



Energy Savings

Farm Energy Efficiency and Opportunities

May 3, 2023

Poultry Grower Meeting

Drew Schiavone, PhD

Energy Specialist

University of Maryland

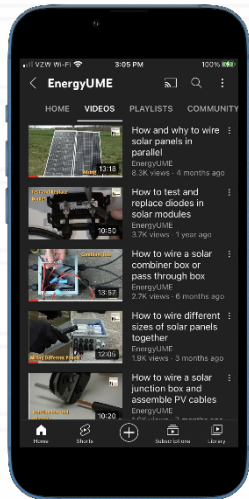


UNIVERSITY OF
MARYLAND
EXTENSION



Energy Resources

VIDEO



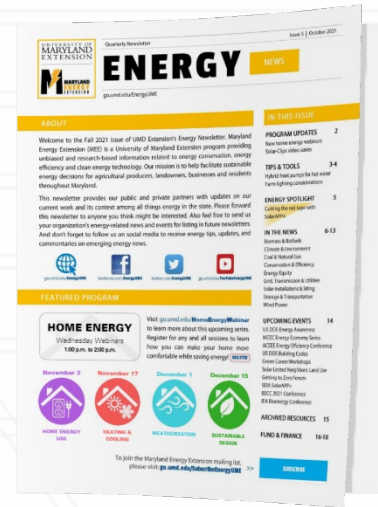
 @EnergyUME


PUBLICATIONS



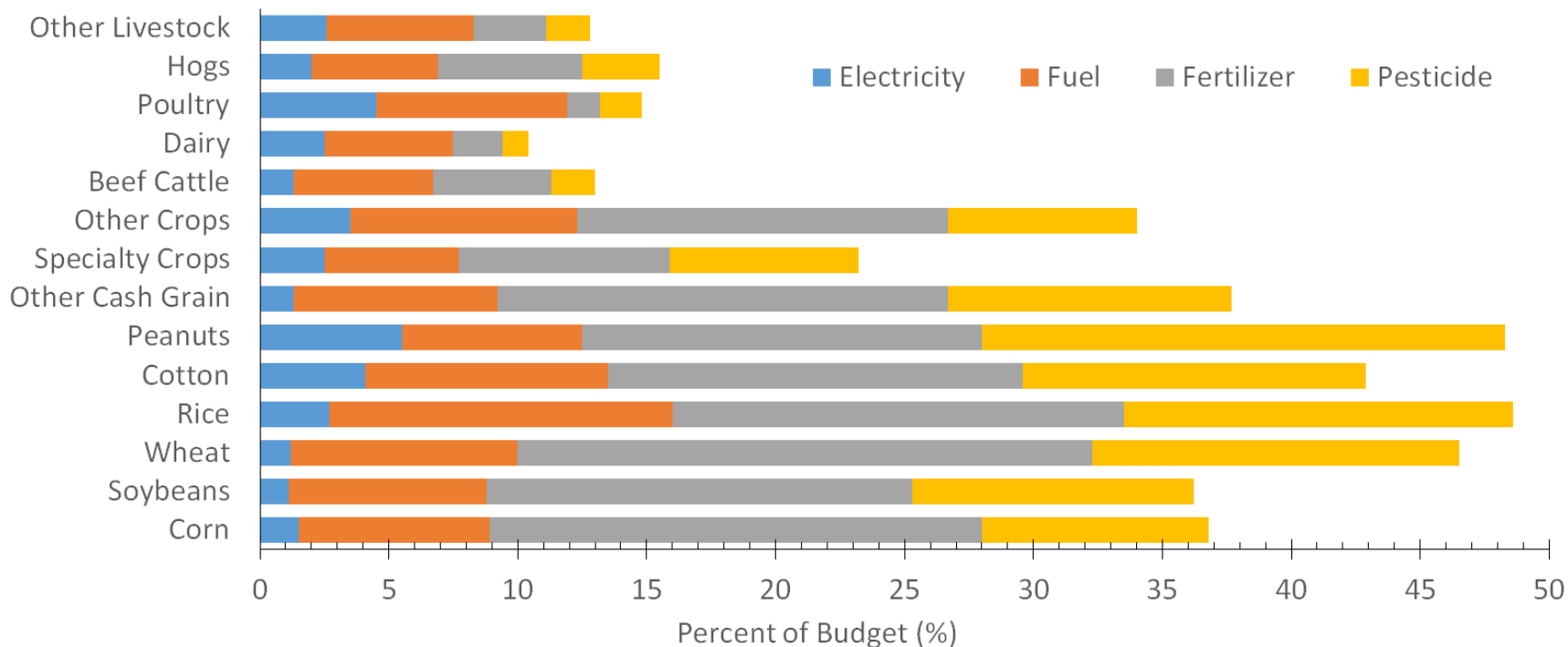
 extension.umd.edu/Energy

NEWSLETTER



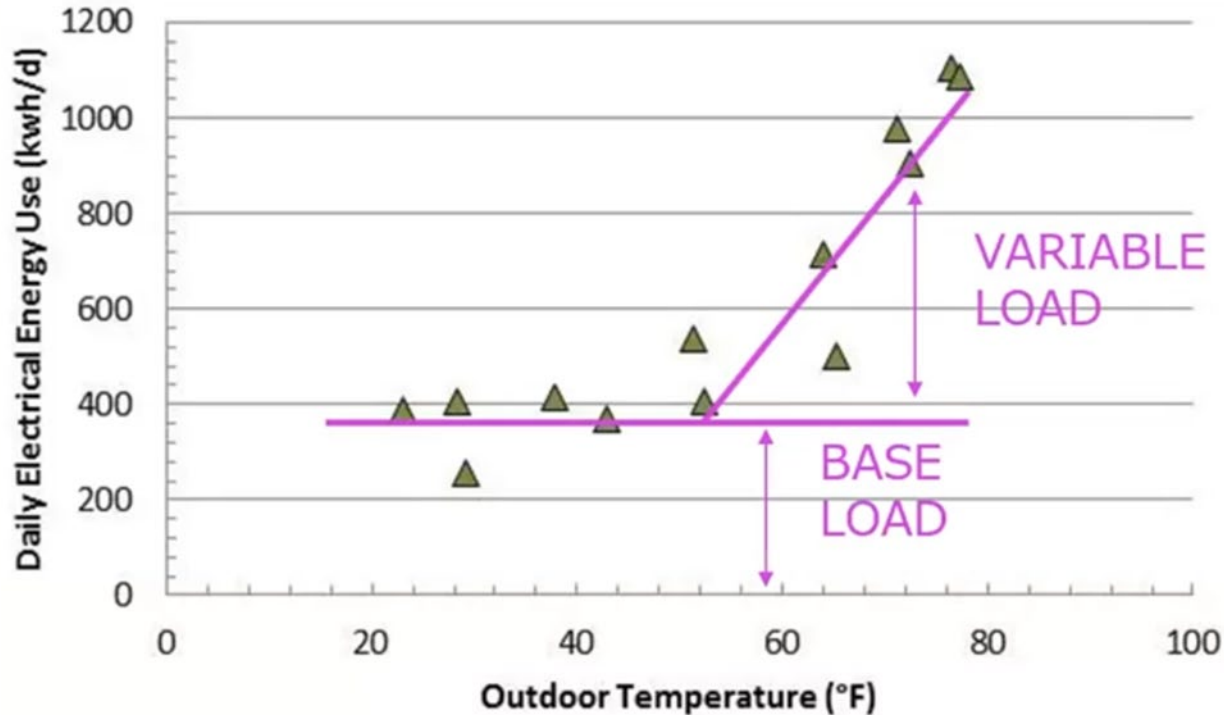
 go.umd.edu/EnergyNews

Where is energy used?



Understanding Farm Energy [FS-1138]

Where is energy used?



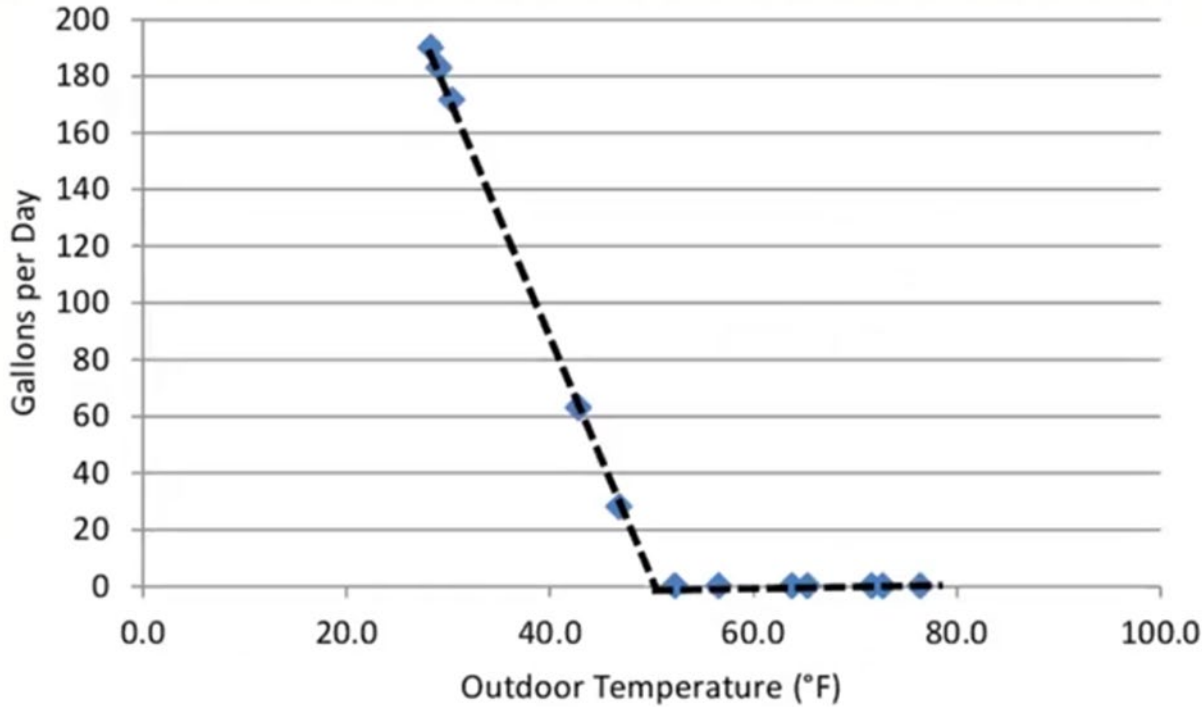
Electricity

- Lighting
- Motors, fans
- Motors, food systems
- Motors, pumps

Refrigeration

Computer Controls

Where is energy used?



