product data sheets are for the specific equipment used in this evaluation. This information is intended for your planning needs, to allow for an understanding and evaluation of the recommended measures, and to help guide you to implement the recommended measures. This includes information on the product specifications, output, and various energy efficiency-related factors. Estimated cost information is included in the Tables of Recommended Measures throughout this report.

1. Blown Fiberglass - Owns Corning L77 fiberglass brochure; https://www2.owenscorning.com/literature/pdfs/L77.pdf
2. Brochure-Gaco-183M-w; https://41z32e1503dj3gyqe3151089-wpengine.netdna-ssl.com/wp-content/uploads/Brochure-Gaco-183M-w.pdf
3. Brood Curtain; https://www.teksupply.com/contractor/supplies/cat1;ts_barn_curtain_accessories-ts_barn_curtain_2;ts_vinyltek_7layer_insulated_curtain_1.html
4. Lithonia-41-watt-4700lm-security light; https://s1.img-b.com/build.com/mediabase/specifications/lithonia_lighting/1433419/lithonia-lighting-tdd2-led-120-per-m4-specification-sheet.pdf
5. Overdrive-10-Watt-1000 lumen-LED; http://www.overdrive-lighting.com/pdf/lamps/Datasheet/Item-712.pdf
6. Dusk to Dawn 27 Watt-LED Outdoor Flood Light; https://www.lampsplus.com/products/white-10-and-three-quarter-inchh-dusk-to-dawn-led-outdoor-flood-light__3y658.html
7. Tunnel Doors/Exhaust Fan Doors Brochure – Cumberland; https://www.cumberlandpoultry.com/content/dam/Brands/Cumberland%20Poultry/Brochures/C-83_O%20Outside%20Tunnel%20Door.pdf/_jcr_content/renditions/original
8. Tunnel Fan Bonnets; https://www.qcsupply.com/fan-cone-cover.html

8 Appendix B: Minimum Standard Recommendations

Lighting: ASABE 344.4, IES Handbook, NRCS-CPS-Lighting System Improvements-Code 670

Ventilation: ASAE EP566.2, NRCS-CPS-Farmstead Energy Improvements-Code 374

Controllers: ASAE EP566.2, The Institute of Electrical and Electronics Engineers, Inc. (IEEE) Recommended Practice and Requirements for Harmonic Control in Electric Power Systems - 519

Other Motors and Pumps: National Electrical Manufacturers Association (NEMA) MG 1-2009

Air Heating and Building Environment: NRCS CPS Building Envelope Improvement Code 672, ASABE ANSI/ASAE S401.2 Guidelines for Use of Thermal Insulation in Agricultural Buildings, National Instructions Title 210 “Engineering Part 301" Use of Spray Polyurethane Foam Insulation and Vapor Retarders for Building Envelope Improvement

Heaters: Industry Standards; An average Btu/Hr./Sq. Ft. minimum standard requirement as derived from several major integrators was used for the adequacy evaluation of the existing heaters.

Waste Handling: NRCS CPS Animal Mortality Facility Code 316, NRCS CPS Waste Storage Facility 313

9 Appendix C: Calculations

9.1 Basics

9.1.1 Annual Run Hours

Annual Run Hours = [Hours per Day in Operation] * [Days per Week in Operation] * [Weeks per Year in Operation]

9.1.2 Btu Conversion Factors

EnSave uses the BTU factors as sourced from the U.S. EIA, last updated in 2015. These factors are as follows:

Electricity	1 kWh = 3,412 BTU
Propane	1 Gal = 91,333 BTU

It should be noted that the EIA just released (6/2020) new 2020 BTU values for these fuels, as follows:

Electricity	1 kWh = 3,412 BTU
Propane	1 Gal = 91,452 BTU

9.1.3 Area Calculations

Plane Area

The plane area of the building is used in many different parts of EnSave's calculations, including air infiltration and stir fans.

Plane Area = [Length of Building] * [Width of Building]

Cross Section Area

Cross Section Area is used in a few calculations. It assumes the ceiling portion is an equilateral triangle if open, and if dropped then the cross section is simply the width multiplied by the dropped ceiling height.

Cross Section Area = ([Width of Building] * [Sidewall Height]) + (([Width of Building] * ([Ceiling Height] – [Sidewall Height])) / 2)

Curtain Wall Opening Area

Curtain Wall Opening Area = [Curtain Opening Length] * [Curtain Opening Height] * [# Curtain Openings]

Above Curtain Wall Opening Area

The area above a curtain wall opening is considered a discrete component of a building:

Area Above Curtain = [Curtain Opening Length] * [Above Curtain Opening Height] * [# Curtain Openings per building]

Below Curtain Wall Opening Area

The area below a curtain wall opening is considered a discrete component of a building:

Area below Curtain = [Curtain Opening Length] * [Below Curtain Opening Height] * [# Curtain Openings per building]

Exposed Foundation Wall Area

Exposed Foundation Wall Area = (([Length of Building] + [Width of Building]) * [Exposed Foundation Wall Height] * 2)

Tunnel Intake Areas

Sidewall Tunnel Intake Area = ([SW-Tunnel Intake Height] * [SW-Tunnel Intake Length]) * [# SW-Tunnel Intakes]

End wall Tunnel Intake Area = ([EW-Tunnel Intake Height] * [EW-Tunnel Intake Length]) * [# EW-Tunnel Intakes]

Exhaust Fan Areas

Sidewall Exhaust Fan Area = ([# exhaust fans in sidewall] * Area of Exhaust Fans

End Wall Exhaust Fan Area = ([# exhaust fans in end wall] * Area of Exhaust Fans

Minimum Ventilation (min vent) Fan Area

Sidewall Min Vent Fan Area = ([# min vent. fans in sidewall] * Area of Min. Vent. Fans

End wall Min Vent Fan Area = ([# min vent. fans in end walls] * Area of Min. Vent. Fans

Vent Box Area

Vent Box Area = (([Vent Box Height(in)] * [Vent Box Length(in)]) /144) * [# Vent Boxes]

Total End Wall Door Area

End Wall Door Area = ([End Wall Door Height] * [End Wall Door Width]) * [# End Wall Doors]

End Wall Area

End Wall Area = ((([Width of Building] * [Sidewall Height]) + ((0.5 * [Width of Building]) * ([Ceiling Height] – [Sidewall Height]))) * [# End Walls]) - ((([End Wall Door Area] +(End wall Tunnel Intake Area) + (End wall Min Vent Fan Area)+(End wall Exhaust Fan Area) + ([Width of Building] * [Exposed Foundation Wall Height] * [# End Walls]))

Solid Sidewall Area

The area of solid sidewalls is the area of sidewalls not covered by any other component, such as curtain openings, tunnel intakes, vent boxes, etc.

Area of Solid Sidewall = ([Length of Building] * [Sidewall Height] * 2) - (([Curtain Wall Opening Area] + (Above Curtain Opening Area) + (Below Curtain Opening Area) + ([Length of Building] * [Exposed Foundation Wall Height] * 2) + (Sidewall Tunnel Intake Area) + (Sidewall Min Vent Fan Area) + (Sidewall Exhaust Fan Area) + (((Vent Box In Wall Factor)*[Vent Box Height] * [Vent Box Length]) * [# Vent Boxes]))

Ceiling Two Area
"Ceiling Two" is a generic name for an area of the ceiling with a different insulation than the rest of the ceiling.

Ceiling Two Area= [Length of Building] * [Ceiling Two Width]

Ceiling One Area
Any ceiling area not part of Ceiling Two is designated the primary ceiling area, or "Ceiling One".

Ceiling One Area = Sqrt (([Ceiling Height] − [Sidewall Height]) ^ 2 + ([Width of Building] / 2) ^ 2) * [Length of Building] * 2 – (Ceiling Two Area)- (((Vent Box In Ceiling Factor)*[Vent Box Height] * [Vent Box Length]) * [# Vent Boxes]))

Building Volume
Building Volume = (([Width of Building] * [Sidewall Height]) + (([Width of Building] * ([Ceiling Height] – [Sidewall Height])) / 2)) * [Length of Building]

9.1.4 R-Value Calculations
R-Value is a standard measurement of heat flow resistance. EnSave's uses the American R-Value, which is in (ft^2·°F·h/Btu). R-Values are an integral component to the heat loss calculations.

R-Value Database
EnSave keeps a database of R-Values of common building and insulation components, drawing from the work of an energy professional in Colorado who has posted the research online at http://www.coloradoenergy.org/. The component types accounted for are Air Film, Siding, Sheathing, Studs, and Insulation.

R-Value Equation for Walls
R-Value for most components is the stated R-Value for the component as found in the database. Existing R-values are sometimes reduced by the analyst to account for degradation from age, moisture, and pest damage etc. Walls are a combination of components.

The R-Value for walls = 1 / ((([Stud %] * (1 / ([Outside Air Film R-Value] + [Siding R-Value] + [Outside Sheathing R-Value] + [Stud R-Value] + [Inside Sheathing R-Value]+ [Inside Air Film R-Value]))) + ((1 – [Stud %]) * (1 / ([Outside Air Film R-Value] + [Siding R-Value] + [Outside Sheathing R-Value] + [Insulation R-Value] + [Inside Sheathing R-Value] + [Inside Air Film R-Value])))))

9.2 Lighting Calculations
Estimated Annual Current Use (kWh) = ([Fixture Total Power Consumption] * [# Bulbs/Fixture] * [# Fixtures]) * (percent dimming) * [Annual Run Hours]) / 1,000

Estimated Annual Recommendation Use (kWh) = [Recommended Total Power Consumption]) * [Recommended Fixture Ratio] * [# Bulbs/Fixture] * [# Fixtures] * (percent dimming) * [Annual Run Hours]) / 1,000

Energy Savings = Estimated Annual Current Use (kWh) - Estimated Annual Recommendation Use (kWh)

Cost Savings = Energy Savings * cost per kWh

Implementation Costs = (# of bulbs * cost per bulb) + (# new fixtures * cost per fixture) + estimated installation fee.

[Payback] = [Implementation Cost] / [Cost Savings]

Variables

- Fixture Total Power Consumption –bulb watts multiplied by any ballast factor, if applicable.
- Recommended Total Power Consumption –the bulb watts multiplied by any ballast factor, if applicable.
- Recommended Fixture Ratio – the ratio of recommended fixtures to current fixtures, for scenarios where we replace one fixture with two smaller fixtures.
- # Bulbs/Fixture – The number of bulbs per fixture.
- # Fixtures – The number of fixtures.
- Annual Run Hours – The annual run hours associated with the fixture.
- Percent dimming – The reduced draw based on dimming the lights as a percentage.

9.3 Ventilation Calculations

Exhaust fans are separated into two categories – "Low Volume High Speed" (LVHS) and "High Volume Low Speed" (HVLS). Specifications for fans are derived from BESS Labs. When the make and/or model # of existing fans are not available, EnSave uses the average specification of fans of similar size and age.

Estimated annual current ventilation use is determined by the remaining electricity available after all other facility uses have been accounted for:

Estimated Current Ventilation Use = [Reported Electricity Use] - ([Estimated Electricity Use from Other Measures] + ([Reported Electricity Use] * 0.02))

Fan run-hours are based on staged run times which divides up the available electricity by ratio and then weighted average to get estimated fan run hours.

Total Run Frequency Units = [# Fans-Stage 1] * [Run Frequency Units Stage 1] + [# Fans- Stage 2] * [Run Frequency Units Stage 2] + [# Fans- Stage 3] * [Run Frequency Units Stage 3]

Electricity Per Run Frequency Unit = [Electricity Available for Ventilation] / [Total Run Frequency Units]

Estimated Annual Current Use Per Stage = [Electricity per Run Frequency Unit] * ([Run Frequency Units] * [# Fans])

Estimated Annual Current Run Hours for Exhaust fans (by stage) (hrs.) = ([Estimated Annual Electricity Use (by stage)] * 1,000) / (([# Fans] * [Airflow]) / [VER])

Estimated Annual Current Run Hours for Circulation (by stage) (hrs.) = [Estimated Annual Electricity Use (by stage)] / ([# Fans] * [Power])

Estimated Annual Recommendation Use for exhaust Fans (kWh) = Estimated Annual Run Hours * (([# fans] * [Recommended Airflow]) / [Recommended VER])/1000

Estimated Annual Recommendation Use for circulation Fans (kWh) = Estimated Annual Run Hours * ([# fans] * [Recommended Power]) / 1000

Energy Savings = Estimated Annual Current Use (kWh) - Estimated Annual Recommendation Use(kWh)

Cost Savings = Energy Savings * cost per kWh

Implementation Costs = (number of fans * price per fan) + estimated installation cost.

[Payback] = [Implementation Cost] / [Cost Savings]

Variables

- Reported Electricity Use – The annual electricity use as reported by the utility.
- Estimated Electricity Use from Other Measures - any electricity already attributed to lighting, electric motors, and other equipment is removed from the available pool of electricity.
- 0.02 – EnSave assumes poultry and swine operations have a 2% miscellaneous electricity use.
- # Fans– The number of identical fans being evaluated.
- Run Frequency Units – A way of parceling out electricity use based on staging:
  - Stage I fans get 5 units.
  - Stage II fans get 3 units.
  - Stage III fans get 1 unit.
- Electricity Available for Ventilation – The total amount of electricity available to allocate to ventilation.
- Total Run Frequency Units – The total number of run frequency units from all fans.
- Annual Run Hours = Derived from overall existing annual ventilation use and staged run times.
- 1,000 – conversion of kilowatts to watts.
- Airflow – The rated airflow (cfm) of the specific fan model or an average of the best matches as available on Bess Labs Archive data.
- VER (cfm/watt) – The ventilation efficiency rating of the specific fan model or an average of the best matches as available on Bess Labs Archive data.
- Estimated Annual Electricity Use – The estimated annual electricity use, as calculated above.
- Power (Wh)– The power of the fan.
- Recommended Airflow (cfm)= Airflow for specific fan model recommended from Bess Labs Current data.
- Recommended VER (cfm/watt) = VER for specific fan model recommended from BessLabs Current data.
- Recommended Power (Wh) – The power of the fan model recommended

9.4 Controller Calculations

Electronic Controls Current Use = [Are Electronic Controls Present?] * ((0.05* [Total Heat Loss Attributed to Building Components]) / [Total Heat Loss Attributed to Building Components]) * ([Current Heating Fuel Use] – [Fuel Use Attributed to Air Infiltration])

Electronic Controls Recommended Use = [0]

Energy Savings = Estimated Annual Current Use (btu) - Estimated Annual Recommendation Use (btu)

Cost Savings = Energy Savings * btu to Fuel conversion * cost per [fuel unit]

Implementation Costs = Electronic controls have an estimated cost of $4,634 per building.

Variables:

- Are Electronic Controls Present? – 0 if present, 1 if not present.
- 0.05 – EnSave assumes that buildings without electronic controls produce 5% more heat loss than buildings with controls.
- Total Heat Loss Attributed to Building Components – The total heat loss attributed to the components of the building, such as ceilings, walls, doors, tunnel intakes, etc. Essentially, everything not otherwise attributed to air infiltration.
- Current Heating Fuel Use – the amount of heating fuel allocated to the building.
- Fuel Use Attributed to Air Infiltration – The amount of heating fuel already allocated to air infiltration.