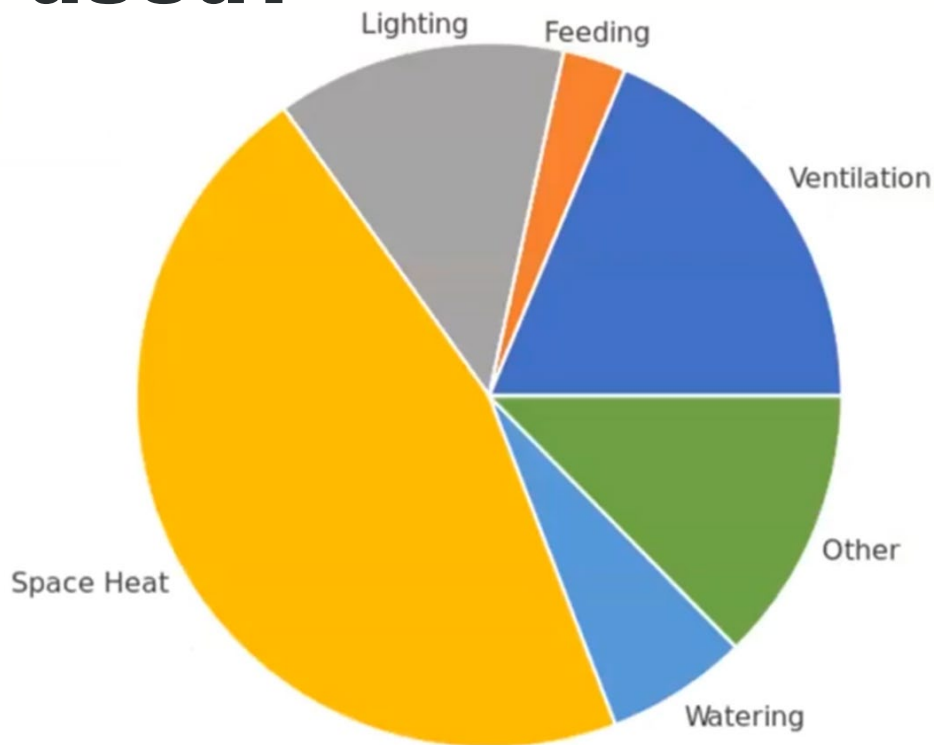
Heating Fuel

- Propane
- Biomass
(*pellets/wood chips*)
- *Birds*

Where is energy used?

Farm-to-Farm Variation

- Different locations
- Different equipment
- Different ways of managing



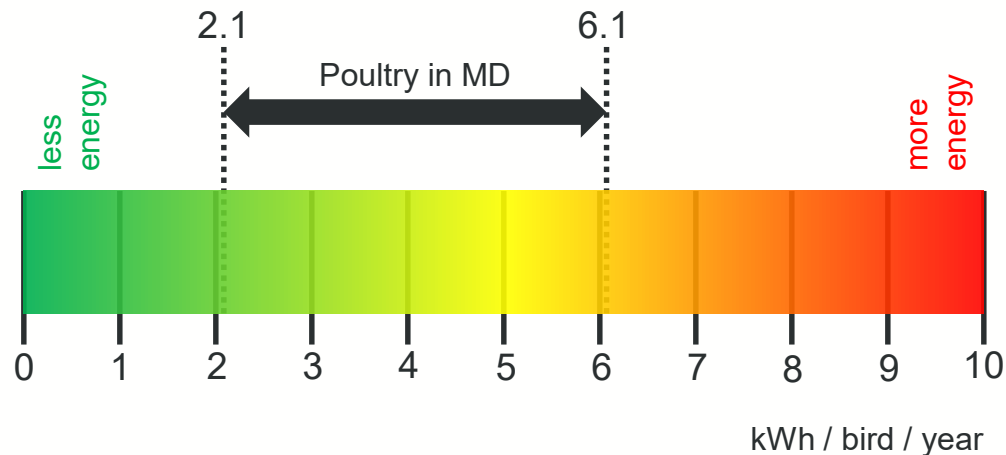
Understanding Farm Energy [FS-1138]

How efficient is your farm?

Energy Use Index (EUI)

- Add all farm energy use over a year
(*except farmstead and field operations*)
- Divide by bird capacity of your farm

$$EUI = \frac{\text{Energy Use [kWh/yr]}}{\text{Bird Capacity [#birds]}}$$



Emerging Energy Issues

Cost of Electricity in Maryland (\$/kWh)



Residential

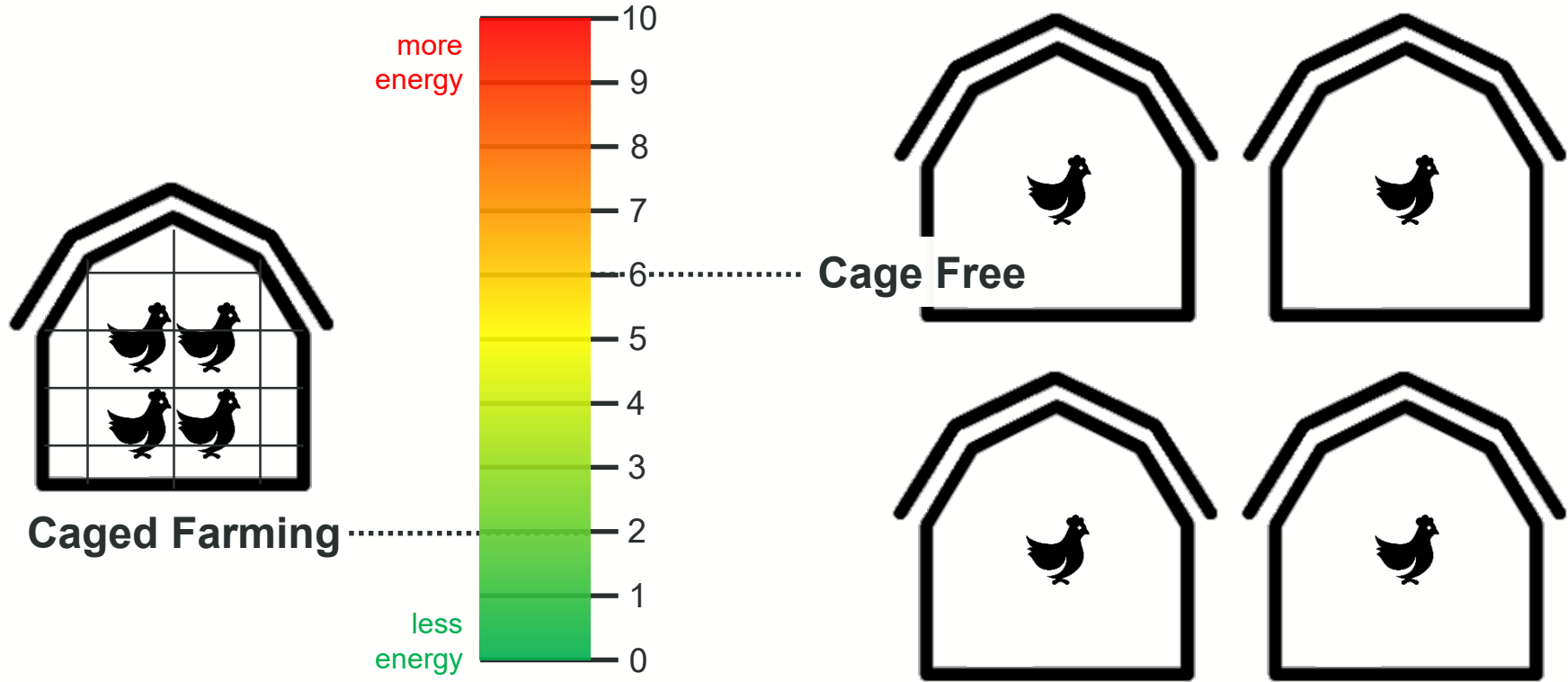
- charge for amount of energy used (\$/kWh)

Commercial

- Charge for amount of energy used (\$/kWh) + charge for highest use rate (\$/peak kW)



Emerging Energy Issues



How to save energy?



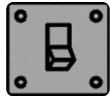
Tier 4 When the system is modified to use efficiency, less renewable energy is needed



Tier 3 Peak demand when the utility provider charges a higher amount for energy use



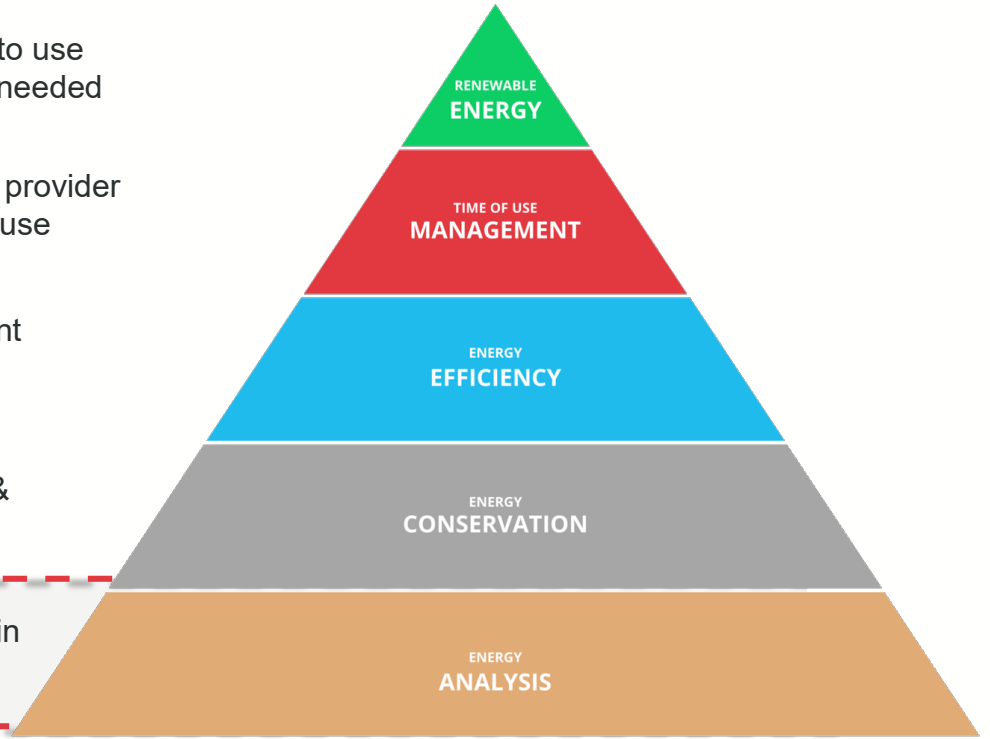
Tier 2 Purchasing & installing efficient equipment & processes



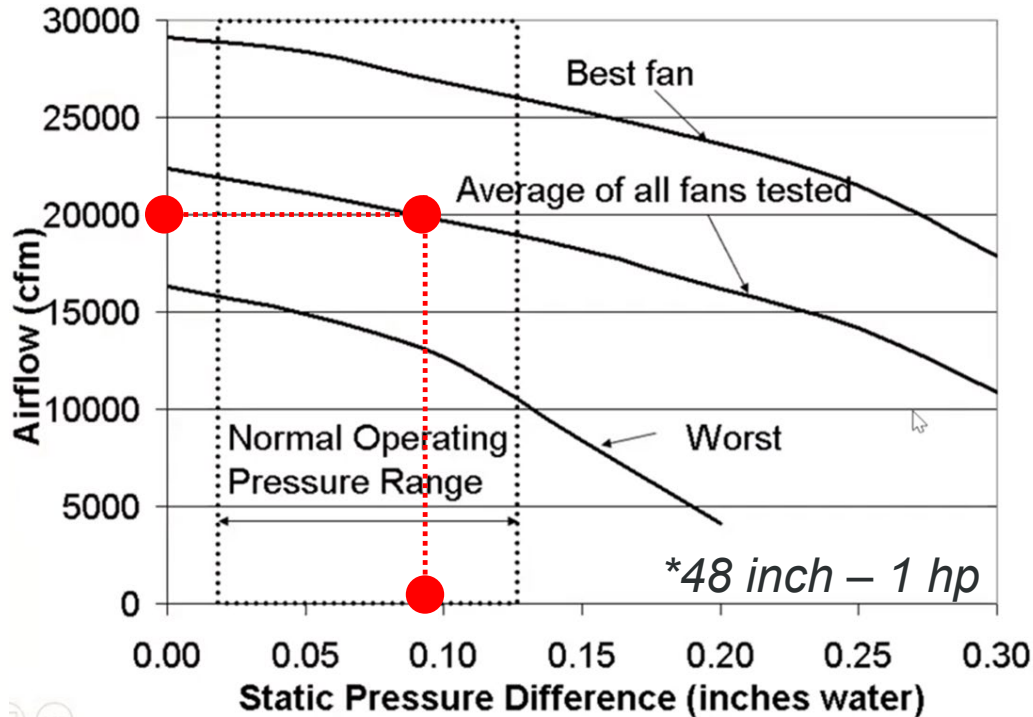
Tier 1 Largely based on behavioral & operational practices. Best ROI



Tier 0 A survey of energy flows within a system to reduce the energy input



Heat & Vent > Performance



Design & Quality

- better blade-housing
- quality motors
- ability to work against pressure



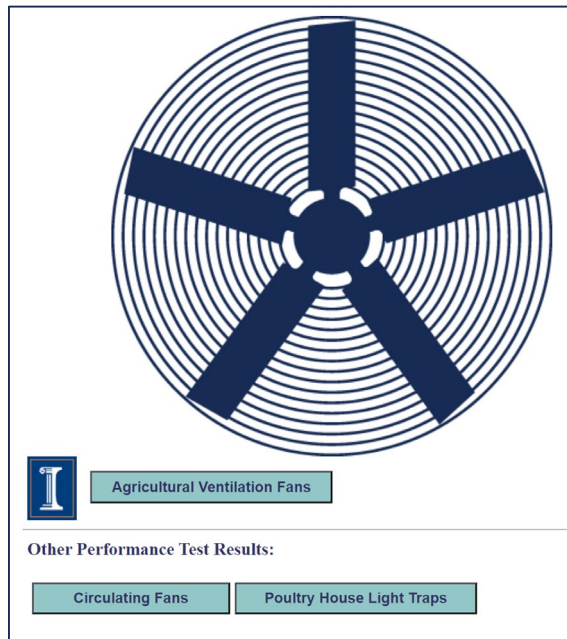
Heat & Vent > Performance

Example fan data: 48-inch diameter; 1 HP fan

Static Pressure Difference (inches water)	Fan Airflow (cfm)	VER (cfm / Watt)
0.00	23,963	34.7
0.05	22,703	29.5
0.10	21,503	24.8
0.15	20,011	20.3
0.20	18,328	15.2
0.25	16,215	9.2
0.30	13,883	N/A

BESS Fan Performance Test Results

www.bess.uiuc.edu





Heat & Vent > Performance

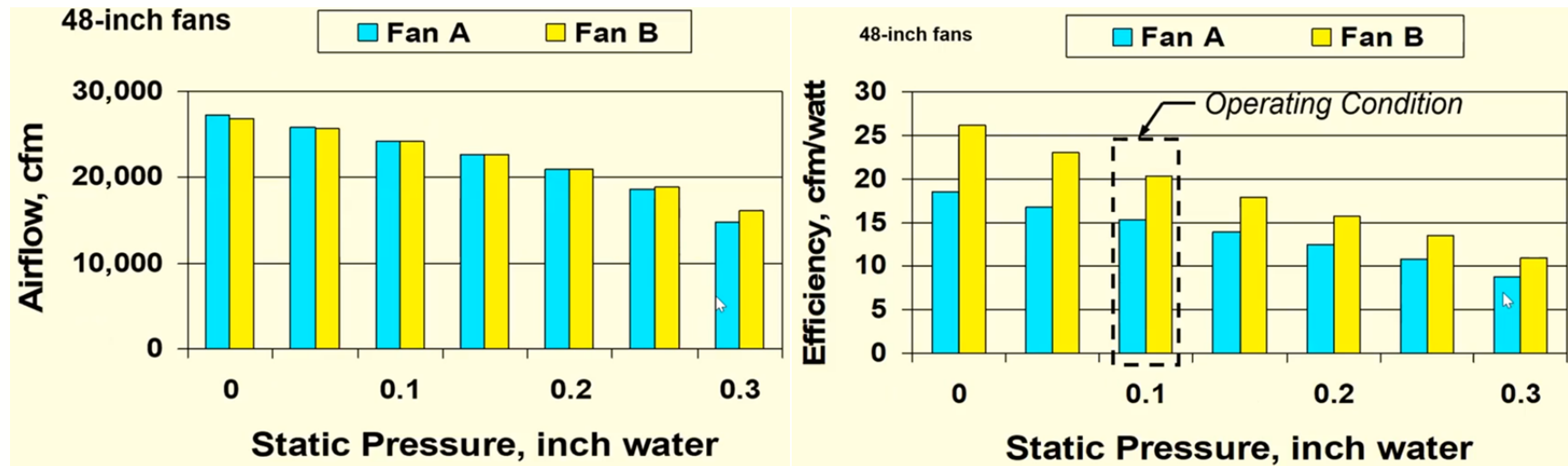
Minimum efficiency: VER = Ventilation Efficiency Ratio

Static Pressure Difference (inches water)	Fan Efficiency, VER (cfm / Watt)		
	24-inch	36-inch	48-inch
0.05	13	18	20
0.10	12	16	18
0.15	11	14	15
0.20	10	11	13