9.5 Other Motors and Pumps Calculations

Evaluations of electric motors are based off of information published by NEMA regarding motor efficiencies.

EnSave keeps a database of electric motor specifications. This database is based on information from NEMA and is comprised of a series of tables of motors and their associated expected efficiency values. Motors marked as “Submersible” do not currently have any recommendations. All other motors are evaluated against the “Recommended Motor Efficiency Value” in the motor database matching the motor’s query values. Motors are assumed to be 1:1 replacement with equivalent horsepower and will run the same number of annual run hours.

Estimated Annual Current Use = (([Motor Horsepower] * [# Motors] * [Motor Load Factor] * 0.7457) / ([Existing Motor Efficiency Value] / 100)) * [Annual Run Hours]

Estimated Annual Recommended Use = (([Motor Horsepower] * [# Motors] * [Motor Load Factor] * 0.7457) / ([Recommended Motor Efficiency Value] / 100)) * [Annual Run Hours]

Energy Savings (kWh) = Estimated Annual Current Use (kWh) - Estimated Annual Recommendation Use (kWh)

Cost Savings = Energy Savings * cost per kWh

Implementation Costs = The cost associated with the recommended motor replacement is estimated based on the HP and type of pump and includes materials and labor.

Variables:

- Motor Horsepower– The rated horsepower of the recommended motor. It is assumed to be the same horsepower of the original motor.

- # Motors – the number of identical motors being evaluated. It is assumed a motor replacement will be a 1:1 swap.
- Motor Load Factor– Motor load factor is assumed to be 85% without a VFD and 50% with a VFD.
- 0.7457 – conversion factor of HP to kWh.
- Motor Efficiency Value – The motor efficiency value associated with the motor. This is expressed as a percent on nameplates, so it is converted to its decimal equivalent.
- Recommended Motor Efficiency Value – The efficiency rating associated with the recommended motor. Typically, this is the efficiency associated with a NEMA Premium motor of equivalent specification.
- 100 – conversion factor for percentage.
- Annual Run Hours – the number of run hours associated with the motor.

9.6 Air Heating and Building Environment Calculations

EnSave's calculations look at two principal sources of air infiltration, mechanical exhaust ventilation heat loss and heat loss from natural air exchanges. Mechanical exhaust ventilation heat loss is heat loss that occurs from the use of exhaust ventilation fans. Heat loss from natural air exchanges is heat loss that takes place due to wind and stack effect. EnSave's calculations for this heat loss uses the Lawrence Berkeley Laboratory (LBL) procedure for estimating this value which incorporates building location based on zones, the number of stories of the building, the building surrounding and building tightness factors.

For these calculations, EnSave determines the ACH50 and Ventilation Loss Rate values for each house group using a factor of how tightly sealed the houses are, based on ASABE paper number 1009236, presented at the 2010 ASABE annual International Meeting.

For this project, the Ex-ACH50 = 5.0 and the Ex-Ventilation Loss Rate (cfm/ft2) = 0.60865, the New-ACH50 = 3.7 and the New-Ventilation Loss Rate (cfm/ft2) = 0.5043

For the purposes of this evaluation to calculate the natural air exchanges in the buildings, an LBL factor of 18.5 was used based on the climate region, the number of stories of the building, and the analyst selected sheltering from wind category based on the current view of the facility on Google Maps. This factor is used to convert to estimated air changes by natural means, without fans.

An average annual exterior temperature of 57°F based on the average annual temperature in your State as obtained from National Oceanic and Atmospheric Administration's (*NOAA) National Centers For Environmental Information* (NCEI) An average interior temperature of 85°F was used, based on a combination of house size, house construction, the number of birds in the houses, the number of flocks per year, the number and capacity of the minimum vent fans, and the provided fuel use.

The sum of hours the fans are on and off during heating is calculated based on the minimum ventilation recommendations per bird based on age (CFM/Bird), the same average exterior temperature as noted above, the existing number of "minimum ventilation" fans and their CFM, the number of birds per house, and the number of flocks per year.

For the purposes of this evaluation, the number of hours the minimum ventilation fans are on while the heat was on was determined to be 334, and the number of hours the minimum ventilation fans are off while the heat was on was determined to be 2,150.

Air Infiltration Exhaust Ventilation Heat Loss (fuel units) = (([Ex-Ventilation Loss Rate] * 1.08 * [Δ Temperature]) * [Annual Heated Hours Exhaust Fans On] * [Plane Area of Building] * [# Identical Buildings]) / [Btu Conversion Factor]

Air Infiltration Natural Air Exchanges (fuel units) = ((((([Ex-ACH50 Factor] / [LBL Factor]) * 0.018) * [Building Volume]) * [Δ Temperature]) * [Annual Heated Hours Exhaust Fans Off]) * [# Identical Buildings]) / [Btu Conversion Factor]

9.6.1 Attic Inlets

Attic Inlets are a heat recovery device that uses the trapped warmer attic air to warm the building air. EnSave only assesses for attic inlets if the building has dropped ceilings. EnSave's calculations assume that the attic inlets would be open while running the exhaust fans and closed otherwise.

If buildings have attic inlets:
Estimated Annual Current Use (fuel units)= - (([EX-Ventilation Loss Rate] * 1.08 * 2.5) * [Annual Heated Hours Exhaust Fans On] * [Plane Area of Building] * [# Identical Buildings] * ([# of Attic Inlets] / ([Plane Area of Building] * 0.000747))) / [Btu Conversion Factor]

Estimated Annual Recommended Use (fuel units)= - ([New-Ventilation Loss Rate] * 1.08 * 2.5) * [Annual Heated Hours Exhaust Fans On] * [Plane Area of Building] * [# Identical Buildings] * (1 - ([# of Attic Inlets] / ([Plane Area of Building] * 0.000747)))) / [Btu Conversion Factor]

If Attic inlets are recommended:
Energy Savings = Estimated Annual Current Use + Estimated Annual Recommended Use

Cost Savings = Energy Savings (fuel units) * Cost per fuel unit

Implementation Costs: Attic inlets are currently set to an implementation cost of $160 per attic inlet.

Variables:

- Ventilation Loss Rate – The average ventilation loss rate for the building, in cfm based on a factor relating to building tightness.
- 1.08 - Conversion factor that turns (cfm · degrees F) to Btus.
- 2.5 – EnSave's calculations assume that the air in the attic is 2.5 degrees Fahrenheit more than the average indoor temperature of the building.
- Annual Heated Hours Exhaust Fans On – The number of hours in a year the exhaust fans were actively pushing air out of the building while the building was being heated. Attic inlets are assumed to only be open while the exhaust fans are on.
- Plane Area of Building – The area of the footprint of the building being evaluated.
- # Identical Buildings – The number of identical buildings being evaluated.
- # of Attic Inlets – The current number of attic inlets in the building.
- 0.000747 – Constant representing the expected number of attic inlets a building should have for maximum effectiveness.
- Btu Conversion Factor – The number of Btus in a standard unit of fuel. See the section "Btu Conversion Factors" for more detail.

- 1 – In instances where attic inlets are present but not in sufficient volumes the equation only considers installing the difference between the current number of inlets and the expected number of attic inlets for full benefits.
- # of Attic Inlets – The current number of attic inlets in the building.

9.6.2 Stir Fans

EnSave's calculations assume that hot air rises to the ceiling at the same rate of conduction heat loss through the ceiling materials. This produces a heat difference between the ceiling and the floor, and the area of this heat difference is equivalent to the plane area of the building. Using these values, EnSave calculates the amount of heat available that is trapped in the ceiling space that, when the stir fans are on, can be mixed into the air recovering the trapped heat. There is an inverse relationship between stir fan effectiveness and ceiling R-value. Stir fans consume electricity but produce heating fuel savings so the fuel savings is offset by the electricity cost to run the fans in the savings calculation.

EnSave only recommends stir fans if the existing number of stir fans is less than half of the would be recommended number of stir fans. If the building already has stir fans, then EnSave adds stir fans of the exact same type that is already present. If no stir fans are present, then EnSave recommends 18" basket fans with 1/15 hp motors for dropped ceilings and 48" paddle fans for open ceilings.

If buildings have stir fans
Annual Estimated Current Use (kWh)= ((([# Fans] * [Power] * [# Groups / Year] * (Hours Heaters are On with Fans Off)) / 1,000) * [# Buildings]

For recommended fans
Annual Estimated Recommended Use (kWh) = ((((0.0003 * [Plane Area of Building]) – [# Fans]) * [# Buildings] * (([Stir Fan HP] * 746) / 0.7) * [Hours Heaters are On with Fans Off]) / 1,000);

Fuel Savings (Fuel Units) = ((([Degree Difference in Ceiling] / [R-value of Ceiling]) / [Btu Value of Fuel]) * [Plane Area of Building] * [Hours Heaters are On with Fans Off]) *0.5* (1-([# Fans] / (0.0003 * [Plane Area of Buildings]))) * [# Buildings]

Cost Savings = (Energy Savings (fuel units) * Cost per fuel unit) – (Annual Estimated Recommended use * cost per kWh)

Variables:

- # Fans – The number of identical fans being evaluated.
- Power (Wh) – The amount of electricity the fans consume during an hour of runtime, inwatts hours.
- Hours Heaters are On with Fans Off – EnSave's calculations assume the stir fans are running only half the time that the heaters are on and the exhaust fans are off.
- # Groups / Year – The number of animal groups that are raised in the building during a calendar year.
- 1,000 – conversion of watts to kilowatts.
- # Buildings – The number of identical buildings in the building group.
- 0.0003 – Factor for the recommended number of fans in a building per square foot of plane area.

- Plane Area of Building
- Stir Fan HP – The horsepower of the fan.
- 746 – Conversion factor of horsepower to watts.
- 0.7 –Efficiency factor on the fan.
- Degree Difference in Ceiling – Open ceilings are assumed to be 8 degrees warmer than the floor, while dropped ceilings are assumed to be 5 degrees warmer than the floor
- Area of Ceiling – The area of the ceiling.
- Heat Loss of Ceiling – The heat loss associated with the entire ceiling. If the ceiling has different R-values in different sections than the average heat loss is used.
- Btu Value of Fuel – The Btu value of the heating fuel used by the building.

Implementation costs = (cost per fan * # of fans recommended) + installation costs.

9.6.3 Sealing Air Leaks

Savings from Air Infiltration is allocated to individual components for sealing relative to the linear feet of the perimeter of the component where applicable. Solid side wall conversion receives a full 50% of the available savings from air infiltration sealing. Components that are allocated savings from perimeter sealing in their evaluation include vent boxes, tunnel intakes, end wall doors and curtain walls. The remaining portion of savings is allocated to sealing the perimeter of the buildings at the bottom and top sill plates.

Component Savings from Air Infiltration Allocation (fuel units) = ((([EX-Air Infiltration Heat Loss from Exhaust Ventilation] + [Ex-Air Infiltration Heat Loss from Natural Air Exchanges]) – (NEW-Air Infiltration Heat Loss from Exhaust Ventilation] + [NEW-Air Infiltration Heat Loss from Natural Air Exchanges]))- [Attic Inlets Savings]) / [Btu Conversion Factor]) * ([Linear Length of Component Perimeter] / [Linear Length of All Recommendations that Reduce Air Infiltration]) * [Building Has Curtain Walls Factor]

Our calculations assume that the buildings, end wall doors, tunnel Inlets, and vent boxes are all quadrilateral and symmetric.

Implementation Costs: Sealing perimeter air leaks is estimated at $1 per linear foot.

9.6.4 Walls, Ceilings, Doors, Brood Curtains, etc.

After the air infiltration and stir fan components have been calculated, the remaining fuel allocation is parceled out proportionally to the remaining building components. For these components, EnSave assumes the buildings are comprised of materials that lose heat through conduction at different rates based on their area and R-Value relative to the other components. Areas of minimum ventilation fans are not evaluated for savings since they cannot be covered for safety purposes.

The fuel is allocated to each building relative to the building size and the efficiency of the building components.

Walls/Ceilings/Doors/Brood Curtains/etc. Fuel Loss (fuel units) = (([Fuel from Fuel Use History] - [Fuel Use Allocated to Air Infiltration + Fuel Use Allocated to Stir Fans]) * ([Building Total Heat Loss] / [Total Heat Loss from All Buildings])) + [Building Fuel Use Allocated to Air Infiltration and Stir Fans]

Estimated Annual Current Component Heat Loss (btu/h °F) = ((([Area of Component] / [Existing R-Value of Component]) * [Grow Out Only Factor]) * [# Buildings]

Current Annual Building Total Heat Loss (btu/h °F) = Sum of (Estimated Annual Current Component Heat Losses.)

Estimated Annual Current Component Use (fuel units) = ((((([Area of Component] / [R-Value of Component]) * [Grow Out Only Factor]) * [# Buildings]) / [Building Total Heat Loss]) * ([Building Fuel Use] – [Building Fuel Use Allocated to Air Infiltration and Stir Fans]]))

Estimated Annual Recommended Component Heat Loss (btu/h °F) = ((([Area of Component] / [Recommended R-Value of Component]) * [Grow Out Only Factor]) * [# Buildings]

Recommended Annual Building Total Heat Loss (btu/h °F) = Sum of (Estimated Annual Recommended Component Heat Losses.)

Estimated annual savings per component (fuel units) = ((Estimated Annual Current Component Heat loss- Estimated Annual Recommended Component Heat loss) * ([Building Fuel Use] – [Fuel Use Allocated to Air Infiltration + Fuel Use Allocated to Stir Fans])) + [Savings Allocation from Air Infiltration]) + Component Savings Allocation from Air Infiltration)

Cost Savings = Energy Savings (fuel units) * Cost per fuel unit

Implementation Costs:

- Walls:
  - The standard recommendation for upgrading walls is to remove the inner sheathing and any existing insulation, and replace it with fiberglass batting, an interior vapor barrier and re-sheath with ½-inch fire retardant plywood. The insulation depth is equivalent to the available stud depth.
  - Implementation costs are estimated at \$3 / ft^2 for 4-inch cavities and \$4 / ft^2 for 6-inch cavities, plus \$1/ ft^2 to remove any existing inside sheathing.
- Converting to Sidewall
  - EnSave evaluates for converting sidewalls to curtain walls by framing out the curtain opening with the same stud size, type, and depth, adding aluminum, steel, or vinyl siding, and adding fiberglass batting, an interior vapor barrier and sheath with ½-plywood.
  - Implementation costs are estimated at \$3 / ft^2 for 4-inch cavities and \$4 / ft^2 for 6-inch cavities, plus \$1/ ft^2 to remove any existing inside sheathing.
- Insulated Curtain:
  - If the facility would prefer insulated sidewall curtains to a solid sidewall conversion, the current curtains are evaluated for replacement with R-3 insulated curtains,
  - Installing insulated curtains is estimated at \$1.50 / ft^2.
- Foundation Walls:
  - Currently EnSave has no recommendations for exposed foundation walls. Historically, EnSave recommended a high-density foam for exposed foundation walls but stopped doing so due to damage from animals and farm equipment.
- Dropped Ceilings:

- EnSave evaluates for installing R-19 blown cellulose ceiling insulation and only if the existing R-Value is below 19.
- Installing Blown cellulose is estimated at $0.50/sf

- Open Ceiling:
  - EnSave evaluates to spray R-7 polyurethane foam to the existing construction if existing R-Value is below 5
  - Installing polyurethane foam is estimated at $1.50 / ft^2.
- End Wall Doors
  - Ensave evaluates to install an R-12 end wall door.
  - End wall door recommendations also receive air infiltration savings relative to their perimeter.
  - Installing end wall doors are estimated at $11 / ft^2.
- Tunnel Intakes:
  - Ensave evaluates to install R-7 tunnel intake doors.
  - Tunnel intake recommendations also receive air infiltration savings relative to their perimeter.
  - Installing tunnel doors is estimated at $9.25 / ft^2.
- Exhaust Fan Covers:
  - Ensave evaluates to install R-7 exhaust fan doors, or R-3 exhaust fan bonnets.
  - Installing exhaust fan doors is estimated to cost $285 / fan door. Installing exhaust fan bonnets is estimated to cost $30 / fan bonnet.
- Brood Curtains
  - Although they are an internal component EnSave evaluates brood curtain replacements as other building components and uses a similar heat loss equation but multiplied by 0.2 to account for the brood curtain only being in use for the first week or so of the flock.
  - EnSave evaluates to install R-3 brood curtains at a 1:1 replacement (Double curtains are not recommended for single curtains.)
  - Installing brood curtains is estimated at $1.20 / ft^2.
- Vent Boxes
  - EnSave evaluates for a 1:1 vent box replacement with an R-value of 1.
  - Installing vent boxes is estimated at $65 per vent box.