☺ Choose efficient fans with **20 cfm/W** or better for 48-inch tunnel fans

Heat & Vent > Performance

Example: Fan airflow & efficiency performance is similar



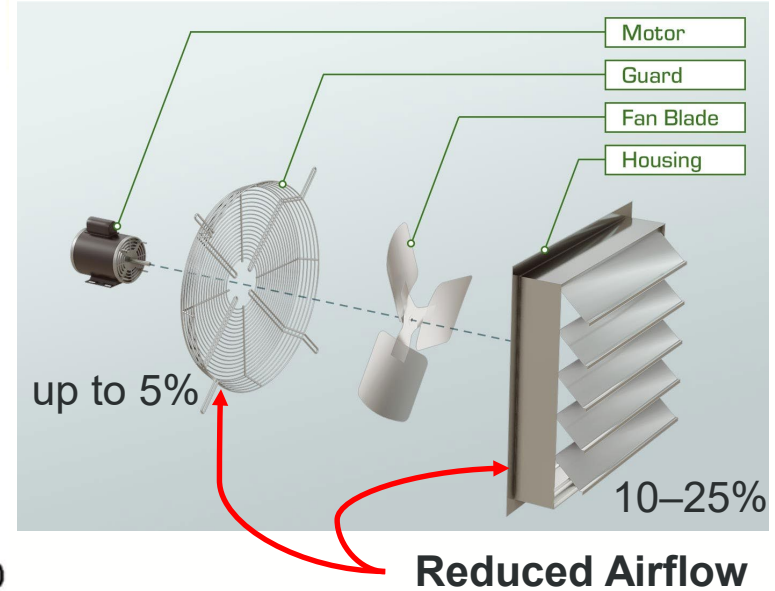
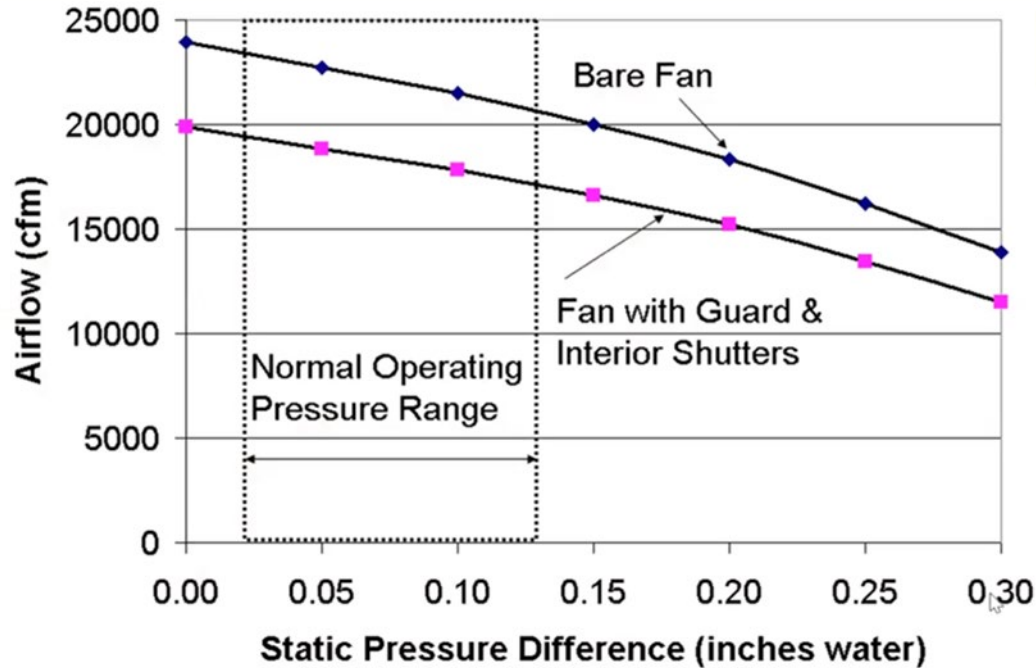
Heat & Vent > Performance

Upfront Costs	Fan A (\$500 / fan)	Fan B (\$1,000 / fan)
Unit Price x 8 fans	\$4,000	\$8,000
Operating Costs		
4 fans @ 4,000 hr	\$2,032	\$1,520
4 fans @ 2,500 hr	\$1,270	\$950
Annual Total	\$3,302	\$2,470
10-yr Total	\$33,020	\$24,700
10-yr Added Cost	\$8,320	\$0
10-yr Total Cost	\$12,320	\$8,000

*4,000 hrs is about 5 ½ months

†Operating cost at \$0.08/kWh

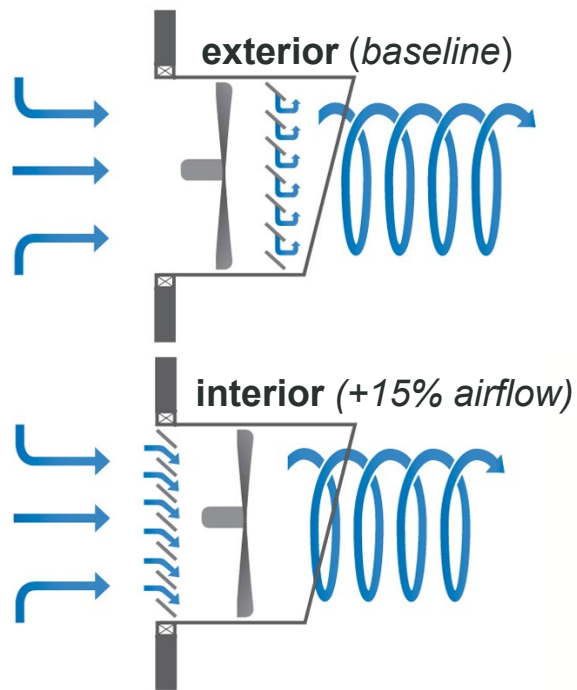
Heat & Vent > Accessories



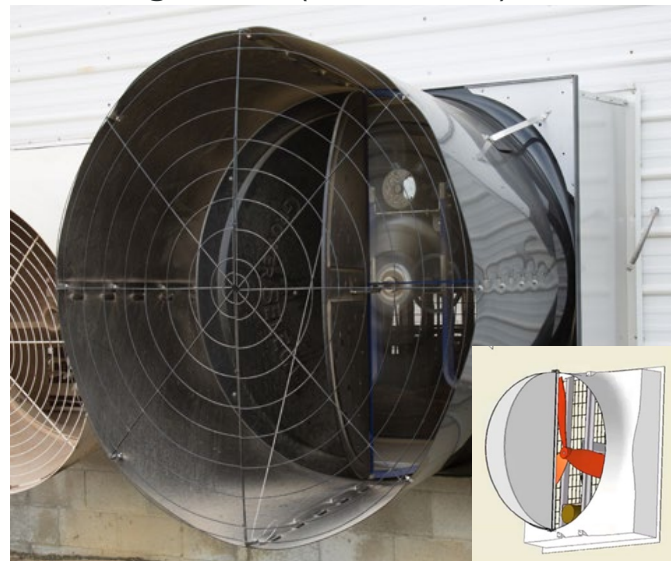
😊 Select fans rated with accessories in place



Heat & Vent > Accessories



Discharge cone (+15 to 25%)

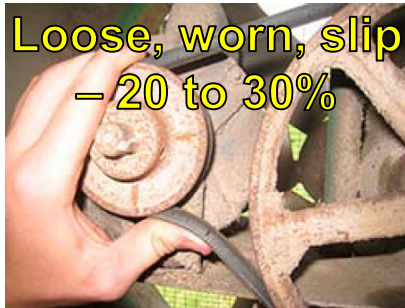


Butterfly shutter (+25 to 35%)

😊 Discharge cones and interior shutters improve performance by 15% apiece

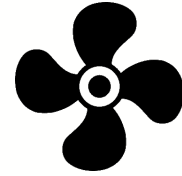
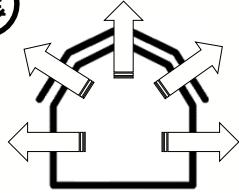


Heat & Vent > Maintenance



☺ Maintain belts and remove dust for about 1/3 more efficiency

Heat & Vent > Environmental Control



Winter Heat Loss
from ventilation system

Retain Heat
with lower ventilation

Remove Excess Ammonia
raise ventilation later

Poor air quality
Wet litter
Low bird productivity

Economic loss

Removes excess ammonia

Negates fuel savings

➤ need 7 to 10 times the ventilation rate to recover good air quality

Heat & Vent > Environmental Control

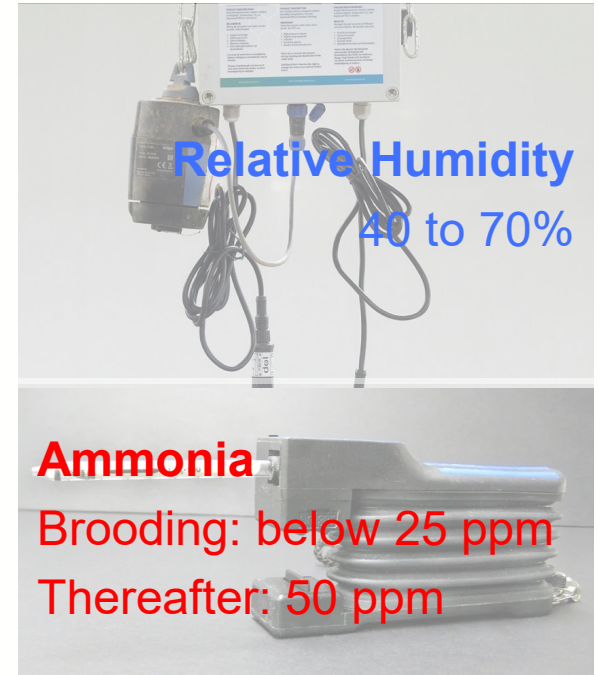
Cold weather ventilation for air quality
based on moisture and ammonia
(*not just temperature-control*)

Ventilation removes:

- Moisture
- Ammonia
- Heat

High Moisture

- soaks into litter
- raises ammonia
(~2 day lag time)



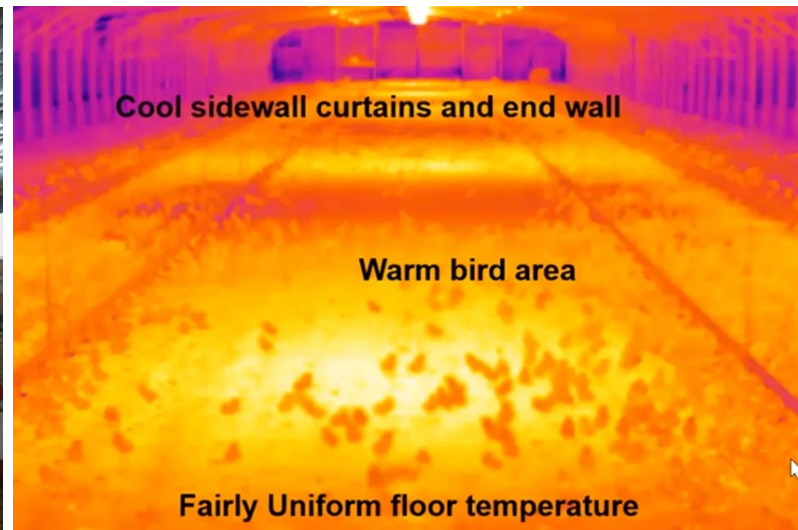
➤ Monitor humidity (ammonia) with handheld instruments to manage ventilation

Heat & Vent > Heating Efficiency

Our eyes see **visible light** in a poultry house



Infrared cameras see **surface temperature**



Czarick

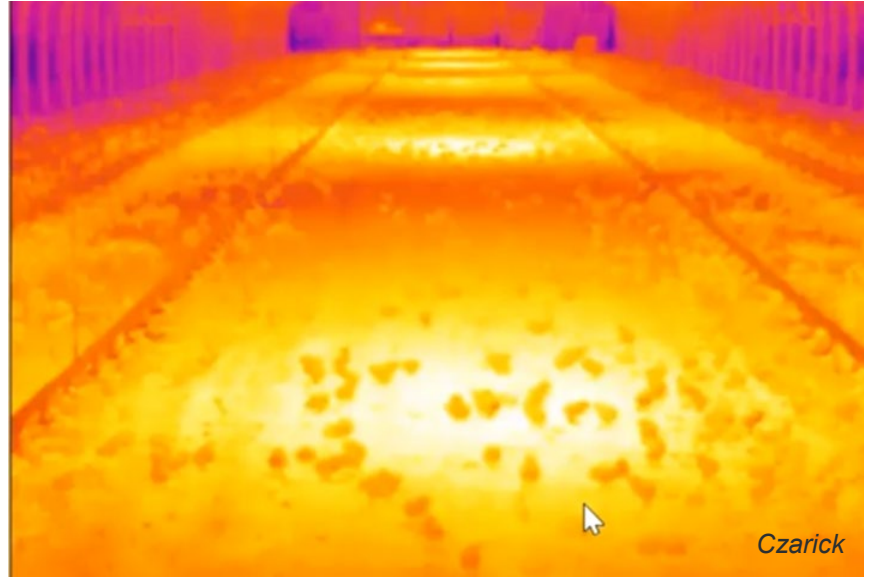
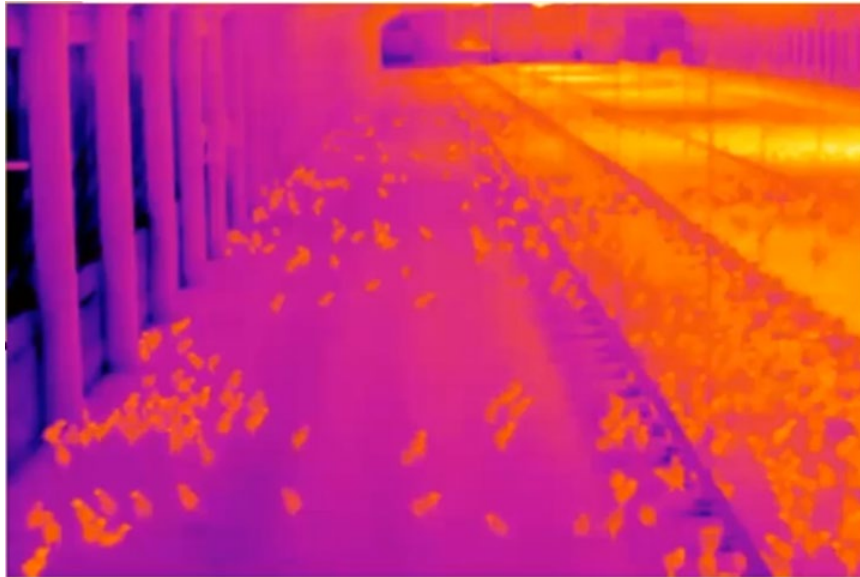


Heat & Vent > Heating Efficiency

temperature uniformity

cold air infiltration near uninsulated walls

uniform heating system installation

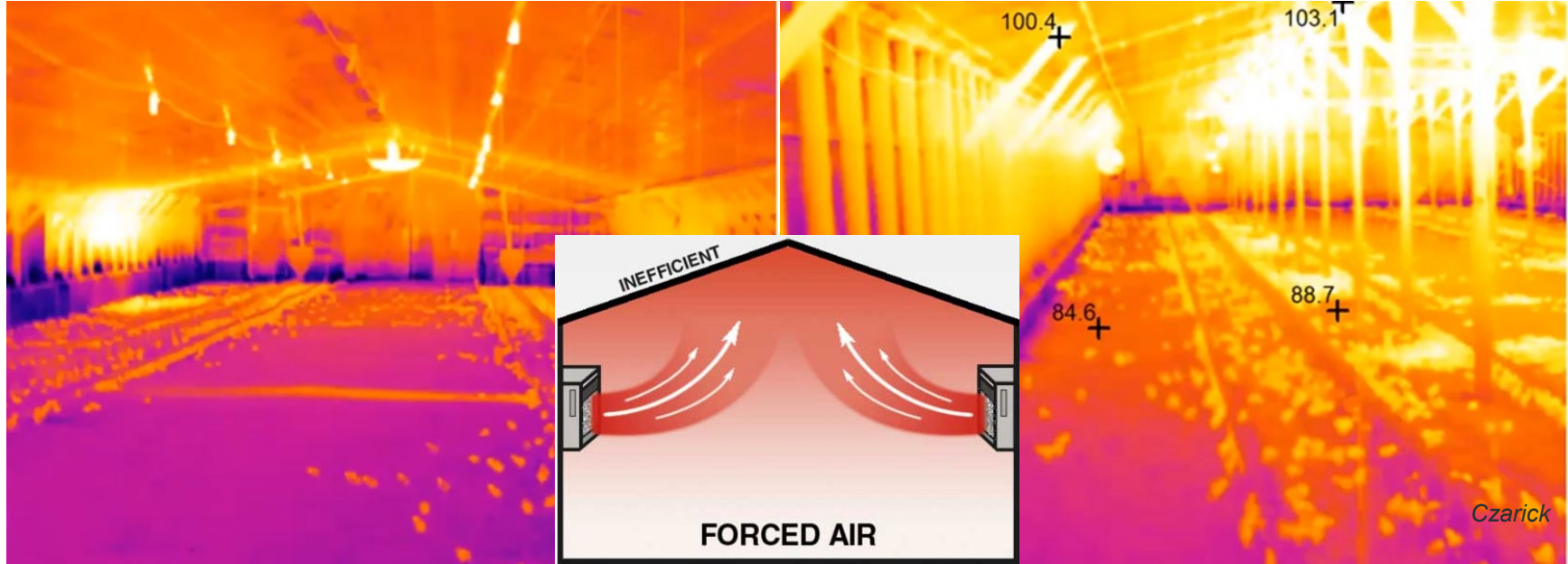


Czarick

Heat & Vent > Heating Efficiency

Forced air furnace with heat going to ceiling

Stratification of warm air near ceiling is not useful

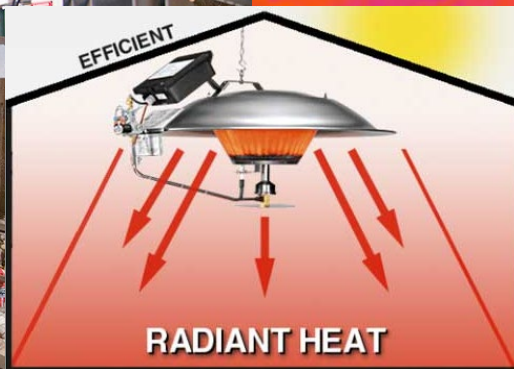
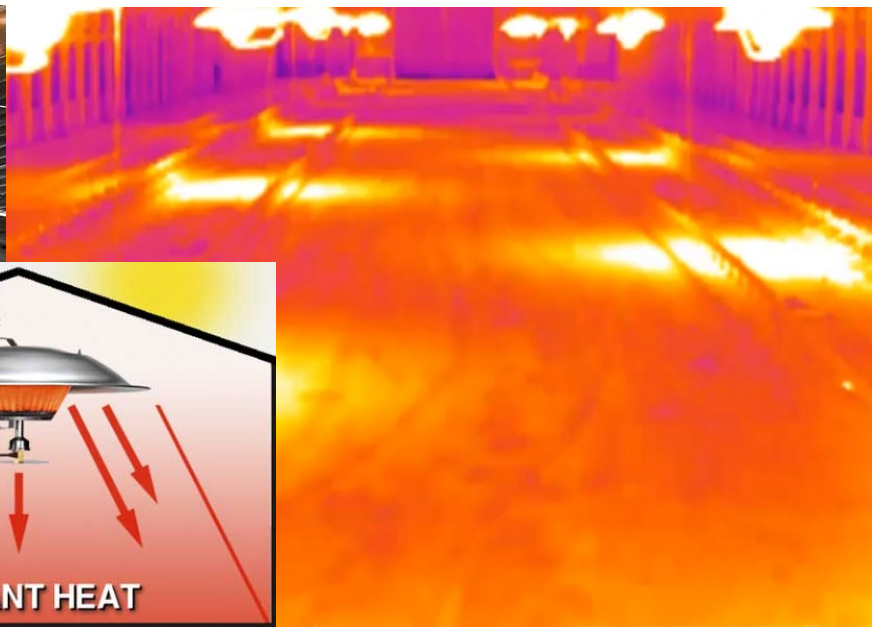