Variables

- Ventilation Loss Rate – The average ventilation loss rate, in cfm from ASABE research and based on building tightness.
- 1.08 – Conversion factor that turns (cfm · degrees F) to Btus.
- Δ Temperature – The difference between the average outdoor temperature and the average indoor temperature of the building, in degrees Fahrenheit.
- Annual Heated Hours Exhaust Fans On – The number of hours in a year the exhaust fans were actively pushing air out of the building while the building was being heated.
- Annual Heated Hours Exhaust Fans Off – The number of hours in a year the exhaust fans were off while the building was being heated.
- Plane Area of Building – The area of the footprint of the building being evaluated.
- # Identical Buildings – The number of identical buildings being evaluated.
- Btu Conversion Factor – The number of Btus in a standard unit of fuel. See the section “Btu Conversion Factors” for more detail.
- Fuel from Fuel Use History – The fuel use recorded from utility and fuel delivery records.

- Total Fuel Use Allocated to Air Infiltration and Stir Fans – The total fuel use allocated to air infiltration and stir fans across all buildings.
- Total Heat Loss from All Buildings – The total heat loss from all buildings, in Btu /(h·°F).
- Area of Component – The area of the component being evaluated.
- R-Value of Component – The R-Value of the component being evaluated
- Grow Out Only Factor- The grow out only factor is used only for the scenario in turkey facilities where turkeys are brooded in one building but grown in a separate building, with the "grow out" building requiring less heat. The factor is used to better allocate the fuel use. The grow out only buildings have 25% the heat loss of the brood buildings at the same facility. Otherwise this is factor set to 1.
- # buildings – The number of identical buildings.
- Building Total Heat Loss – The sum of the heat loss values from all components of the building.
- Building Fuel Use – The estimated annual fuel use allocation to the building.

9.6.5 Heaters

Estimated Annual Current Use (fuel units) = ([# Heaters] * ([Input Rating] * ((1 - [Radiant Heater Efficiency Bonus]) / [Btu Conversion Factor])) * [Annual Run Hours]) + ([Do Heaters have Pilot Lights?] * ([# Heaters] * ([Btu of Pilot Lights] / [Btu Conversion Factor]) * ([Heating Season in Weeks] * [Hours Per Week Pilot Lights are On]))

Estimated Annual Recommended Use (fuel units) = (([# Heaters] * ([Input Rating] * ((1 - [Radiant Heater Efficiency Bonus]) / [Btu Conversion Factor])) * [Annual Run Hours]) + ([Do Heaters have Pilot Lights?] * ([# Heaters] * ([Btu of Pilot Lights] / [Btu Conversion Factor]) * ([Heating Season in Weeks] * [Hours Per Week Pilot Lights are On])))

Energy Savings (fuel units) = Estimated Annual Current Use – Estimated Annual Recommended Use

Cost Savings = Energy Savings (fuel units) * Cost per fuel unit

<u>Implementation Costs:</u>

- The quantity of recommended radiant tube heaters is the amount to equal the current output Btu/hr. of the building divided by 125,000 btu/hr. per heater.
- Tube heaters are estimated to have an implementation cost of $1,100 each.
- The quantity of recommended radiant brooders is the amount to equal the current output Btu/hr. of the building divided by 40,000 btu/hr.
- Radiant brooders are estimated to have an implementation cost of $275 each.

Variables:

- # Heaters – the number of identical heaters being evaluated.
- Input Rating – The input rating of the heater, in BTU.
- Radiant Heater Efficiency Bonus – If the heater is a "Radiant Heater" the efficiency bonus is 0.15, otherwise this value is 0. (estimating that radiant heaters use 15% less fuel to maintain their input rating than a non-radiant heater.)
- Btu Conversion Factor – The number of BTUs in a standard unit of fuel. See the section "Btu Conversion Factors" for more detail.

- Annual Run Hours – the number of run hours associated with the heater. (Either the standard hours/days/weeks equation or EnSave estimates a value based on existing fuel use.
- Do Heaters have Pilot Lights? – 0 if the heaters have electronic ignition, 1 if the heaters have pilot lights.
- Btu of Pilot Lights – Pilot lights are assumed to consume 2,000 Btu/hour during the heating season.
- Heating Season in Weeks – The length of the heating season in weeks
- Hours Per Week Pilot Lights are On – Pilot lights are assumed to be on constantly throughout the heating season.

10 Appendix D: Details

10.1 Lighting Details

In the following tables, LLD stands for lamp lumen depreciation, LDD stands for lamp dirt depreciation, RSDD stands for room surface dirt depreciation, CU stands for coefficient of utilization, and LLF stands for the Light Loss Factor.

Table LD.1. Poultry House Lighting Schedule

Location	Lighting Period	# Houses	Start Day #	End Day #	Hours / Day On	Light Intensity (%)	Est. Annual Run Time (Hours)
Brood	Brood	4	1	8	23	100	828
Brood	Brood	4	9	18	18	100	810
Grow Out 1	Brood	4	9	18	18	100	810
Brood	Brood	4	19	28	16	50	360
Brood	Brood	4	29	56	16	20	403
Brood	Brood	4	57	59	23	20	62
Grow Out 1	Brood	4	19	28	16	50	360
Grow Out 1	Brood	4	29	56	16	20	403
Grow Out 1	Brood	4	57	59	23	20	62
Grow Out 2	Brood	4	19	28	16	50	360
Grow Out 2	Brood	4	29	56	16	20	403
Grow Out 2	Brood	4	57	59	23	20	62

Table LD.2. Existing Poultry House Lighting Adequacy and Coefficients

Description	Area (ft²)	Description	LLD	LDD	RSDD	CU	Weighted Avg. Lumens per Fixture	LLF	Calculated Light Level (fc)	Min. Rec. Light Level (fc)	Calculated Light Level (lux)	Min. Rec. Light Level (lux)
Houses 1-4 Brood Area Lights	13,440	10W LED lights, 10W LED lights	0.85	0.95	0.87	0.52	1,000	0.7	1	2.8	13	30
Houses 1-4 Non-Brood Area 1 Lights	10,080	10W LED lights, 10W LED lights., 10W LED lights., 10W LED lights	0.85	0.95	0.87	0.58	945	0.7	1	0.5	12	5
Houses 1-4 Non-Brood Area 2 Lights	10,080	10W LED lights, 10W LED lights, 10W LED lights, 10W LED lights	0.85	0.95	0.87	0.58	945	0.7	1	0.5	14	5

Table LD.3. Existing General Lighting Adequacy and Coefficients

Description	Area (ft²)	Description	LLD	LDD	RSDD	CU	Weighted Avg. Lumens per Fixture	LLF	Calculated Light Level (fc)	Min. Rec. Light Level (fc)	Calculated Light Level (lux)	Min. Rec. Light Level (lux)
Houses 1-4 Security Lights	196	150W HPS lights	0.91	0.7	0.87	0.93	15,000	0.46	33	0.2	352	2
Houses 2 Security Light	196	65W CFL lights	0.85	0.7	0.87	0.93	550	0.52	1	0.2	15	2
Manure Shed Light	735	150W HPS lights	0.91	0.8	0.87	0.74	15,000	0.53	8	4.6	85	50
Control Room 3-4 Lights	84	10W LED lights	0.85	0.9	0.87	0.89	1,000	0.67	14	9.3	152	100
Control Room 1-2 Lights	84	57W INC lights, 10W LED lights	0.85	0.9	0.87	0.89	830	0.67	12	9.3	126	100
Office Lights	480	10W LED lights, 57W INC lights	0.85	0.9	0.87	0.89	830	0.67	11	9.3	118	100

Description	Area (ft²)	Description	LLD	LDD	RSDD	CU	Weighted Avg. Lumens per Fixture	LLF	Calculated Light Level (fc)	Min. Rec. Light Level (fc)	Calculated Light Level (lux)	Min. Rec. Light Level (lux)
Generator Room Lights	150	42W CFL lights	0.85	0.8	0.87	0.82	2,650	0.59	14	4.6	148	50

Table LD.4 Evaluated General Lighting Adequacy and Coefficients

Description	Area (ft²)	Description	LLD	Weighted Avg. Lumens per Fixture	LLF	Calculated Light Level (fc)	Min. Rec. Light Level (fc)	Calculated Light Level (lux)	Min. Rec. Light Level (lux)
Houses 1-4 Security Lights	196	(7) 41W Dusk-Dawn 4,700 lumen LED lights	0.85	4,700	0.52	12	0.2	124	2
Houses 2 Security Light	196	(1) 27W Dusk-Dawn 2,247 lumen LED lights	0.85	2,247	0.52	6	0.2	59	2
Manure Shed Light	735	(1) 41W Dusk-Dawn 4,700 lumen LED lights	0.85	4,700	0.59	3	4.6	30	50
Control Rooms 1-2 Lights	84	(2) 10W, 1,000 lumen LED light, 10W LED lights	0.85	950	0.67	13	9.3	144	100
Office Area Lights	90	10W LED lights, (1) 10W, 1,000 lumen LED light	0.85	950	0.67	13	9.3	135	100
Generator Area Lights	375	(4) 10W 1,000 lumen LED lights	0.85	1,000	0.59	5	4.6	56	50

10.2 Ventilation Details

Table VD.1. Ventilation Adequacy

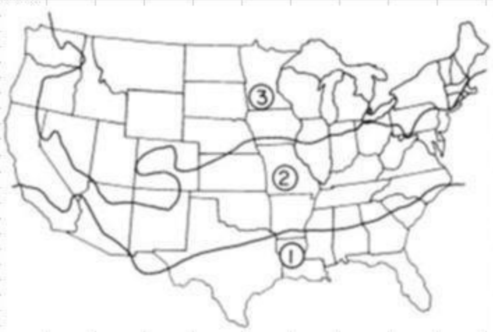
	Houses 1 and 2: Exhaust Ventilation Adequacy		
	Design conditions		
	Inside Goal Temperature (°F) from Fans Only	91	
	Design Summer Outside Temperature (°F) *	89	
	Basic house information		
	House Length (ft)	560	
	House Width (ft)	60	
	Total Side Wall Height (ft)	6.58	
	Peak Ceiling Height (ft)	10	
	Open or Dropped Ceiling (o/d)	d	
	Bird information		
	Number of Birds	35,000	
	Bird Weight (lbs)	7	
	Heat Production per Pound (Btu/hr/lbs)	5.8	
	Side wall construction		
	Curtain Height (ft)	0	
	Side Wall Height (excluding foundation)	6	
	Stem/foundation wall height	0.58	
House surface insulation values (ft^2*°F*hr/BTU)			
	Ceiling R-Value	14.40	
	End Wall R-Value	13.5	
	Side Wall R-Value	13.5	
	Foundation R-Value	1.33	
Total Poultry House Heat Load =			1,501,819 Btu's/hr
Existing Ventilation Capacity (CFM)=			*387,800 cfm*
Recommended 'Max' Ventilation Capacity Needed =			*280,714 cfm*
Approximate needed number of tunnel fans @ 22,000 CFM =			*12.8*
Average Existing air speed =			*780 ft/min*
Existing CFM per square foot of floor space =			*11.5*
Existing CFM per bird =			*11.1*
*Some Calculations sourced from UGA Calculator			
* ASHRAE Summer dry bulb 2 1/2% temperature for the given location was used for the outside temperature.			

10.3 Building Environment R-Value Details

R-Values Chart

Poultry:		
Broilers	Walls	Ceilings
All zones	7.00	9.00
Layers/Breeders	Walls	Ceilings
zone 1	5.88	14.08
zone 2	5.88	16.95
zone 3	12.05	25.00
Dairy:		
Parlor	Walls	Ceilings
zone 1	14.08	22.22
zone 2	14.08	25.00
zone 3	20.00	33.33
Holding Area	Walls	Ceilings
zone 1	5.88	14.08
zone 2	5.88	16.95
zone 3	12.05	25.00
Open Air Livestock Buildin	Walls	Ceilings
All zones	N/A	5.88
Enclosed Livestock Buildin	Walls	Ceilings
zone 1	14.08	22.22
zone 2	14.08	25.00
zone 3	20.00	33.33
Other:		
Office	Walls	Ceilings
zone 1	14.08	22.22
zone 2	14.08	25.00
zone 3	20.00	33.33
Shop	Walls	Ceilings
zone 1	14.08	22.22
zone 2	14.08	25.00
zone 3	20.00	33.33
Heated/Cold Storage	Walls	Ceilings
zone 1	14.08	22.22
zone 2	14.08	25.00
zone 3	20.00	33.33
Unheated Storage	Walls	Ceilings
All zones	N/A	5.88

Zone:



11 Appendix E: Estimated Annual Energy Efficiency Improvements

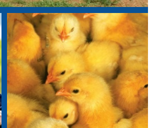
Table A.1 provides a detailed listing of all recommended measures.