Heat & Vent > Heating Efficiency

Direct floor warmth



Reduced house air temperature



😊 Radiant heat allows lower house air temperature & reduces fuel use by ~30%



Heat & Vent > Heating Efficiency

Well-insulated house keeps walls warmer



Overhead radiant tube brooders





Heat & Vent > Infiltration

uneven temperature conditions and infiltration with natural ventilation curtain sided houses



↗ curtain houses use 5-10% less energy with more fuel (heat) & less electricity (light, fans)

Heat & Vent > Infiltration

radiant tube brooder in curtain houses with cold uninsulated walls



SP Test

- Close all openings (*inlets, shutters, doors*)
- SP test with a 36-in fan (*0.15 in SP difference*)
- SP test with a 48-in fan (*0.30 in SP difference*)

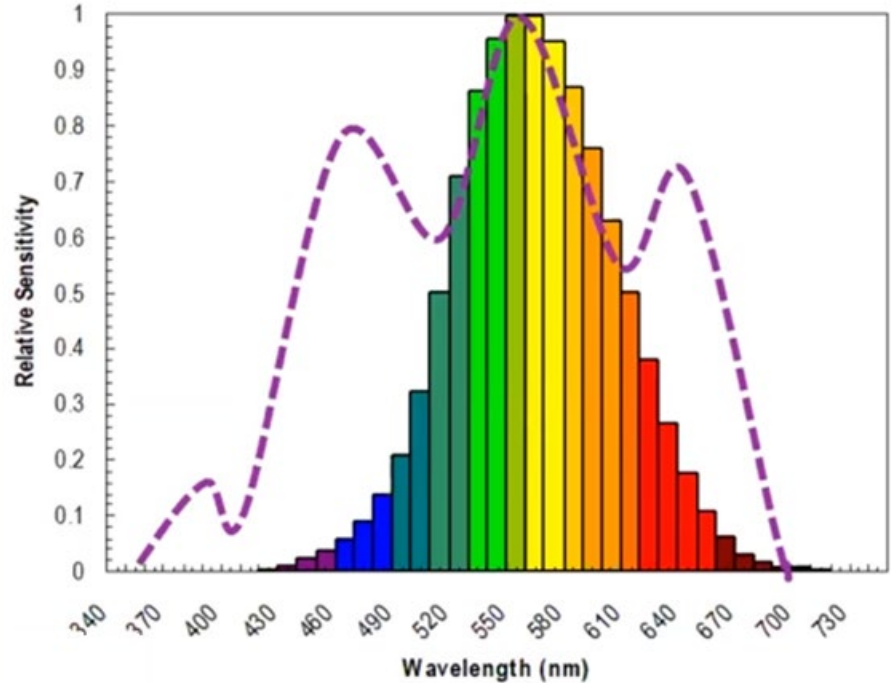


➤ static pressure test house to determine need for infiltration reduction

Lighting

Lumens per watt

(electricity into human-visible light)



Lighting > Efficiency

Lighting Facts Per Bulb	
Brightness	800 lumens
Estimated Yearly Energy Cost	\$1.02
Based on 3 hrs/day, 11¢/kWh Cost depends on rates and use	
Life	22.8 years
Based on 3 hrs/day	
Light Appearance	
Warm ▲ ▼ Cool	
2700 K	
Energy Used	8.5 watts

$$\text{Efficacy} = \frac{\text{lumens}}{\text{Watts}}$$



Lighting Type	Efficacy (lm/W)
Halogen	21
CFL	70
Metal Halide	68
HPS	80
LED	119

Lighting Type	Number of Units (#)	Input Power (W)	Annual Use (hr)	Utility Rate (\$)	Annual Costs (\$)
Metal Halide	10	× 50	× 4,200	× 0.0994	= 208.74
CFL	10	× 24	× 4,200	× 0.0994	= 100.20
LED	10	× 13	× 4,200	× 0.0994	= 54.27

Operating cost of 24W CFL, 50W metal halide & 13W LED with same light output

Lighting > Illuminance

Work area or task	Illuminance (<i>lux</i>)
Detailed Bench Work	1,000
Veterinary Treatment	1,000
Office, Task Lighting	750 – 1,000
Egg Processing	700 -1,000
Egg Handling	500
Rough Bench Work	500
General Machinery Repair	300
Animal Handling	200
Feed Room / Mixing	200
Ladders / Stairs	200
Loading Platform	200
Equipment / Utility Rooms	100 – 200
Farm Shop / Active Storage	100
Housing Area / Feed Bunk	100
General Storage	50

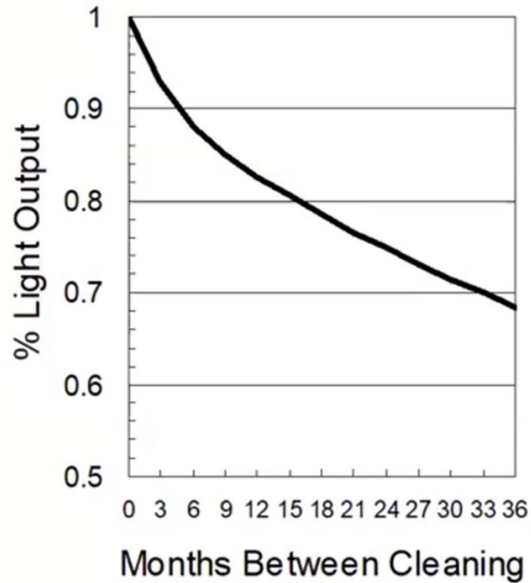
Lighting Options	Flock Age	Light Intensity lux (foot-candles)	Photo Period (hours of light per day)	
Option 1	Pullets			
	Brooding (1 - 3 days)	20 (2)	23	
	Growing (4 days - 19 weeks)	5 (0.5)	9 to 11	
	Laying (20 - 72 weeks)	10 - 30 (1 - 3)	Increase by ½ hour per week to maximum of 16 - 17 hours.	
Option 2	Pullets			
	Brooding (1 - 3 days)	20 (2)	23	
	Growing:	(4 days - 2 weeks)	5 (0.5)	23
		(2 - 3 weeks)	5 (0.5)	21
		(3 - 4 weeks)	5 (0.5)	19
		(4 - 5 weeks)	5 (0.5)	17
		(5 - 6 weeks)	5 (0.5)	15
		(6 - 7 weeks)	5 (0.5)	13
(8 - 9 weeks)	5 (0.5)	11		
(9 - 20 weeks)	5 (0.5)	11		
Laying (20 - 72 weeks)	10 - 30 (1 - 3)	Increase by ½ hour per week to maximum of 16 - 17 hours.		

😊 Typical light levels for broilers and layers are about **10 to 20 lux (1 to 2 foot-candles)**

Harmon & Petersen (2011) [store.extension.iastate.edu]
ASABE. (2005). Standard EP344.4 [spar.msstate.edu]



Lighting > Maintenance



😊 Cleaning every 4 months instead of every year allows you to install ~15% fewer fixtures and still maintain the same light level

Feed & Water



Motor Efficiency

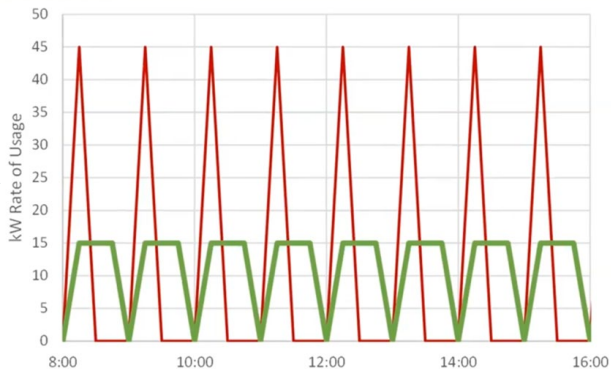


high efficiency motor

Feed & Water



Management &
Maintenance

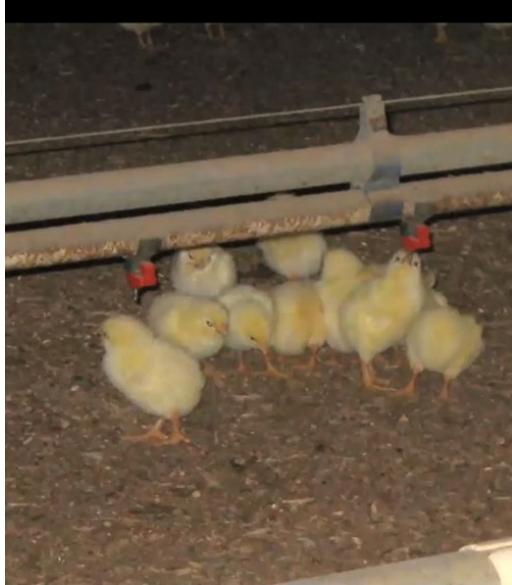


Demand Management

Run all feeders at the same
time (max kW = **45**)