Table A.1. Detail Listing of Recommended Annual Energy Efficiency Improvements

		Estimated Annual Reduction in Energy Use						Estimated Costs, Savings, Payback, and Prioritization for Implementation				Greenhouse Gases			Air Pollutant Co-Benefits	
Map ID	Recommended Measure	Current Item	Recommended Item	# to Install	Electric Savings (kWh)	Propane Savings (gal)	Energy Savings (MMBtu)	Installed Cost [a], $	Energy Cost Savings [b], $/yr.	Payback in Years [a / b], yr.	Est. Life in Years	Estimated CO_2 (lbs)	Estimated N_2O (lbs)	Estimated CH_4 (lbs)	Estimated SO_2 (lbs)	Estimated NO_x (lbs)
A	Office Area Lights	(1) 57W INC light	(1) 10W, 1,000 lumen LED light	1	68	0	0.23	$4	$8	0.5	10.0	58.37	<0.01	0.01	0.13	0.06
B	Houses 1-4 Security Lights	(7) 150W HPS lights	(7) 41W Dusk-Dawn 4,700 lumen LED lights	7	4,495	0	15.34	$938	$505	1.9	10.0	3,833.49	0.05	0.34	8.75	3.80
C	Control Rooms 1-2 Lights	(2) 57W INC lights	(2) 10W, 1,000 lumen LED light	2	37	0	0.13	$8	$4	2.0	10.0	31.43	<0.01	<0.01	0.07	0.03
D	Houses 1-4: Seal Air Leaks	4 houses with moderate air sealing	Seal approximately 2,480 linear ft. per house in 4 houses to eliminate air leaks.	N/A	0	2,136	195.08	$9,920	$2,910	3.4	10.0	26,698.93	1.92	0.43	0.21	27.77
E	House 2 Security Light	(1) 65W CFL light	(1) 27W Dusk-Dawn 2,247 lumen LED lights	1	166	0	0.57	$80	$19	4.2	10.0	141.57	<0.01	0.01	0.32	0.14
F	Generator Area Lights	(4) 42W CFL lights	(4) 10W 1,000 lumen LED lights	4	27	0	0.09	$16	$3	5.3	10.0	22.71	<0.01	<0.01	0.05	0.02
G	Houses 1-4: Brood Curtains	4 houses with (4) uninsulated brood curtains	Install (4) insulated brood curtains (approximately 1,987 ft² per house) in 4 houses.	16	0	722	65.92	$9,538	$983	9.7	10.0	9,021.47	0.65	0.14	0.07	9.38
H	Houses 1-4: Tunnel Intakes	4 houses with (2) uninsulated tunnel curtains	Install (2) insulated tunnel intake doors (approximately 894 ft² per house) in 4 houses.	16	0	2,369	216.39	$32,211	$3,228	10.0	20.0	29,615.69	2.13	0.47	0.24	30.80

		Estimated Annual Reduction in Energy Use						Estimated Costs, Savings, Payback, and Prioritization for Implementation				Greenhouse Gases			Air Pollutant Co-Benefits	
Map ID	**Recommended Measure**	**Current Item**	**Recommended Item**	**# to Install**	**Electric Savings (kWh)**	**Propane Savings (gal)**	**Energy Savings (MMBtu)**	**Installed Cost [a], $**	**Energy Cost Savings [b], $/yr.**	**Payback in Years [a / b], yr.**	**Est. Life in Years**	**Estimated CO_2 (lbs)**	**Estimated N_2O (lbs)**	**Estimated CH_4 (lbs)**	**Estimated SO_2 (lbs)**	**Estimated NO_x (lbs)**
I	Houses 1-4: Ceiling Insulation	4 houses with 33,531 ft² per house of blown fiberglass	Install 33,531 ft² per house of ceiling insulation in 4 houses.	N/A	0	3,608	329.53	$67,061	$4,916	13.6	20.0	45,100.52	3.25	0.72	0.36	46.90
J	Houses 1-4: Exhaust Ventilation Fan Covers	4 houses with 350 ft² per house of exhaust ventilation fans	*Install Insulated Fan Covers (doors/bonnets)	56	0	817/ 635.6	74.63/ 58.05	$15,960/ $1,680	$1,113/ $866	14.3/ 1.9	20.0/ 5.0	10,214.52/ 7,945	0.74/ 0.57	0.16/ 0.13	0.08/ 0.06	10.62/ 8.26
Totals					**4,793**	**9,652**	**898**	**$135,735**	**$13,690**	**9.9**	**N/A**	**124,738.70**	**8.74**	**2.29**	**10.29**	**129.53**

***Values for exhaust fan doors are used in the totals**



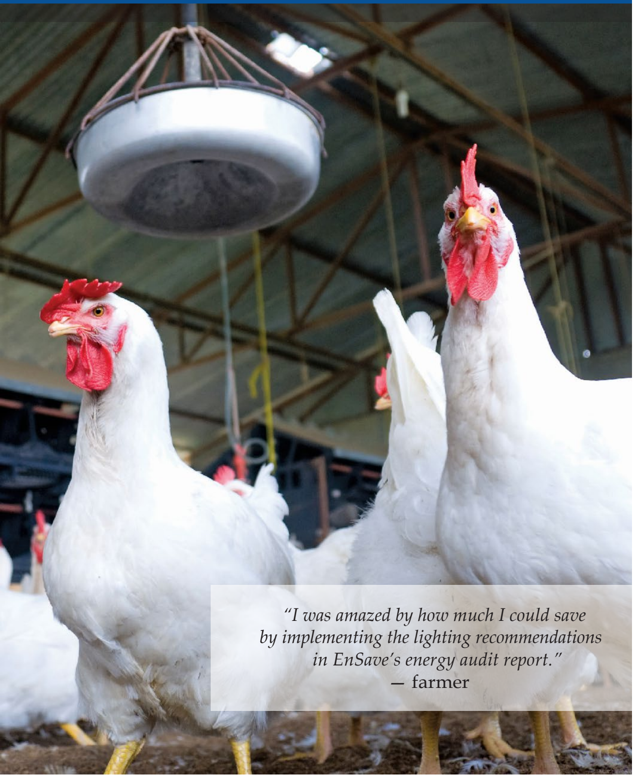
Best Practices Guide

Energy Savings Opportunities for Poultry

Inside the Guide

Welcome to EnSave's Best Practices Guide.

We have prepared this guide to help poultry producers begin the path toward energy independence.
This guide is intended primarily for broilers, although many measures apply to other types of poultry.

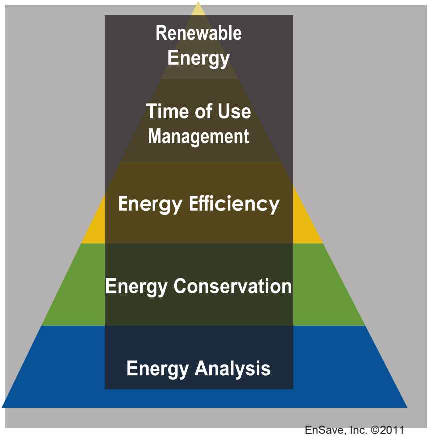


"I was amazed by how much I could save by implementing the lighting recommendations in EnSave's energy audit report."
— farmer

The Energy Pyramid

The energy pyramid is a useful concept designed to help people understand the process of using energy efficiently. In some cases too much emphasis is put on renewable energy to solve the nation's energy needs. Rather than being the first course of action, renewable energy should be considered only after a farm has considered all other steps of the pyramid.

The energy pyramid illustrates the steps in the process of becoming more energy independent, from the simplest and least expensive technique to the most complex.



EnSave, Inc. ©2011

Using Energy Efficiently

Farmers who are hoping to make their farms more energy efficient should consider all the steps in the energy pyramid, from the simplest and least expensive technique to the most complex.

RENEWABLE ENERGY

The last step on the energy pyramid is renewable energy, which is generating your own energy from naturally replenished sources for use on the farm. Examples include solar power, wind power, methane digesters, and hydroelectricity.

TIME OF USE MANAGEMENT

Electricity costs can vary over the course of the day. Running equipment during peak hours can be costly. By running equipment during off-peak hours, money and energy can be saved.

ENERGY EFFICIENCY

The third level on the energy pyramid is energy efficiency, which is performing the same services while using less energy. Work smarter and save money with more energy efficient equipment.

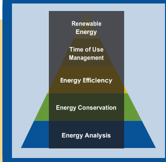
ENERGY CONSERVATION

The easiest way to conserve energy is to change current behavior: turn off lights if no one is using them, unplug unused equipment, and turn the thermostat lower in the winter and higher in the summer.

ENERGY ANALYSIS

This is the very first level towards reducing energy usage. By having an audit or assessment done (or doing an assessment on your own), opportunities to reduce energy use and costs can be identified.

Throughout this brochure, you will find helpful ideas that address each step of the pyramid, from bottom to top.



Get in Touch

If you have any questions about the energy pyramid or would like to learn more about how these ideas can work on your farm or facility, contact EnSave, Inc. today.

65 Millet Street | Suite 105 | Richmond, Vermont 05477
www.ensave.com | (800)732-1399

Farm Energy Audits

EnSave provides farm energy audits for producers across the United States. An energy audit analyzes current energy use and provides recommendations for energy conservation and energy efficiency. There is a tremendous opportunity on the farm to save energy and money by developing a cost-effective plan to upgrade or add energy efficient equipment.

1. We conduct an initial interview with the farmer to gather information about the operation and explain the audit process.
2. A local data collector visits the farm to verify and collect information about energy use
3. Our energy engineers complete a thorough data analysis
4. We deliver an audit report with energy analysis and recommendations
5. We follow up with the farmer to answer questions, review the plan's recommendations, and discuss opportunities for implementation.

We provide several types of energy audits in order to best serve each farmer, and to meet specifications required by various government cost-share programs. EnSave provides farm energy audits for all types of agriculture, including dairy, poultry, swine, greenhouses, and others. We can review electric energy savings as well as propane, natural gas, and diesel. Our farm energy audits serve as a decision-making tool farmers can begin using immediately in order to take control of their energy costs.

Can Your Farm Benefit from an Energy Audit?

For broiler and turkey growers with two or more houses.

Complete the 12-question survey below. If your score is greater than 2, you may benefit from an energy audit. For more details or questions, call an energy expert at EnSave for a free consultation.

	Yes = 0	No = 1
1. Do you have an insulated brood curtain?		
2. Do you have attic inlets in your house(s)?		
3. Do you have ceiling stir fans (used for heating)?		
4. Do you have insulated tunnel inlet doors?		
5. Do you have electronic controls in the houses?		
	Yes = 0	**No = 2**
6. Do you have at least six inches of insulation in/on your ceilings?		
7. Is the framed portion of your sidewalls insulated?		
8. Has the house(s) been recently sealed from air leaks?		
9. Do you use radiant heaters in your house?		
	Yes = 2	**No = 0**
10. Are you interested in converting from curtain wall to solid insulated sidewalls?		
11. Do you use incandescent lights?		
	Yes = 1	**No = 0**
12. Are your tunnel ventilation fans older than 10 years?		
Total Score From Both Columns		

If your score is greater than 2, you may benefit from an energy audit!

Installation Tips

- ☑ Choose lights specifically designed for poultry applications
- ☑ Choose lights that come with a 3 year warranty or better
- ☑ Choose lights that have a color temperature between 3,500-6,400 Kelvin
- ☑ Check with you integrator to make sure LEDs are permitted

LED Lighting

Light-Emitting Diodes (LEDs) are an energy efficient lighting option for poultry housing. They use about 15% of the energy that an equivalent incandescent light uses. LEDs last much longer than any other lighting option, with a useful life range of 40,000-50,000 hours. LEDs have been proven to stimulate the birds to eat and drink as well as incandescent lights and CFLs. They may cost more initially than other lights, but they last longer and cost less to operate. LED lighting has superior dimming qualities to other lighting options and are capable of dimming to 0% with no flicker.

Before installing LEDs, check with your integrator and your electrician to ensure adequate lighting levels are met and that LEDs are permitted within your growing contract. The American Society of Agricultural and Biological Engineers publishes "Lighting Systems for Agricultural Facilities," a standard that specifies the minimum lighting level recommended for different types and ages of poultry. It is also important to have a dimmer that is compatible with LEDs. These steps will help facilitate a successful retrofit.

Preventative Maintenance

If the time is not right for an upgrade, some simple preventative maintenance can often help reduce bills in the short term, and help extend the life of the equipment. Here are some ideas that can be implemented today.

keep equipment clean Remove dust, soot, and debris from equipment including fans, heaters, and lights, to keep the equipment as efficient as possible. Make sure that water and feed lines are clean and not restricted. This extends the life of the equipment, reduces energy use, and keeps the farm running smoothly.

inspect regularly Check equipment regularly and replace parts that are showing excessive wear, before they break and cause irreparable damage.

fix leaks Air leaks in a poultry house increase heating and cooling loads, making the house less efficient and difficult to control. Seal cracks in the walls and ceiling to prevent any air leaks. Regular inspection helps identify leaks, keeping your poultry houses running efficiently and providing the farmer with more control over the house environment.

Efficient Fluorescent Lighting

Compact fluorescent (CFL) and cold cathode fluorescent (CCFL) lighting are more energy efficient than incandescent lights, and poultry houses can be easily retrofitted with these energy efficient lights. CFLs deliver the same amount of light as incandescent lights, but use approximately 25% of the electricity. CFLs may cost more initially, but they cost much less to operate and last up to 10 times as long as incandescent lights.

CCFLs can last up to 25 times longer than incandescent lights and have similar efficiencies to CFLs. Dimmable CFLs have been improved over the years, and CCFLs are very good at dimming. It is important to use a dimmer that is compatible with the type of lights used. Both types of lighting will successfully stimulate birds to eat and drink. For shop lighting or other lighting outside the poultry house, T-8 and T-5 lights with electronic ballasts replace the older T-12s and have several benefits. The T-8s and T-5s use about 25% less energy, generate less noise, more light per watt, better color rendering, minimal flickering, cooler operation, and save on electric costs.

Low-Cost Tips

- Choose a dimmer that is compatible with the bulbs.
- Use nickel-plated brass keylesssockets.
- Choose good quality bulbs.
- Clean lights after every flock.
- Light work areas, not entire building.
- Turn off lights when not in use.
- Use sensors or timers where appropriate.

Insulated Solid Sidewalls

Curtain walls are a major source of heat loss on a poultry farm. They have low insulation value (R-1.0), and they allow a large amount of air leakage. Converting curtain walls to solid sidewalls saves a significant amount of energy and gives the farmer more control over the environment of the house.

Insulation works by reducing heat transfer from one area to another. In winter, insulation reduces the transfer of heat from inside the poultry house to the outside air, helping the house stay at warmer temperatures. In summer, insulation reduces the transfer of heat from outside the house to within the house, helping the house stay at cooler temperatures. Insulation helps regulate the temperature within a poultry house, reducing the need of supplemental heating and cooling.

Installation Tips

- Make sure curtain opening is well sealed.
- Make sure insulation fits tight and covers the entire area.

Low-Cost Tips

- Check brooding curtain for holes or tears and patch them
- Install a steel pipe in the bottom of the brood curtain to create a tight seal with the floor of the house.
- Position bird boards a foot or so toward the non-brooding end of the house for a tighter seal between the curtain and the walls.

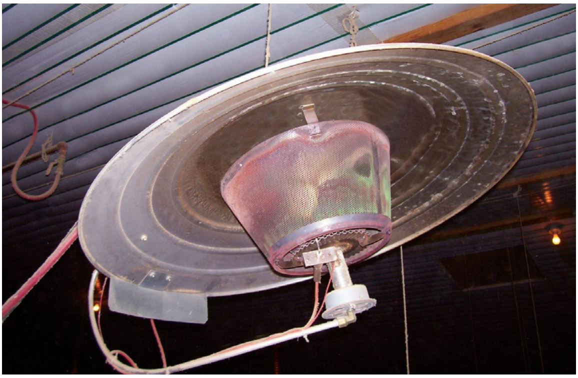
Brood Curtains

Heating an entire poultry house during the brood period requires a lot of fuel. Most farmers close half of the house off with a brood curtain, only using half of the house for the brood period, significantly reducing fuel consumption.

An insulated brood curtain is a cost effective way to further reduce fuel usage during the brooding period.

For a brood curtain to be effective, it needs to create a tight seal against the walls, floor, and ceiling of the house. Any loose seals or tears in the curtain will allow cold air to leak into the brood chamber, increasing the amount of fuel used to keep the house at the required temperature.

Regular brood curtains have little insulation value (R-1). Insulated brood curtains have more insulation (R-2.5). An insulated brood curtain is a cost effective way to further reduce fuel usage during the brooding period. They are more expensive than uninsulated brood curtains, but the reduction in fuel usage will more than pay for the insulated curtain over the life of the brood curtain. Typical paybacks for an insulated brood curtain are about two years.



Radiant Heating

Radiant heaters are the most efficient means of heating a poultry house. Radiant heaters directly heat the objects in a house, allowing the air temperature in a house to be lower than the temperature of the objects. Traditional forced hot air heaters and pancake brooders heat the air in a house. The heat in the air is lost when the air is changed in the house. Radiant heaters use between 15% to 30% less fuel than forced hot air heaters and pancake brooders when installed and managed properly.

In addition to being a more efficient heat source, radiant heaters have other distinct advantages compared to traditional poultry house heaters. Radiant heaters transfer heat directly to the litter pack, removing moisture and heating the litter so that the birds do not lose heat through their feet. Radiant heaters can also be mounted higher in the house, eliminating the need to raise and lower the heaters. Radiant heaters also take less time to preheat a house.

Maintenance and Safety Tips

- ☑ **Clean reflectors and heating elements between every flock.**
- ☑ **Check gas lines for leaks between every flock.**
- ☑ **Operate heaters at the specified gas pressure.**

Circulation (Stir) Fans

Benefits from recirculating the air in a poultry house include reduced fuel use, less wear and tear on the heating equipment, and decreased litter moisture.

Circulation fans have been found to be effective at mixing the air in a poultry house to create more uniform temperatures. Circulation fans are used to recirculate warm air from the ceiling to floor level where the birds need it.

Hot air rises to the ceiling of a poultry house, trapping itself out of reach of the birds. A properly designed and installed circulation fan system will move the warm air from the ceiling to the floor without creating enough air flow to chill the birds.

Fans for air recirculation do not need to be large or powerful, and there are several types of fans that will work. Some common types used are 18" basket fans and 48" paddle fans. Benefits from recirculating the air in a poultry house include reduced fuel use, less wear and tear on the heating equipment, and decreased litter moisture. Both open and closed ceiling houses can benefit from adding circulation fans to more evenly mix the heat in the house.

Low-Cost Tips

- ☑ Clean circulation fans with a brush or leaf blower after every flock.
- ☑ Keep basket fans parallel with the ceiling to properly move the warm air along the ceiling.
- ☑ Use paddle fans in the updraft mode.

Attic Inlets

Attic inlets can reduce heating fuel use in a dropped-ceiling poultry house by introducing "pre-heated" air from the attic into the house. Attic inlets work with the ventilation fans to provide clean, heated air from the attic. Daytime temperatures in attics can be as high as 25º F above the outside temperature. The warm attic air reduces the run time of the heating system, which reduces the amount of fuel used as well as reducing wear on the heating system. Attic inlets have also been found to reduce litter moisture by introducing warm, dry air from the attic.

Attic inlets should not be the first step in reducing energy usage in a poultry house. Sealing air leaks and adding insulation are steps to be done before installing attic inlets and will maximize the effectiveness of the attic inlets. There are two main types of attic inlets: gravity and actuated. Gravity attic inlets use the static pressure of the house to open the inlets. Actuated inlets are connected to controllers and can be set to open and close at various times and conditions. Both types are effective tools to reduce energy use in a poultry house if installed and managed correctly.

Low-Cost Tips

- **Clean inlets between flocks to ensure maximum performance.**
- **Establish proper operating guidelines so that inlets are used during safe and effective periods.**
- **Make sure houses are well-sealed to maximize the effectiveness of the attic inlets.**
- **Check that attic inlet controls are working properly.**

Insulated Tunnel Doors

Installation Tips

- ☑ Make sure the tunnel inlet is square and plumb.
- ☑ Use high quality mounting equipment and hinges.
- ☑ Make sure winching equipment allows for a full seal of the door.
- ☑ Make sure the door is properly sized to the inlet.

Tunnel doors have shown a decrease in heating fuel use and a decrease in litter moisture in many poultry houses.

Tunnel inlets are a significant area for heat loss in a tunnel ventilated poultry house. Traditional tunnel curtains have a low insulation value and can be loose fitting. Insulated tunnel doors were designed to provide more insulation and a better seal for tunnel inlets.

Heaters at the inlet end of the house can run up to 30% more than the heaters in the center of the house when using an ordinary tunnel curtain to seal off the tunnel inlet. Tunnel doors have shown a decrease in heating fuel use and a decrease in litter moisture in many poultry houses.

There are some issues with insulated tunnel doors that need to be addressed to ensure the equipment works in the intended manner. The framing on the tunnel inlet wall needs to be square and plumb to provide a good seal with the door. The winching equipment needs to be properly installed so that the door seals fully against the wall. The door also needs to be properly sized with the tunnel inlet to create a good seal. Metal hinges and mounting equipment have been found to work much better than plastic hardware. Insulated tunnel doors can be a very cost effective investment on the farm when installed correctly.

Tunnel Ventilation Fans

Tunnel ventilation fans are exhaust fans located at one end of the poultry house. Two large air inlets are installed at the opposite end of the house. The fans draw outside air through the openings and down the length of the house, producing a wind tunnel effect. This is an efficient method of cooling down the birds during the warmer months and can be combined with evaporative cooling for increased temperature control.

An energy efficient fan may cost more up front, but the lower operating cost will justify this cost over the life of the fan.

The easiest way to select fans is to choose fans that have been run through standardized tests, such as the ones done by the Bioenvironmental and Structural Systems (BESS) Laboratory at the University of Illinois. BESS Labs tests fans with accessories such as shutters, guards, and cones to determine the efficiency of each fan. An energy efficient fan may cost more up front, but the lower operating cost will justify this cost over the life of the fan.

Low-Cost Tips

- ☑ **Keep fans clean and well maintained. Dirty shutters can decrease airflow up to 40%.**
- ☑ **Check and maintain belt tension on fan motors.**
- ☑ **Use cog-type fan belts, as they are typically 2% more efficient than v-belts.**

End Wall Doors

End wall doors can be a significant area for heat loss if the doors are not in good condition. Warped, poor-sealing doors can allow air leaks, which negatively effect the temperature environment within the poultry house. This can lead to higher heating costs, litter caking, lower feed intake, lower feed conversion efficiencies, and smaller birds.

A good door should be strong enough to withstand the elements, have a good seal to eliminate leaks, withstand the pressurization requirements of the poultry house, and have good insulating properties. Although end doors are only used twice per flock, good doors will save energy all year by reducing air infiltration and heat loss. A door that is durable, insulated, and seals well is an excellent investment and will help save energy on the farm.used to power multiple loads.

Benefits of Good End Wall Doors

- **Seal air leaks, leading to less heating fuel use.**
- **Higher insulation value, leading to less heating fuel use.**
- **Less litter moisture.**

NEMA Premium® Motors

When installing a new motor or replacing an old motor, consider using a NEMA Premium® motor. While they may cost more initially, they are often cheaper to operate in the long run.

When purchasing a new motor, take into account the length of time the motor will run, how high electric bills currently are, and the right sized motor for the job. If the motor is only running sporadically, a retrofit to a NEMA Premium® motor may not make sense. However, the longer the motor runs, the greater the potential for savings. In new installations, NEMA Premium® motors are the standard.

Premium efficiency motors are usually made to higher manufacturing standards, and stricter quality controls. For more information, visit: www.nema.org/gov/energy/efficiency/premium/

Low-Cost Tips

- ☑ **Select the right size motor for the job**
- ☑ **Inspect all motors on a regular basis**
- ☑ **Clean motors regularly**
- ☑ **Replace V-type belts with notched belts**

Controllers

Today's poultry houses require constant monitoring of temperature to maximize bird growth. Traditional controls use thermostats to control the heating and cooling systems in a house. Thermostats can often drift out of calibration, allowing for overheating and over-cooling. Water, feed, and air quality also need to be constantly monitored. These can be overwhelming tasks for a poultry grower without the help of an electronic controller.

Controllers can coordinate heating, cooling, ventilation, and lighting systems so they work in an integrated fashion. The house can then remain in the optimum growing conditions, maximizing the growth rate and feed conversion efficiency of the birds. Energy can also be saved by reducing heating and cooling due to overheating or over-cooling.

Controllers are PC compatible, so regular reports on temperature, feed and water conditions, and even bird weights can be sent directly to the office computer. The data can then be analyzed for trends and trouble areas. Alarms can be set on the controllers to alert a farmer when undesired conditions occur in the poultry house.

Controllers can coordinate heating, cooling, ventilation, and lighting systems so they work in an integrated fashion.

Benefits of a Controller

- Controllers can make immediate adjustments to house conditions.
- Money, energy, and time saved.
- Provides an alarm system to alert you to serious conditions.
- Helps maintain optimum growing conditions to maximize profit and bird comfort.

Understanding Demand Charges and Time of Use

To reduce your electric demand, consider:

- **Moving certain operations to off-peak periods**
- **Avoiding having all equipment running at the same time**
- **Making sure your equipment is properly sized for the need**
- **Implementing electronic controls**

Electric demand is the rate at which electricity is being used by a consumer at any given time, and is measured in kilowatts (kW). The electric utility is concerned about the peak demand because it must maintain power quality with appropriate equipment and capacity to meet this peak. The consumer's peak demand during the month is based on a moving 15-minute average for that month.

To pay for the generation and transmission capacity to meet peak demand, utilities charge their larger energy users a demand charge based on the single highest 15-minute demand period measured in a month or a specified time period.

Some utilities have different demand rates based on the time of day when the peak occurs. The higher demand rates are for periods of the day when the utility sees higher demand. Since this demand is based on when the energy is used, there may be opportunities to reduce demand charges by better managing the time period in which equipment is used. This is what EnSave refers to as "time-of-use management."

Reducing demand not only saves you money, but also helps the environment. When utilities do not need to generate as much power, they avoid needing to increase capacity through building new power plants or purchasing more energy from other suppliers.

While an energy audit explains where your energy is being used, if demand charges are a concern for your farm you may benefit from a more detailed analysis. To learn about how time of use management can help your farm save money, call EnSave at (800) 732-1399.

Renewable Energy

It is recommended that, before pursuing a renewable technology, current operations be as energy efficient as possible.

However, once a farm has implemented all cost effective energy efficient equipment, renewable energy projects may make sense.

EnSave offers services to help you decide what your next steps should be regarding renewable energy.

For resource information on wind energy, photovoltaic, geothermal, and other renewable energy technology, call EnSave at 800-732-1399.

About EnSave

EnSave is the leading agricultural energy efficiency consulting firm in the United States. We help our clients achieve their energy efficiency goals while also helping farmers save energy and reduce their environmental impact. The inspiration for our work is the hard working men and women on the farm, and we strive to provide solutions that strengthen the farm and provide long-term viability.

Our passion is helping American agriculture become more sustainable and profitable through energy efficiency and resource conservation.

EnSave does not represent or recommend any equipment manufacturer or dealer. Our goal is to help our clients save energy and conserve resources. Please consult a licensed professional before installing any new equipment on your farm.

For more information on how EnSave can work with you, please contact us at (800) 732-1399.

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EnSave

Brooding Curtains

Low-Cost Tips

- Check brooding curtain for holes or tears, and patch them.
- Install a steel pipe in the bottom of the brood curtain to create a tight seal with the floor of the house.
- Make sure the houses are well-sealed and insulated, especially in the brood chamber.
- Position bird boards a foot or so toward the non-brooding end of the house for a tighter seal between the curtain and the walls.

It is very important to maintain a high temperature in the poultry house when chicks first enter the house. Chicks like a temperature of approximately 95° F for the first 8-14 days in the house. This time period is critical to developing the skeletal structure, white meat, vascular system, digestive system, and immune system of the birds. If a house is under-heated, the birds will use all of the energy from their feed for body heat instead of using the energy for structural development, inhibiting the growth of the birds.

Heating an entire poultry house to 95° F requires a lot of fuel. Most farmers close half of the house off with a brood curtain, only using half of the house for the first 8-14 days. This greatly reduces fuel consumption in the brooding period. For a brood curtain to be effective, it needs to create a tight seal against the walls, floor, and ceiling of the house. Any loose seals or tears in the curtain will allow cold air to leak into the brood chamber, increasing the amount of fuel used to keep the house at the required temperature.

Comparing Regular Brood Curtains with Insulated Curtains

Regular brood curtains have little insulative value (R-1). Insulated brood curtains have more insulation (R-2.5). An insulated brood curtain is a cost effective way to further reduce fuel usage during the brooding period. They are more expensive than uninsulated brood curtains, but the reduction in fuel usage will more than pay for the insulated curtain over the life of the brood curtain. Typical paybacks for an inuslated brood curtain are about two years.

PHOTO COURTESY NARCD

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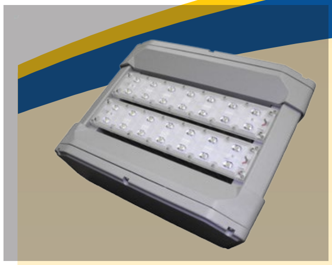
▶ Exterior LED Lighting



Other Considerations

Exterior LED fixtures can be purchased with the housing/ assembly included, or as a retrofit kit. Retrofitting an existing assembly instead of purchasing the lamp and the housing/assembly can reduce installation costs considerably. EnSave recommends referring to the Qualified Products List by the DLC when selecting an LED retrofit kit.

Over the lifetime of one LED fixture, an equivalent standard metal halide bulb would need to be replaced approximately 5 times at an average cost of $12 per lamp. As a result of reducing the number of replacement lamps, the LED provides an additional $60 in savings over the life of the bulb.

HID ballasts have a rated life of about 40,000 hours, which is less than the rated life of an LED. By switching to an LED fixture, additional saving can be found from eliminating the need to replace the ballast of the original fixture, which would occur within the LED's lifespan.

Exterior Lighting Replacements

Light emitting diode (LED) replacements are available for all standard wattages of exterior lighting fixtures. LED fixtures have numerous benefits when compared with standard exterior lighting technologies such as incandescent, mercury vapor, metal halide, halogen, and high pressure sodium. Benefits include lower power consumption to produce the same amount of light, longer fixture life, lower maintenance costs, and no mercury contained in the lamp. When selecting an exterior LED, EnSave recommends referring to the Qualified Products List provided by the Design Lights Consortium (DLC): **www.designlights.org/qpl**.