Spread out the timing of your
feeders (max kW = **15**)

Feed & Water

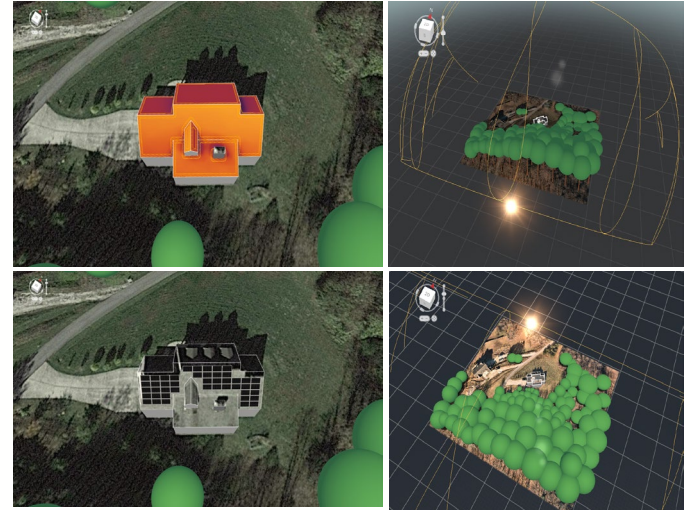


Watering System

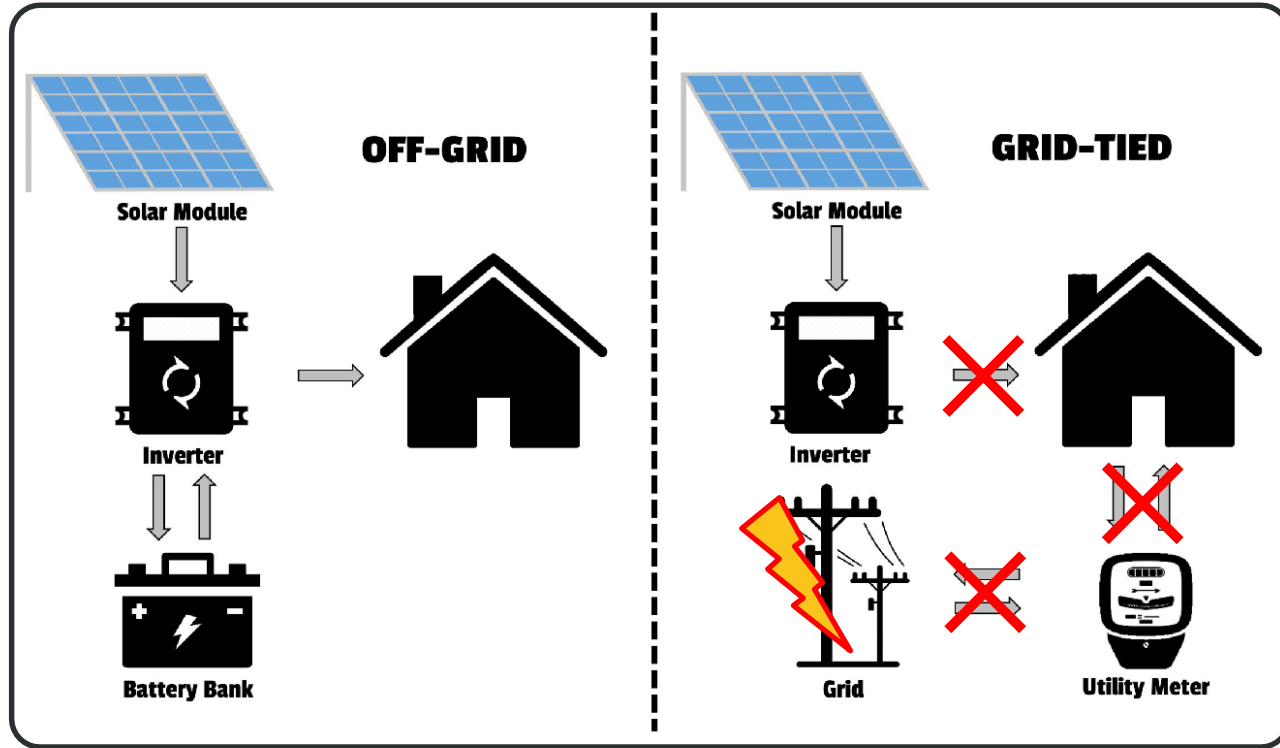
- Eliminate leaks
- Look for low pressure systems
- Variable speed drive for pump

Alternative > Solar

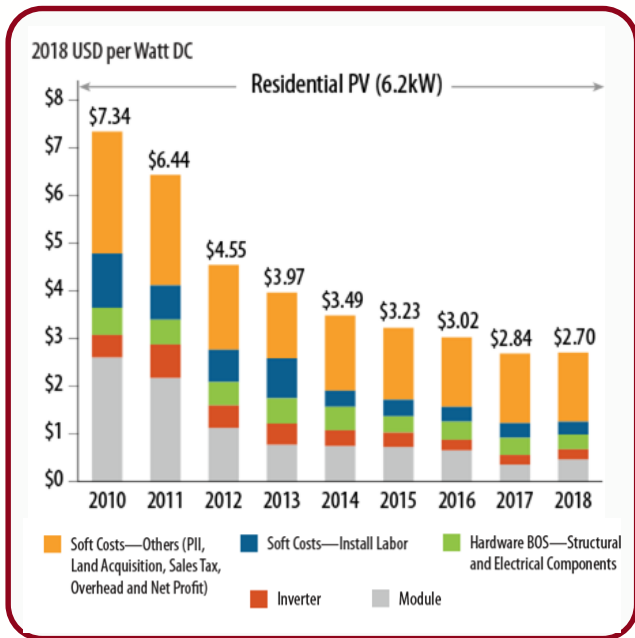
Is Solar PV Right for Me?		✓/✗
1.	Do you have a <u>south-facing</u> roof?	<input type="checkbox"/>
2.	Does your roof have enough space for PV panels?	<input type="checkbox"/>
3.	Is your roof <u>unshaded</u> ?	<input type="checkbox"/>
4.	What is the <u>angle</u> of your roof?	<input type="checkbox"/>
5.	Is your roof in good condition?	<input type="checkbox"/>



Alternative > Solar



Alternative > Solar



Solar costs in Maryland

System Size (kW)	Average Cost (\$) <i>before ITC*</i>	Average Cost (\$) <i>after ITC*</i>
5	13,867	10,261
6	16,640	12,314
7	19,413	14,366
8	22,187	16,418
9	24,960	18,470
10	27,733	20,523

* Federal Investment Tax Credit (ITC) of 30%.

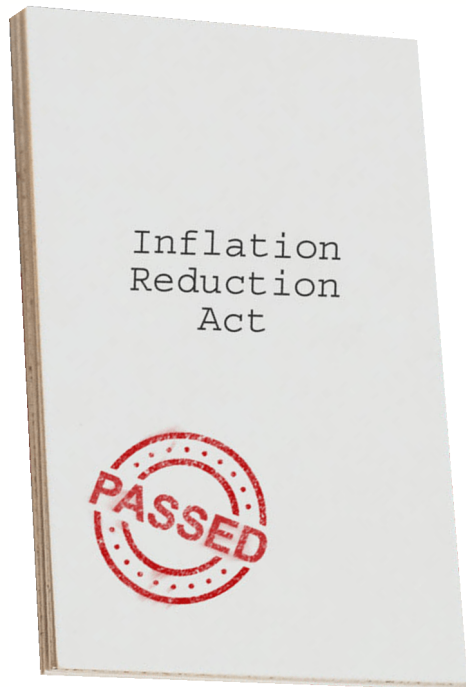
Battery Storage Costs

Battery Capacity (kWh)	Battery Only (\$/kWh)	Battery + Inverter (\$/kWh)
1–5	800	1,652
6–10	705	1,079
11–15	697	903
16–20	690	991
All	727	1,160

Equipment	\$	kWh
Tesla Powerwall 2	10,284	14
Redflow Zcell	9,256	10
LG Chem Resu	6,020	9.8

NREL (2018). Solar Installed System Cost Analysis [via [NREL.gov](https://www.nrel.gov)]

Financing > Incentives



Commercial + Rural Energy for America Program (REAP)



New in 2023: 40% grants for rural businesses, farms and agricultural producers!

Businesses must be located in rural areas with populations of 50,000 residents or less. Agricultural producers may be in rural or non-rural areas, must have at least 50% of their gross income coming from agricultural operations.

Eligible projects include renewable energy (e.g., solar, wind, biomass) and energy efficiency upgrades (e.g., high efficiency HVAC, insulation, refrigeration, switching from diesel to electric irrigation motors).

Deadline for fiscal year 2023 application is **March 31, 2023**.

[More details and applications at USDA.gov](#).