Average Fixture Life

LED lamps have an average rated life of 50,000 hours, which could result in between 5 and 50 years of life on the farm depending on the use. In contrast, the lifespan of standard exterior lighting technologies ranges from approximately 1,500 to 24,000 hours. Thus, an LED fixture has at least twice the useful life of a standard exterior lighting fixture. Increasing the life span reduces maintenance costs on the farm by minimizing the labor and materials to replace lamps more frequently, adding additional savings beyond the simple payback period.

LED LAMPS
(50,000 hour lifespan)

- 24hr/day use = 5.7 year effective useful life
- 3hr/day use = 45 year effective useful life

STANDARD METAL HALIDE LAMPS
(10,000 hour lifespan)

- 24hr/day use = 1.1 year effective useful life
- 3hr/day use = 9.1 year effective useful life

Cost Savings Example

LED fixtures typically consume 50 to 75% less electricity than comparable standard lighting technologies. The table below provides an example of annual energy cost savings achieved by replacing a standard metal halide fixture with an LED fixture. Savings are based on an electric rate of $0.10 per kilowatt-hour and 12 hours per day of use; your actual savings will vary based on electricity rates and daily use.

Lamp	Lamp Wattage	Total Fixture Wattage	Electricity Cost ($/kWh)	Daily Use (hours)	Daily Cost	Yearly Use (hours)	Yearly Cost	% Savings
Standard Metal Halide	175	209	0.10	12	$0.25	4,380	$91.54	62%
LED	80	80			$0.10		$35.04	
Savings					$0.15		$56.50	

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Saving Energy for America's Farms

Efficient LED Lighting

Lighting often represents one of the best opportunities to reduce electricity use on the farm, and lighting retrofits typically have shorter paybacks than other energy efficiency upgrades. Optimizing lighting levels on the farm can reduce energy usage while ensuring a safe and visually attractive work environment. Important factors to consider when optimizing your farm's lighting system include light quality (color temperature and color rendering index), optimal lighting level for the task or area, and the efficiency and longevity of the light fixtures you are installing. Lighting with a correlated color temperature of 4,000-8,000 Kelvin can improve working conditions and safety.

About LEDs

Light-emitting diodes (LEDs) have advanced significantly in recent years. Over the past decade, LED lighting technology has rapidly advanced while prices have decreased by approximately 90%. LED lighting is quickly making other lighting types obsolete due to the sharp increase in efficiency and decrease in cost. According to the United States Department of Energy, LED lighting is projected to achieve a market share of 84% of lighting sales by 2080.

The main advantages of LEDs are their efficiency (measures in lumens per Watt) and their long useful life, which reduces labor and material costs to maintain fixtures. LEDs last much longer than any other lighting option, with a useful life range of 40,000-50,000 hours, and they use about 15% of the energy of an incandescent light. LEDs also have superior dimming qualities compared to other lighting options and are able to dim to 0% with no flicker. However, you may need to purchase a dimmer that is compatible with LEDs.

Important Considerations

If you have requirements for certain lighting levels on your farm, check with an electrician to ensure adequate lighting levels are met. The American Society of Agricultural and Biological Engineers (ASABE) publishes a lighting standard with recommended illumination levels in Agricultural Facilities—ASAE EP344.3 "Lighting Systems for Agricultural Facilities."

To speak with one of our lighting experts, call us at 800-732-1399

Leverage our expertise and experience to answer these questions:

Lighting considerations:

- Choose lights designed for agricultural applications if possible
- Choose lights that come with a three-year warranty or better
- Consult third-party listings, like the Design Lights Consortium, to evaluate LED options (www.designlights.org)
- Consider installing timers or photocells to outdoor lighting
- Consider the use of motion/ occupancy sensors where appropriate
- Keep reflector shields and lenses clean

Insulated Tunnel Doors

Tunnel inlets are a significant area for heat loss in a tunnel ventilated poultry house. Traditional tunnel curtains have a low insulative value and can be loose fitting. Insulated tunnel doors were designed to provide more insulation and a better seal for tunnel inlets. Heaters at the inlet end of the house can run up to 30% more than the heaters in the center of the house when using an ordinary tunnel curtain to seal off the tunnel inlet. Tunnel doors have shown a decrease in heating fuel use and a decrease in litter moisture in many poultry houses.

Tunnel doors are built into the wall of the house and use winching systems to open and close. The doors open to a 45° angle, directing the air upward and towards the center of the house. This design helps eliminate dead air spots in tunnel ventilated houses, reducing temperature variations in the house as well as reducing litter moisture.

Installing Tunnel Doors for Maximum Energy Efficiency

There are some issues with insulated tunnel doors that need to be addressed to ensure the equipment works in the intended manner. Installation of the doors is the most important issue. A poorly installed tunnel door may perform worse than a tunnel curtain. The framing on the tunnel inlet wall needs to be square and plumb to provide a good seal with the door. The winching equipment needs to be properly installed so that the door seals fully against the wall. The door also needs to be properly sized with the tunnel inlet to create a good seal.

Mounting equipment for the tunnel doors is another important issue to address. Some of the first tunnel door models used plastic hinges and mounting equipment, and many of these components failed prematurely. Metal hinges and mounting equipment have been found to work much better. It is important that quality materials are used on the installation of the doors. If the tunnel door becomes misaligned it will not perform as intended and may do more harm than good.

Insulated tunnel doors can be a very cost effective investment on the farm when installed correctly. The increased R-value and sealing properties of a properly installed tunnel door will provide direct energy savings to the farmer. Be a wise consumer when purchasing tunnel doors for the farm. Make sure the hardware used for mounting is of good quality, and choose an installer who has experience with installing tunnel doors. A properly installed tunnel door system will provide energy savings and reduce litter moisture.

Installation Tips

- ☑ Make sure the tunnel inlet is square and plumb before installing the door.
- ☑ Use high quality mounting equipment and hinges.
- ☑ Make sure winching equipment allows for a full seal of the door.
- ☑ Make sure the door is properly sized to the inlet.

Insulated tunnel doors can be a very cost effective investment on the farm when installed correctly.

For more information, call EnSave at (800) 732-1399.
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Tunnel Ventilation Fans

Low-Cost Tips

- Keep fans clean and well maintained. Dirty shutters can decrease airflow up to 40%. Clean the shutters once every two months.
- Check and maintain belt tension on fan motors when cleaning the fan shutters, and plan on replacing tunnel fan belts annually. Belt slippage will reduce airflow and increase belt wear.
- Use cog-type fan belts, as they are typically 2% more efficient than v-belts.

Tunnel ventilation fans are exhaust fans located at one end of the poultry house. Two large air inlets are installed at the opposite end of the house. The fans draw outside air through the openings and down the length of the house, producing a wind tunnel effect. This is an efficient method of cooling down the birds during the warmer months and can be combined with evaporative cooling for increased temperature control.

Several factors affect tunnel ventilation fan performance. Airflow is the amount of air that a fan can move and is typically measured in cubic feet per minute (CFM). Efficiency of a fan is typically measured in CFM / watt. Fan performance is dependent on static pressure, and the common pressure used to compare fan performance for broiler houses is 0.10-inches water static pressure. Fan airflow ratio measures a fan's resistance to performance change at different static pressures. An airflow ratio will be between zero and one, and a high airflow ratio means the fan is more resistant to a change in performance as the static pressure changes. Houses with cool cells require tunnel fans with a high airflow ratio to pull air through the cool cell.

Choosing the Best Ventilation Fans for Your Poultry House

The easiest way to select fans is to choose fans that have been run through standardized tests, such as the ones done by the Bioenvironmental and Structural Systems (BESS) Laboratory at the University of Illinois. BESS Labs tests fans with accessories such as shutters, guards, and cones to determine the efficiency of each fan. An energy efficient fan may cost more up front, but the lower operating cost will justify this cost over the life of the fan.

Fan performance test information from the BESS Labs tests can be found on their website, www.bess.uiuc.edu, along with other useful information such as fan manufacturer contact information.

For more information, call EnSave at (800) 732-1399.
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OWENS CORNING
INNOVATIONS FOR LIVING

INTRODUCING

PROPINK L77

LOOSEFILL INSULATION

MULTI-USE APPLICATION
PERFECT FOR WALLS, ATTICS, CATHEDRAL CEILINGS AND FLOORS

18% YIELD IMPROVEMENT
HIGHEST COVERAGE IN THE INDUSTRY

PROPINK L77 LOOSEFILL INSULATION

INSULATION THAT WORKS AS HARD AS YOU DO

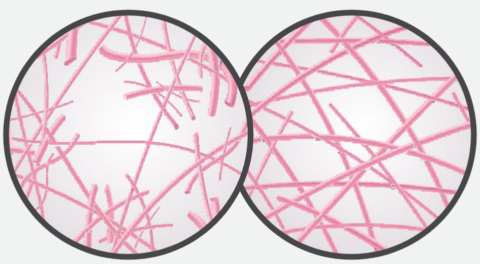
THE HIGHEST COVERAGE IN THE INDUSTRY THROUGH YIELD IMPROVEMENT

INTRODUCING
PROPINK® L77 LOOSEFILL INSULATION

Leave it to Owens Corning, the pioneer of fiberglass, to create a new fiber, loosefill product and manufacturing process that is so efficient and versatile, it is revolutionizing the industry. No other loosefill insulation measures up to its coverage, performance and energy-efficiency. **PROPINK® L77 LooseFill Insulation leads the industry in thermal performance and yield.**

HIGH PERFORMANCE FIBERIZING TECHNOLOGY

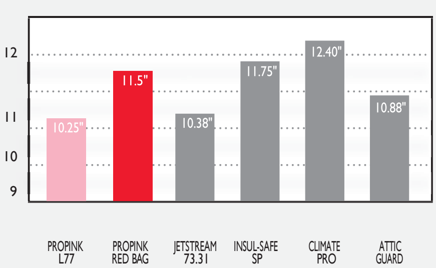
Owens Corning developed a new fiber which when blown creates a effectively distributed network of thermal reservoirs to resist heat transfer. This High Performance Fiberizing Technology produces a fiber construction that achieves a higher thermal performance in blown applications.



OLDER FIBERS | **NEW HIGH PERFORMANCE FIBERIZING TECHNOLOGY**

A new High Performance Fiberizing Technology boasts effectively distributed thermal reservoirs (see above) to achieve and maintain industry-standard thermal requirements with less glass material (see below).

INCHES OF INSULATION TO ACHIEVE R-30



PROPRIETARY MANUFACTURING PROCESS

To produce PROPINK® L77 LooseFill Insulation, Owens Corning developed a proprietary manufacturing process specifically for loosefill products. *This new process resulted in a yield improvement of 18% in terms of product performance.*

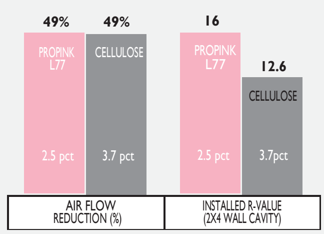
VERSATILE MULTI-USE APPLICATION

PROPINK® L77 LooseFill Insulation has been designed for use in walls, attics, cathedral ceilings and floors.

AIR INFILTRATION IN WALLS

PROPINK® L77 LooseFill Insulation also offers exceptional performance for air-infiltration control and thermal protection.

- Easily installed in walls and improved nesting for compaction
- Can now be "dense packed" into walls at an installed density of up to 2.50 pounds per cubic foot*
- Achieves an airflow reduction equal to cellulose, while providing R-Value greater than cellulose**



Source: Comparative Study on Air Infiltration by NAHB Research Center, 10/09

PROPINK® L77 LooseFill Insulation exhibits unsurpassed versatility—for installation, flexibility, performance, and productivity.

PROPINK® L77 LOOSEFILL INSULATION blows faster, is more energy-efficient, covers more square footage per bag, and can be used for multiple applications.

INNOVATION INVERSATILITY

Owens Corning has been the leader in producing high-quality building materials for over 70 years. Almost every major technological innovation in glass fiber technology has been the result of our meeting the needs of our customers. That's why our insulating products are rated Number One in Builder Magazine Brand Use Study* for the last 16 years.

Our partnership with professional installers across the country has resulted in a new loosefill formulation that's so versatile, it's changing the way installers work, reducing the amount of time on each job. With products—like PROPINK® L77 LooseFill Insulation—you increase your productivity on each and every job because of enhanced coverage, thermal performance and more consistent quality. PROPINK® L77 Insulation will make your crews more productive, while supplying an exceptional product to your customers. After all, only Owens Corning could perfect insulation so that it works as hard as you do.

* Hanley Wood, 2010

PERFORMANCE . PRODUC

PERFORMANCE

PROPINK® L77 LooseFill Insulation provides the highest yield of any loosefill insulation currently on the market.

Use less insulation for each job with increased thermal performance.

BETTER COVERAGE

- A single 33-pound bag provides 77 square feet of coverage at R-30 in attic applications.
- That's a coverage increase of nearly 18% over PROPINK® Unbonded LooseFill Insulation (red bag).

Complete energy performance for the life of the home.

- Non-combustible and non-corrosive
- Non-conducive to moisture retention
- Material design integrity that doesn't settle, preserving its thermal properties
- Formaldehyde Free
- Resistant to fungus and mold growth
- Third party certified 50% recycled content—the highest percentage

  in the industry.

PRODUCTIVITY

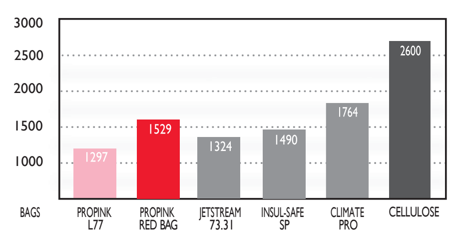
PROPINK® L77 LooseFill Insulation is certified for use in multiple applications, including walls, attics, cathedral ceilings and floors in new construction and retrofit applications.

Recognize better productivity in your warehouse and on your blow trucks—use PROPINK® L77 LooseFill Insulation across multiple applications.

WAREHOUSE PRODUCTIVITY

- With the coverage increase you'll use less—reducing space allocation in your warehouse for inventory.
- Multiple applications mean the inventory you carry turns faster.

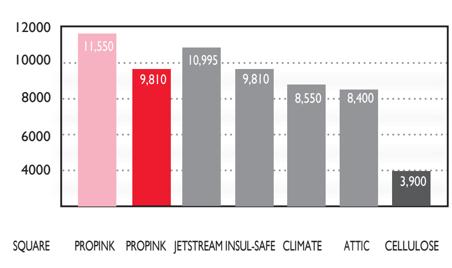
BAGS OF LOOSEFILL INVENTORY REQUIRED FOR 100,000 SQ/FT OF ATTIC COVERAGE AT R-30



BLOW TRUCK PRODUCTIVITY

- When a blow truck leaves the shop with PROPINK® L77 Insulation, it provides 18% more coverage—saving fuel costs and improving labor productivity.

BLOW TRUCK CAPACITY
(Assuming 150 bags on blowing truck. Insulation value at R-30.)



FOR INSULA TION THA T W ORKS AS HARD AS YOU DO , CHECK OUT PR OPINK ® L77 LOOSEFILL INSULA TION . W ANT T O KNO W MORE

TIVIT Y. PROFI TABILIT Y.

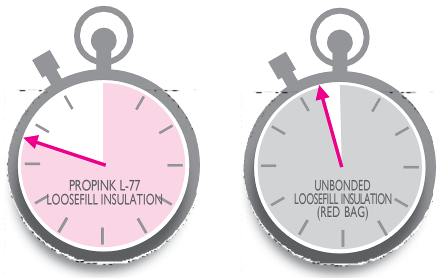
PROFITABILITY

PROPINK® L77 LooseFill Insulation saves you time on every job because you need 15% less product to insulate the same area (compared to red bag).

Improve crew productivity with increased thermal performance and consistent quality.

BLOW TIME

- Blowing time is reduced by 15% depending on blow rates used for each product to insulate the same area (compared to red bag).



MACHINE SETTING

- Owens Corning provides recommended machine settings specific to PROPINK® L77 LooseFill Insulation to ensure quick and easy installation.
- The product's consistent quality requires only minor blowing machine changes during installation, as opposed to complete recalibration.

For appropriate machine settings, call 1-800-GET-PINK for more information.

PUT PROPINK® L77 LOOSEFILL INSULATION TO WORK FORYOU

PROPINK® L77 LooseFill Insulation isn't just a better product, it's a better product whose performance directly impacts your productivity and profitability. **PROPINK® L77 LOOSEFILL INSULATION DOES MORE THAN WORK—IT WORKS FOR YOU!**

ADVANTAGES

- Highest coverage—use less product to achieve the same R-Value
- Save space in your warehouse
- Save space on your truck
- Improve labor productivity—unload trucks faster, spend less time managing inventory
- Use one product for many applications
- Optimize inventory on hand–improving your inventory turns
- Save time during installation & help eliminate builder call backs
- Maximize one of your most valued assets—your blow truck

HIGHER PRODUCTIVITY AND BETTER PROFITABILITY FOR YOU,YOUR CREW AND YOUR BUSINESS.

WHY PINK IS GREEN™

By delivering solutions that conserve energy and protect the environment, Owens Corning is helping make the world a better place, one community at a time. We manufacture building materials that save energy, reduce reliance on fossil fuels and decrease greenhouse gas emissions around the world.

PROPINK® L77 Loosefill Insulation carries the GREENGUARD® Certification, an industry independent, third-party testing program for low emitting products and materials. In fact, Owens Corning was the first insulation manufacturer to qualify for the stringent GREENGUARD® Product Emission Standard for Children and Schools.

Owens Corning is the first insulation and masonry veneer manufacturer to receive NAHB Research Center GREEN certification which helps builders and designers select products that meet specific green practices and can earn points towards the National Green Building Standard.

Owens Corning glass fiber and foam products made in North America are certified for their recycled content by Scientific Certification Systems (SCS). Our glass fiber products use an average of 50% recycled glass content, and our rigid foam insulation uses an average of 20% recycled content, with all foam scrap recycled back into the process instead of going to landfills

Owens Corning is an ENERGY STAR Partner. ENERGY STAR is a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy helping us all save money and protect the environment through energy efficient products and practices.

MBDC Cradle-to-Cradle Certified℠ PROPINK® L77 Loosefill Insulation at the Silver level. This certification means a product meets criteria in a number of areas which include: safe and healthy materials; design for reutilization (e.g. recycling); energy efficiency; efficient water consumption and the deployment of socially responsible strategies..

PROPINK® L77 INSULATION APPLICATION CHARTS

(information applies to new construction and retrofit applications.)
(NOMINAL BAG WEIGHT 33 LBS)

ATTICS

R-VALUE	BAGS PER 1000 SQ. FT.	MAX NET COVERAGE	MIN WT/SQ. FT.	MINIMUM THICKNESS (IN)	MINIMUM SETTLED THICKNESS (IN)
R-13	5.5	182.9	0.180	4.75	4.75
R-19	8.1	124.2	0.266	6.75	6.75
R-22	9.4	106.3	0.311	7.75	7.75
R-26	11.2	89.6	0.368	9.00	9.00
R-30	13.0	77.0	0.428	10.25	10.25
R-38	16.8	59.5	0.555	12.75	12.75
R-44	20.1	49.8	0.662	14.75	14.75
R-49	22.6	44.2	0.747	16.25	16.25
R-60	28.5	35.1	0.940	19.50	19.50

WALLS

R-VALUE	MINIMUM THICKNESS	INSTALLED DENSITY LBS. PER CU. FT.	MAXIMUM COVERAGE PER BAG	BAGS PER 1000 SQ. FT.	MINIMUM WEIGHT LBS. PER SQ. FT.
R-13	3.5 (2X4)	1.3	87.0	11.5	0.379
R-15	3.5 (2X4)	1.5	75.4	13.3	0.438
R-21	5.5 (2X6)	1.3	55.4	18.1	0.596
R-24	5.5 (2X6)	1.8	40.0	25.0	0.825

This product shows virtually no settling. This information applies to new construction and retro applications. Unisol Volu-Matic III machine was used to determine the coverage information above. The machine was set up in 3rd gear, with a 75% open gate and a 3" hose, blowing the wool out in a 10 ft. arc.

FLOORS

R-VALUE	MINIMUM THICKNESS	INSTALLED DENSITY LBS. PER CU. FT.	MAXIMUM COVERAGE PER BAG	BAGS PER 1000 SQ. FT.	MINIMUM WEIGHT LBS. PER SQ. FT.
R-31	2X8	1.4	39.0	25.6	0.846
R-39	2X10	1.4	30.6	32.7	1.079
R-48	2X12	1.5	23.5	42.6	1.406

CATHEDRAL CEILINGS

R-VALUE	MINIMUM THICKNESS	INSTALLED DENSITY LBS. PER CU. FT.	MAXIMUM COVERAGE PER BAG	BAGS PER 1000 SQ. FT.	MINIMUM WEIGHT LBS. PER SQ. FT.
R-28	2X8	1.3	42.0	23.8	0.785
R-36	2X10	1.3	32.9	30.4	1.002
R-44	2X12	1.3	27.1	36.9	1.219

INNOVATIONS FOR LIVING®

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ONE OWENS CORNING PARKWAY
TOLEDO, OHIO, USA 43659

1-800-GET-PINK®
www.owenscorning.com

Pub. No. 44426-G. Printed in U.S.A. March 2010.

Insulation. Air Barrier. Vapor Retarder. Thermal Break.

Gaco 183M Closed Cell Foam provides it all…and more.

ENERGY-EFFICIENT. | STRONG. | HEALTHY. | RESPONSIBLE. | QUIET.

SMART FROM THE START.

Gaco 183M

CLOSED CELL FOAM

CONTRACTOR / APPLICATOR BENEFITS

EXCEPTIONAL SPRAYABILITY. Superior formulation provides consistent, forgiving, user friendly foam with predictable yields and less gun clogging.

WINTER AND SUMMER FORMULATIONS. Sprays in any climate; expands your spray window in colder temperatures.

LESS VISCOUS. Reduces wear and tear on equipment.

LOWER ODOR. Improves work environment.

EXCELLENT ADHESION. Ideal for use on all types of substrates.

OWNER / SPECIFIER BENEFITS

ENERGY EFFICIENT. Higher aged R-values than conventional insulation and a seamless air barrier reduce uncontrolled air leakage resulting in lower energy costs. ABAA Evaluated and approved for use in air barrier systems.

DESIGN FLEXIBILITY AND STRENGTH. Adheres to the substrate, allowing for easy monolithic installation for greater structural strength and stability, and enhances resistance to water damage; expands to fill even irregularly shaped and hard to reach areas.

SUSTAINABLE AND HEALTHY. GREENGUARD Gold Certified as safe and healthy for indoor environments; reduces condensation, moisture and mold, provides a sound barrier to help block airborne noise, contains no ozone-depleting chemicals and may contribute up to 20 LEED credits.

LOWER CONSTRUCTION COSTS/VALUE ENGINEERING. Achieve insulation, air barrier, vapor retarder and thermal break all in one for reduced material costs; energy efficiency results in smaller HVAC system requirements.

LONG TERM VALUE. Customers today are concerned about their building's integrity; spray foam helps a building withstand the tests of the elements and time.

Insulation. Air Barrier. Vapor Retarder. Thermal Break.

Gaco 183M Closed Cell Foam provides it all…and more.

As building codes continue to become more stringent, and states and localities continue to adopt codes requiring increased energy efficiency and low emissions, Gaco 183M provides a multifunctional solution to the rising cost of building materials required to meet today's demand for high-performance buildings.

Not only does Gaco 183M offer the exceptional all-around performance that spray foam applicators demand, architects and specifiers will appreciate its design flexibility and sustainable contribution to healthy building interiors, along with the energy efficiency and occupant comfort that owners desire.

An air barrier system stops the uncontrolled flow of air into and out of the building envelope, thereby reducing moisture problems, building heating and cooling costs, and greenhouse gas production; it improves indoor air quality, acoustical isolation and the indoor environment; overall, an air barrier system results in sustainable, durable buildings.

As an ABAA Evaluated Material as part of an ABAA Evaluated Assembly, Gaco 183M Closed Cell Foam is approved for use in air barrier systems.

Building products can have a significant impact on indoor air quality, and can emit hundreds of chemicals into the air that building occupants breathe. GREENGUARD Certification has been widely adopted as a trusted standard for low-emitting products. More than 400 green building codes, standards, guidelines, procurements policies, and rating systems recognize or reference GREENGUARD Certified products.

Gaco 183M is GREENGUARD Gold Certified, signifying that it has been tested and certified to be in compliance with stringent chemical emissions guidelines set by UL Environment, and that it meets some of the world's most rigorous, third-party chemical emissions standards.

CLASS A (CLASS 1) FIRE RATING	AC377 APPENDIX X APPROVED	ONE HOUR FIRE RESISTANCE RATING PER ANSI/UL 263 (ASTM E119)	MEETS PERFORMANCE REQUIREMENTS OF NFPA 285	MEETS OR EXCEEDS TODAY'S TOUGH NEW BUILDING AND ENERGY CODES

TESTED AND APPROVED. Gaco 183M is tested and approved for use in Construction Types I, II, III, IV and V (all construction types applicable to residential, commercial and industrial construction).

USE IN, ON AND AROUND:

- Walls
- Ceilings
- Floors
- Attics
- Crawlspaces
- Foundations
- Concrete Slabs
- Residential Ducts
- Plenums
- Piping

RECOMMENDED FOR USE IN:

- Commercial and Industrial Buildings
- Metal Buildings
- Military Construction and Renovation
- Agricultural Buildings
- Cold Storage and Freezers
- Storage Tanks
- Other Industrial Applications and More

Gaco 183M Closed Cell Foam Product Data Sheet | September 2016

Note: This product is listed as GacoWallFoam 183M

Gaco 183M is a two component HFC-blown (zero ozone-depleting) liquid spray system that cures to a medium-density rigid cellular polyurethane insulation material. Gaco 183M contains polyols derived from naturally renewable oils, post-consumer recycled plastics, and pre-consumer recycled materials.

This closed cell foam is designed to provide: excellent thermal performance; air impermeable insulation; and, an integral part of an air barrier assembly.

Gaco 183M is a Class A (Class 1) fire rated foam that meets the requirements of ICC-ES AC377 Acceptance Criteria for Foam Plastic Insulation. Gaco 183M meets the requirements of AC377 Appendix X for use in attic and crawl spaces without an additional ignition barrier. See Intertek Research Report IRR-1002 for code compliant application information.

PHYSICAL PROPERTIES

The following physical property tests were conducted by independent certified laboratories with traceable samples in accordance ICC-ES AC377 and ASTM C1029 for Type II foam and ABAA D-115-010 for Air Barrier Materials and Assemblies.

PROPERTY*	ASTM TEST	VALUE	UNIT
Core Density:	D1622	2.0 ± 10%	lbs/ft^3
Aged R-Value**:	C518	R 6.4 at 1", R 23.3 at 3.5" (R 6.67 per inch at > 3.5"	$h \cdot ft^2 \cdot °F/Btu$
Compressive Strength (Parallel to Rise):	D1621	32	psi
Tensile Strength:	D1623	64	psi
Water Absorption (96 hours, 2" head, 70-74°F (21-23°C)):	D2842	0.71	% by volume
Water Vapor Permeance:	E96 - Method A	1.12	perm-in
Dimensional Stability (7 Days):	D2126	L=6%, W=5%, T=3%	% linear change
Open Cell Content:	D2856	2.6	%
Air Permeance @ 75 Pa (Infiltration/Exfiltration):	E283 E2178	0.00 0.0013	$L/s/m^2$ $L/s/m^2$
Air Barrier Assembly Testing:	E2357	0.0027	$L/s/m^2$
Crack Bridging:	C1305	Pass @ -15°F (-26°C)	Pass
Pull Adhesion Concrete Masonry Unit: Gypsum Sheating (Dens Glass): Oriented Strand Board (OSB):		 237 162 210	 kPa kPa kPa
Fungi Resistance:	C1338	Pass	no growth

*These items are provided for general information.
**Federal Trade Commission regulations published in the Federal Register 16 CFR Part 460 require that R value testing of polyurethane foam insulation must be conducted on aged samples at a 75°F mean test temperature. Failure to comply can result in substantial fines by the FTC.

SURFACE BURNING CHARACTERISTICS

Meets Class A (Class 1) requirements when tested in accordance with ASTM E84 (UL 723) as defined in NFPA 101 and Section 803 of the International Building Code (2009, 2012).

SYSTEM	THICKNESS	FLAME SPREAD INDEX	SMOKE DEVELOPED INDEX
Gaco 183M	4" (10.2 cm)	10	400

LARGE SCALE FIRE TESTING

TEST	PERFORMANCE	LOCATION	FOAM THICKNESS / COATING
AC377, Appendix X	Ignition Barrier	Attic and crawlspace walls Attic and crawlspace ceiling	Up to 7.5" (19.05 cm) / no coating required Up to 9.5" (24.13 cm) / no coating required
NFPA 286	Thermal Barrier	Vertical surfaces Horizontal or sloped surfaces	Up to 5.5" (13.97 cm) / DC315 - 20 mil wet Up to 7.5" (19.05 cm) / DC315 - 20 mil wet
NFPA 286	Thermal Barrier	Vertical surfaces Horizontal or sloped surfaces	Up to 5.5" (13.97 cm) / DC315 - 6 mil wet primer & 22 mil wet Up to 9.5" (24.13 cm) / DC315 - 6 mil wet primer & 22 mil wet

Gaco 183M meets or exceeds the IBC requirements for exterior walls in type I, II, III, IV and V construction. This includes NFPA 285 and NFPA 259 testing with Intertek Listings (GWL/FIP 30-02, GWL/FIP 30-01) and one-hour fire resistance rating per ANSI/UL 263 (UL Design W426) which is equivalent to ASTM E119.

Gaco 183M Closed Cell Foam Product Data Sheet | September 2016

Note: This product is listed as GacoWallFoam 183M

(Continued)

VAPOR RETARDER

Gaco 183M meets the requirement for a Class II vapor retarder per the International Code Council and ASHRAE when installed at 1.12 inches in depth.