Updated 1/9/2023

Commercial + Solar



Currently: The current 26% Commercial Solar Investment Tax Credit is increased to **30% and extended through 2024**; the 30% applies to solar projects placed in service during or after 2022.

Coming in 2023: The base credit applies to projects <1 MW or that meet prevailing wage and apprenticeship requirements. If a project is >1 MW and does not meet those requirements, **the base credit is 6%**.

There will also new credit adders that can be stacked for additional benefit:

- **Up to 10%** for projects that are located in "energy communities" (defined as brownfield sites, communities with high fossil fuel employment and high unemployment, and/or communities with closed coal mines or coal-fired power plants).
- **Up to 10%** for solar projects <5MW located in low-income communities; applications will be required.
- **Up to 20%** for solar projects < 5MW and built as part of an affordable housing project or to benefit low-income households; applications will be required.
- **Up to 10%** for using US-manufactured solar products and construction material.
- Energy storage facilities are also eligible.

In 2025: this provision becomes the "Clean Electricity Investment Credit"; extended through 2032 or until emission targets are reached.

[Visit Solar Energy Industries Association \(SEIA\)](#) for a review of the Investment Tax Credit Extension (Section 1302), Production Tax Credit Addition (Section 1301), and Transition to New Technology Neutral Credit (Sections 13701 and 13702).

[View Federal Solar Tax Credits for Businesses](#) via Energy.gov

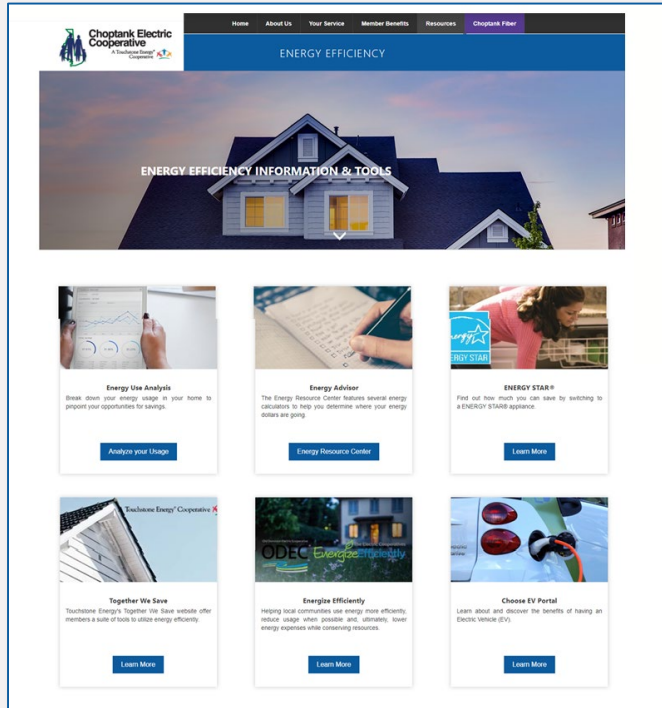
Note: This provision also allows a direct pay option for tax-exempt entities. More to come on this!

In addition to federal incentives, many businesses in Minnesota also have access to **Property Assessed Clean Energy (PACE)** financing for solar projects.

[LEARN MORE ABOUT PACE](#)

go.umd.edu/IRA

Financing > Incentives



Rebates & Discounts

Electric Water Heater

\$250 *Rebate*

Heat Pump Water Heater

\$300 *Rebate* | \$300 *FITC*

Programs & Incentives

Chop-A-Watt

\$7,000 *in weatherization*

Beat the Peak

Reflected in PCA

choptankelectric.coop/energy-efficiency

Financing > Incentives



The screenshot shows the Delmarva Power website interface. The top navigation bar includes 'Outage', 'Pay Bill', 'Moving', 'Contact Us', and a search bar. The main content area is titled 'Ways to Save' and features several promotional tiles for 'Maryland' residents, including 'Marketplace', 'Peak Energy Savings Credit', 'Energy Assessments', 'Energy Wise Rewards', 'My Account Online Tools', 'Recycling', 'Rebates & Discounts', and 'My Account Online Tools'. A sidebar on the left contains a menu for 'For Your Home' and 'For Your Business'. The footer includes social media icons and contact information.

Rebates & Discounts

Air Purifier	\$40 Rebate
Clothes Washer	\$75 Rebate
Dehumidifier	\$30 Rebate
Hybrid Water Heater	\$700 Rebate \$300 FITC
LED Bulbs Fixtures	\$3 \$5 Rebate
Refrigerator	\$75 Rebate
Smart Thermostat	\$75 Rebate

Programs & Incentives

Appliance Recycling	\$50 Refrigerator \$25 AC
Peak Energy Savings Credit	\$1.25 per kWh Bill Credit
Energy Wise Rewards	Thermostat Auto Adjust








www.delmarva.com/WaysToSave

Financing > Grants & Loans

Energy Efficiency



Eligible Projects

-  Lighting
-  Heating
-  Cooling
-  Ventilation
-  Fans
-  Automated Controls
-  Insulation

Renewable Energy



Eligible Projects

-  Solar
-  Wind
-  Small Hydroelectric
-  Anaerobic Digesters
-  Biomass
-  Geothermal
-  Wave/Ocean Power



Rural Development

Rural Energy for America Program (REAP)

rd.usda.gov

50%

Financing > Grants & Loans



Maryland
Energy
Administration

Commercial, Industrial & Ag Grant (CI&A)

deep energy retrofit projects grants. Awards: \$10,000 to \$100,000

Jane E. Lawton Conservation Loan Program

loan finance for energy performance upgrades; All Other: \$850,000 (FY21); 1% Interest rate

Maryland Energy Storage Income Tax Credit

energy storage systems for commercial property; \$750,000 in certificates awarded each tax year

energy.maryland.gov

Maryland Agricultural &
Resource-Based Industry
Development Corporation



Maryland Urban Agriculture

Commercial Lending Incentive Grant (MUACLIG)

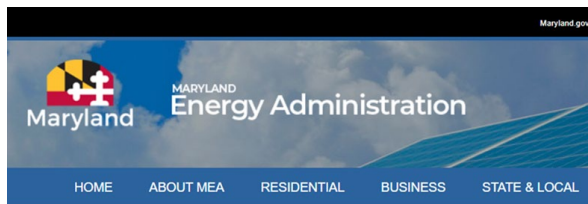
- urban farmers to seek commercial lender financing the development or expansion of ag enterprise.*
- Maximum incentive grant is \$10,000*

Rural Business Energy Efficiency Improvement Loan Fund

- Loans for energy efficiency projects implementing recommendations of a third-party energy auditor 2,500 to \$30,000*

marbidco.org

Financing > Grants & Loans



Residential Incentives

Grants & Loans

Bio-heating oil purchases	Receive tax credits for purchasing biofuels.
BeSMART Energy Efficiency Loan for Homeowners	Maryland Department of Housing and Community Development's loan provides financing to improve energy efficiency, ex.replacing and upgrading appliances, heating, ventilation and cooling systems, and whole house envelope improvements.
Clean Burning Wood Stove Rebate Program	Receive rebates for clean wood burning stoves.
Community Solar	Allows Maryland residents to purchase subscriptions for energy from community solar arrays. <i>Inactive program</i>
Community Solar LMI-PPA Program	Maryland PSC-approved Subscriber Organizations can apply to receive incentives for supplying PPAs that maximize value to low-to-moderate income (LMI) subscribers.
Low-to-Moderate Income Energy Efficiency Grant	Local governments and non-profits can apply for competitive grants to enable energy efficiency projects that benefit Marylanders experiencing low-to-moderate income.

Grant Programs

Community Solar LMI-PPA <i>Offset PPA-related costs for SSOs providing for LMI</i>	December 16, 2022 <i>variable</i>
Low Income Solar Grant <i>Design and install solar for a limited number of LI household</i>	November 15, 2022 <i>up to \$25,000</i>
Resiliency Hub Grant <i>solar plus energy storage to serve as resiliency hubs for LMI</i>	March 1, 2022 <i>\$3,000 per kW</i>
Solar Canopy Grant <i>Install parking lot and parking garage solar canopy systems</i>	December 2, 2022 <i>\$500 per kW</i>

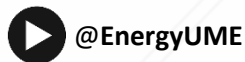
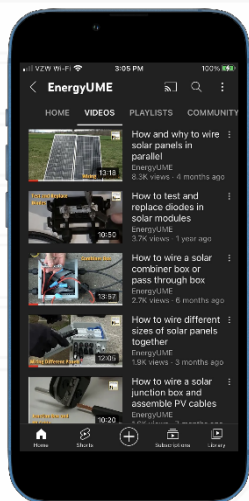
Tax Credits & Rebates

Clean Energy Rebate <i>Purchase and install eligible systems at primary residence</i>	June 30, 2023 <i>\$1,000 PV \$500 WH</i>
Commercial Clean Energy <i>Install eligible clean energy on facilities located in the state</i>	June 30, 2023 <i>variable</i>
Energy Storage Tax Credit <i>install energy storage on residential or commercial property</i>	TBA (30%) <i>\$5k home \$150k co</i>

energy.maryland.gov

Energy Resources

VIDEO



PUBLICATIONS



NEWSLETTER



The background features a large, faint watermark of the University of Maryland Extension logo, which is a circular emblem with a grid-like pattern. The text "UNIVERSITY OF MARYLAND EXTENSION" is centered within this emblem in a white, serif font.

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CONTACT INFORMATION

Drew Schiavone, PhD

Western Maryland Research and Education Center

phone: 301.432.2767 / email: dschiavo@umd.edu