AIR BARRIER PERFORMANCE

Gaco 183M is an air impermeable insulation (ASTM E283, ASTM E2178); it has passed air barrier assembly testing (ASTM E2357) and has been evaluated by the Air Barrier Association of America in accordance with ABAA D-115-010.

INDOOR AIR QUALITY

Gaco 183M is a low VOC emitting material and is GREENGUARD Gold Certified (29167-410, 29167-420) (formerly known as GREENGUARD Children & Schools Certification) by UL Environment. This program demands strict certification criteria and considers safety factors to account for sensitive individuals (such as children and the elderly), and ensures that a product is acceptable for use in environments such as schools and healthcare facilities. It is referenced by both the Collaborative for High Performance Schools (CHPS) and the Leadership in Energy and Environmental Design (LEED) Building Rating System.

LEED INFORMATION

Gaco 183M has a minimum of 8.6% recycled content based on weight, including 6.6% pre-consumer material and 2.0% post-consumer material. Gaco 183M raw materials are blended in Waukesha, WI. Actual polyurethane foam end product production is done on-site by the applicator.

TYPICAL LIQUID CHEMICAL PROPERTIES

"A" Component contains polymeric isocyanate. "B" Component contains polyols, catalysts, fire retardants, surfactants and blowing agents.

PROPERTY	TEST TEMPERATURE	ASTM TEST	VALUE	UNIT
Viscosity – "A" Component Viscosity – "B" Component	77°F (25°C)	ASTM D2196	200 ±50 750 ± 50	cps
Lbs/gal and S.G. – "A" Component Lbs/gal and S.G. – "B" Component	77°F (25°C)	ASTM D1638	10.34 / 1.24 10 / 1.20	lbs/gal and S.G.
Mixing Ratio – "A" & "B" Component	77°F (25°C)		1:1	By volume
Stability When Stored at 50°F to 70°F (10°C to 21°C)			"A" Component: 12 months "B" Component: 6 months	Months

APPLICATION

To ensure optimum performance, a minimum pass thickness of 3/4" (1.9 cm) is recommended with the maximum not to exceed 2" (5.1 cm) per pass. To obtain optimum results substrate temperature should be within the ranges as stated below. All substrates must be dry at the time of application. Do not apply to wood surfaces with a moisture content of above 18%.

MATERIAL	SUBSTRATE TEMPERATURE
Gaco 183M	40°F to 120°F (4°C to 49°C)
Gaco 183MW	30°F to 100°F (-1°C to 38°C)

EQUIPMENT SETTINGS	VALUE	PRODUCT CHARACTERISTICS	VALUE
Pre-Heat: Iso (A)	105°F - 135°F (41°C - 57°C)	Cream Time	1 sec
Pre-Heat: Poly (B)	105°F - 135°F (41°C - 57°C)	Rise Time	3 - 6 sec
Hose Heat	105°F - 135°F (41°C - 57°C)	Tack Free Time	4 - 8 sec
Recommended Spray Pressure	1,000 - 1,200 psi (dynamic)	Cure Time	4 hours

Gaco Western

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VinylTek 7 Layer Insulated Curtain

Ideal for extremely cold climates and the north side of buildings. Helps to reduce your heating costs! Our ClearView models, with a 12" clear PVC strip, allows light in while your curtain is closed. This feature reduces lighting costs while keeping the cold out.

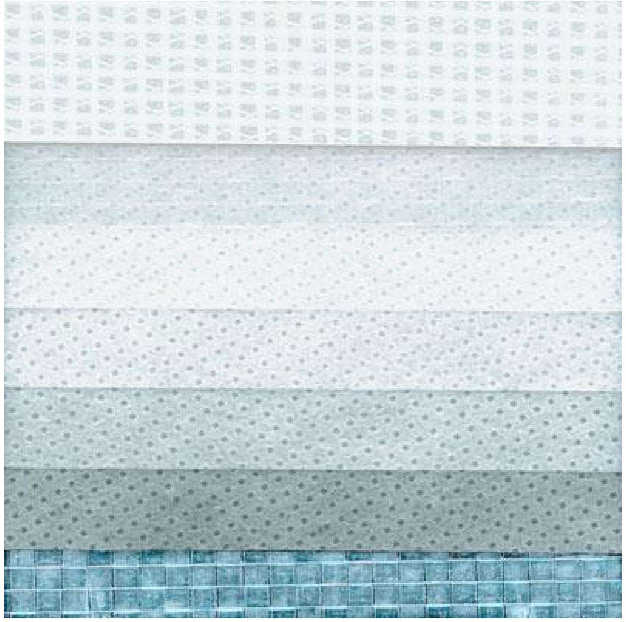
7-Layer Curtain Construction:

2 Outer layers:

- One layer 13.5 oz. White vinyl outside.
- One layer 5.2 oz. polyethylene vapor barrier inside

5 Interior layers:

- Four layers of high tech non- woven insulating materials. One layer 5.2 oz. polyethylene vapor barrier.
- Estimated R value of 3.
- All 7 curtain layers will not absorb moisture, eliminating the problem of rot and mildew.
- Approximately 1/10" thick (when compressed).
- Priced per running foot.



TDD2 LED

LED Area Luminaire

Cataloq Num b r	
Notes	
Ty,pe	

Hit, r, l-y e over the page to see all interactive elements

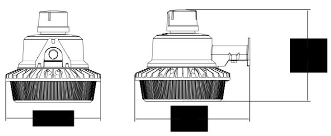
Specifications

Width: 9-1/2" *(24 .0cm)*

Height: 9-1/8" *(23.0 cm)*

Depth: 11 -3/8" *(29.0 cm)*

Weight: 4.8 lbs. *(2.17 kg)*

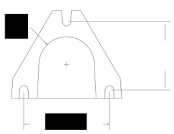


Backplate

Width: 2-3/4" *(7cm)*

Height: 2-1/4" *(5.6cm)*

Opening: 1-3/4" *(4.5cm)*



OMA Mounting Arm (Optional)

Introduction

The popular TDD2 LED luminaire is now available with long-lasting, energy-efficient LED technology . Featuring a classic dayform, the TDD2 LED offers a fresh update to a traditional appearance and is powered by advanced LEDs.

The TDD2 LED luminaire is powerful yet energy efficient, capable of replacing a 175W mercury vapor luminaire while saving 82% in energy costs. The TDD2 LED eliminates frequent lamp and ballast replacements associated with traditional technologie s. Can be wall or post mounted with integral bracket or onto 1-5/8" mast arm .

Ordering Information

EXAMPLE: TDD2 LED P1 SOK 120 PER DNA M4

TDD2 LED						
Series	**Light Engine**	**Color Temperature**	**Voltage**	**Controls**	**Finish**	**Option**
TDD2 LED	PI 4,700 lumens	SOK 5000K	120 120volts	PER Tw ist-lock photocell included	DNA Grey	M4

Accessories

Ordered and shippe d separately

OMA Mounting Arm

FEATURES & SPECIFICATIONS

INTENDED USE
The energy savings, long life and easy-t o-install design of the TDD2 LED make it the smart choice for building-and post-mo unted doorway, pathway and yard ill um inat io n for nearly any facility.

CONSTRUCTION
Die-cast aluminum housing has an impa ct-resis t ant, polycarbonate lens which protects the LEDs. The fixture is sealed against moisture and environmental contaminants.

FINISH
Exteri or parts are protected by a therm oset powder-coat finish that provides superi or resistan ce to corrosion and weathering. A tightly controlled multi-stage process ensures a minimum 2 mils thickness for a finish that can withstand extreme climate changes witho ut cracking or pee ling.

OPTICS
Prote ctive polycarb onate lens covers LEDs. Rem o vable lo wer diffuser provides some up-light for a traditi onal appearance. DesignLights Consortium® (DLC) qualif ied with or without diffuser. Light engine is 5000K (80 min. CRI).

ELECTRICAL
Light engine consists of high-p owered LEDs mo unted to the o uter edge of the integral aluminum heat sink to maximize heat dissipation and pr omote long LED life (L87/100,000 ho urs at 25° C). 6kV surge pr otecti on. Elect ronic driver operates at 120V. Twist -lock rep laceable ph otocell is standard.

INSTALLATION
Easily mounts to a woo den post or p o le using 2" lag screws, included. Compatible with OMA-1-5/8" mounting arm, so ld separately.

LISTINGS
UL Listed to U.S. and Canad ian safety standa rds for wet locati ons.

WARRANTY
Five-year limite d warranty. Complete warranty terms located at:

Note: Actual per forman ce may differ as a result of end-user environment and appli cati o n. All values are design or typical values, measured under labo rat o ry conditi ons at 25 °C. Sp ecifications sub ject to chang e with o ut noti ce.

Performance Data

Lumen Output

Lumen values are from photometric tests performed in accordance with IESNA LM-79-08. Data is considered to be representative of the configurations shown, within the tolerances allowed by Lighting Facts.

Performance Package	CCT	System Watts	50K (5000K, 70 CRI)				
P1	5000K	41 W	4,700				115

Electrical Load

Current (A)
120V
0.20

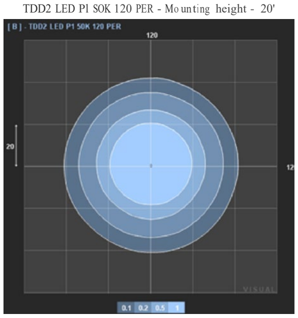
Photometric Diagrams

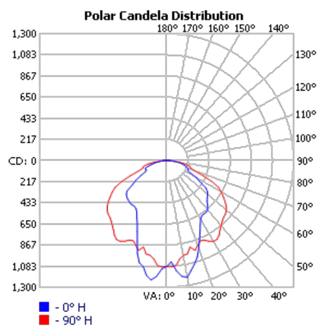
To see complete photometric reports or download .ies files for this product, visit the Lithonia Lighting Outdoor TDD LED homepage. Tested in accordance with IESNA LM-79 and LM-80 standards.

LEGEND

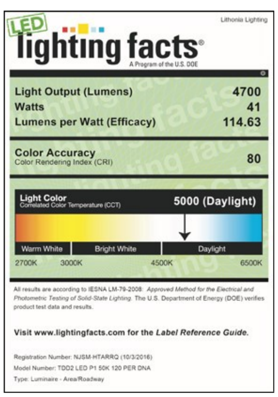
0.2 fc
0.5 fc
1.0 fc
2.0 fc

TDD2 LED P1 50K 120 PER - Mounting height - 20'





Lighting Facts Labels



ITEM # 712 L10WA19DIM50K.xlsTab

Overdrive® LED by Innovation	1OW LED A Bulb Dimmable - SOOOK Wet Location	Item # 712 / L10WA19DIM/S0K

1	**LAMP SPECIFICATION**			
1-1	Lamp Type	LED A Bulb Dimmable		
1-2	Dimmable (Y/N)	YES		
1-3	Base	E26 (Medium Base)		
1-4	Lamp Finish/Type	A19 Shape		
1-5	Lamp Wattage	10W		
1-6	Wattage Comparison (FC on Floor)	60W Incand		
1-7	Rated Average Life (hours) L70	25,000		
1-8	Reliable Operating Temperature	-4F to 113		
1-9	Wet Location Rated	YES		
1-10	Enclosed Fixture Rated	YES		
2	**Photometric Characteristics**			
2-1	Initial Lumens	1000		
2-2	Centre Beam Candle Power (Cd)	see LM-79 report		
2-3	Beam Angle (50% I Max) in Degree	120		
2-4	Beam Angle (10% I Max) in Degree	205		
2-5	Initial Lumens per Watt	100		
2-6	Color Temperature	5000K		
2.7	Color Rendering Index (CRI)	80		
3	**Electrical Characteristics**			
3-1	Input Line Voltage/Frequency	120V 60 Hz	3-2 Power Factor	0.92
3-3	Lamp rated Wattage	10W	3-4 Input Line Current	95mA
3-5	Total Harmonic Distortion	35%	3-6 Dimming Range in %	Full
4	**Dimensional Characteristics**			
4-1	Nominal Length (Inches/mm)	4.25" / 108 mm	4-2 Diameter	2.36" / 60 mm
S	**Product Information**			
5-1	Description	10W LED A Bulb Dimmable -5000K, Medium Base - Wet Location		
5-2	Primary Application	Household Use, Office, Agriculture & Commercial		
5-3	Warranty	5 Years from date of purchase		
5-4	TCLP Compliant	YES	5-6 RoHS Compliant	YES
5-5	Energy Star or LM79 (Y/N)	LM79	5-8 UL / FCC	YES
6	**PACKING DETAILS**			
6-1	Color Box Size (Inches) 1x1	2.44 x 2.44 x 4.72	6-2 Inner Carton Size (cm) 1x12	10.35 x 7.72 x 5.12
6-3	Master Carton Size (Inches) 1x48	16.50 x 11.14 x 11.81	6-4 Gross Weight / Net Weight (lbs)	12.50 / 7.94

Note: This data sheet is not controlled copy & is subject to change without notice. Standard Tolerances apply on data given above.

White 10 3/4"H Dusk to Dawn LED Outdoor Flood Light $59.99 ADD TO CART

White 10 3/4"H Dusk to Dawn LED Outdoor Flood Light

11 Reviews | 10 Questions, 13 Answers

$59.99

FREE SHIPPING & **FREE RETURNS*** | Low Price Guarantee
IN STOCK – Ships in 1 to 2 Days

1 ADD TO CART SAVE

MORE OPTIONS

CHAT VIEW IN YOUR ROOM

PRODUCT DETAILS

Light your outdoor spaces with this LED flood light finished in white with a convenient dusk to dawn sensor.

Additional Info:

Add a sense of safety to your home with this outdoor flood light. Featuring a classic white finish and an energy efficient LED option for long lasting illumination. This design has a dusk to dawn sensor, for cost effective savings. Add it to your wall for maximum security. Rubber lens covers are included for deactivating the dusk to dawn sensor if desired.

- 10 3/4" high x 6 1/4" wide x extends 5 3/4" from the wall.
- Built-in LED module uses 27 watts.
- 4000K, 2240 lumens, comparable to a 100 watt incandescent bulb.

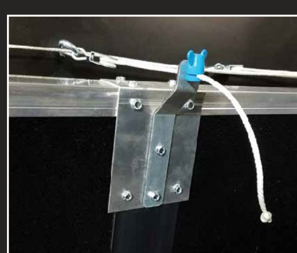
VENTILATION SYSTEMS

INSIDE TUNNEL DOOR

Low Maintenance, Energy Efficient

Tunnel doors help eliminate dead zone areas created by curtain sidewalls and curtain pockets. Cumberland's Inside Tunnel Door system comes fully assembled and is constructed using a rigid, ultra lightweight, laminate foam panel for easy installation. Choose white or black door panels in 2', 3', 4', 5', and 6' heights.

Ratchet bracket option



Tension bar option

T-Bracing at panel connection points adds rigidity

AGCO Your Agriculture Company

SOUTHWESTERN SALES

Fan Cone Cover

Review this product

QC Part #

10692

MFR # FANCVR

IN STOCK

SIZE

60

$29.79

Description

Protect your fan shutters during cold and windy conditions with a Fan Cover from Southwestern Sales. The 6 oz black/white material helps reduce heat loss in fans.1/4" shock-cord drawstring for securing to fan cone