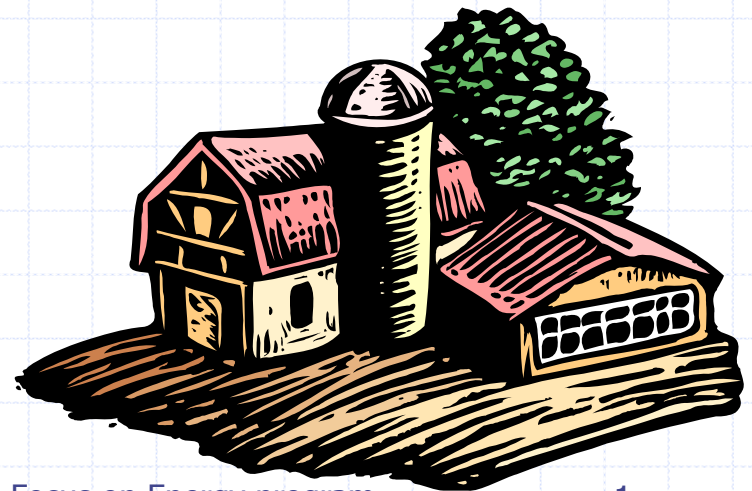
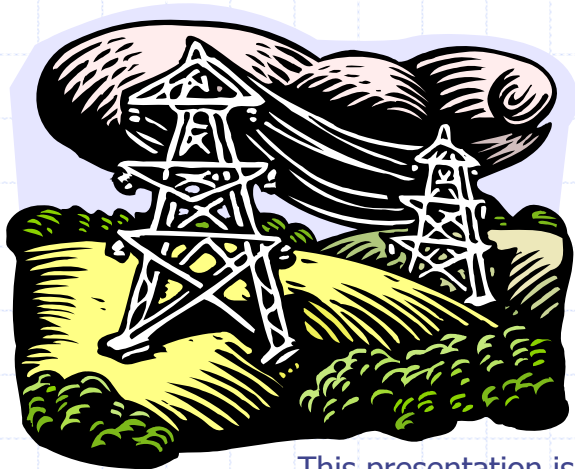


# Capturing Energy Efficiencies on Dairy Farms

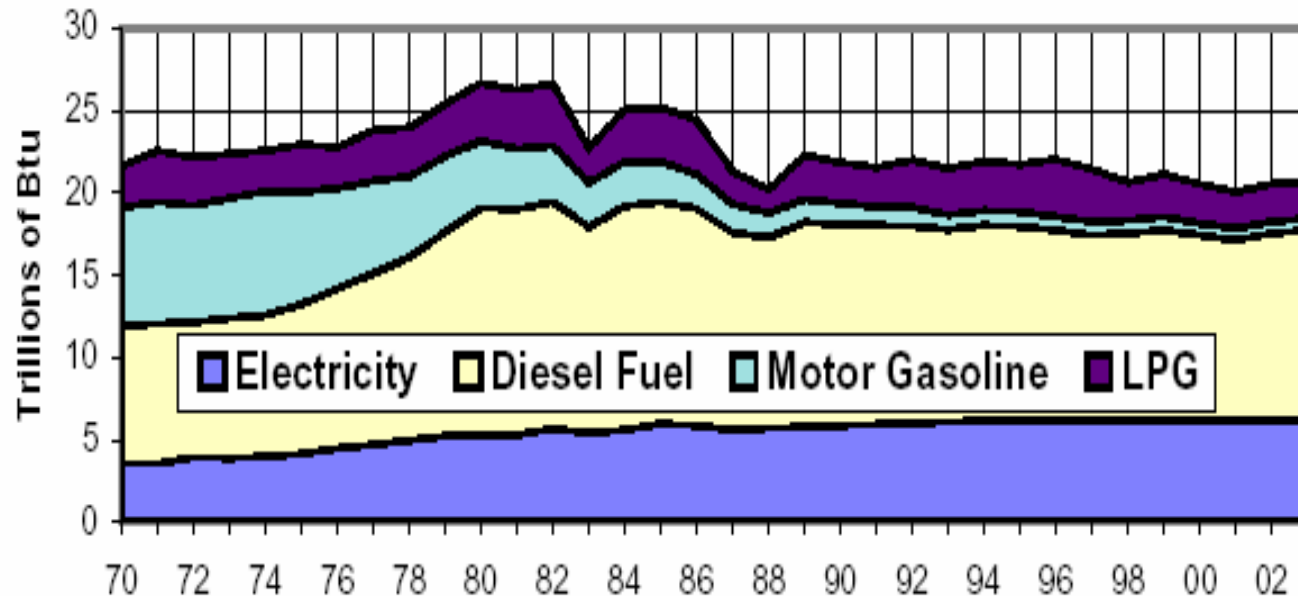
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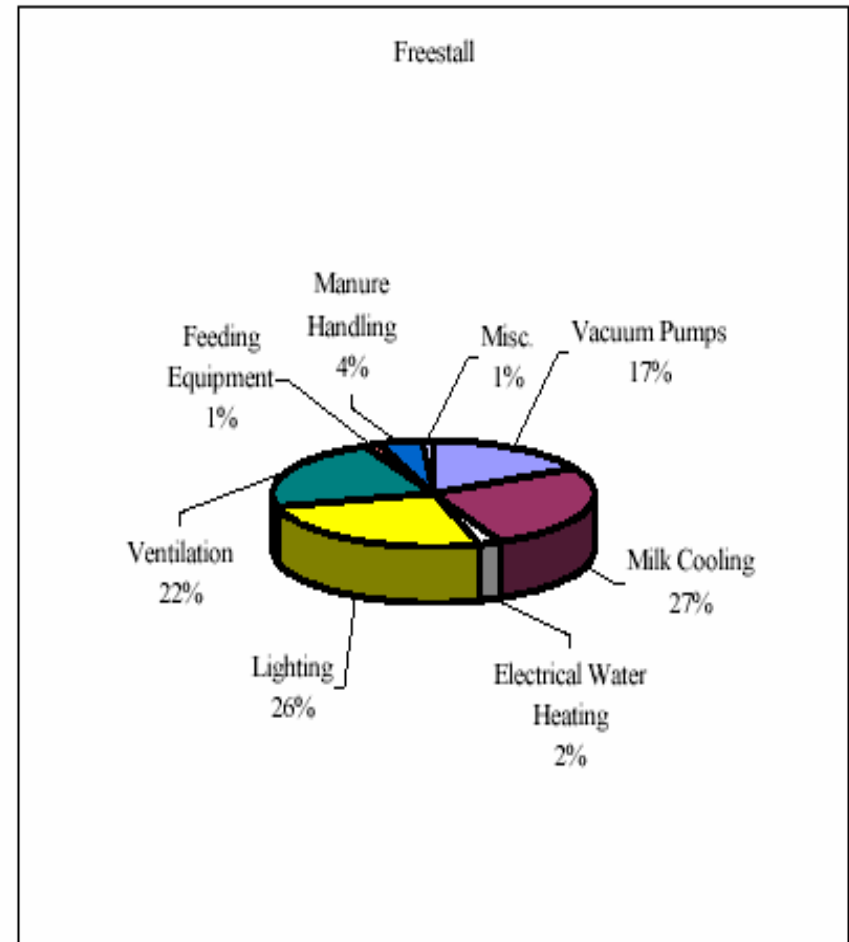
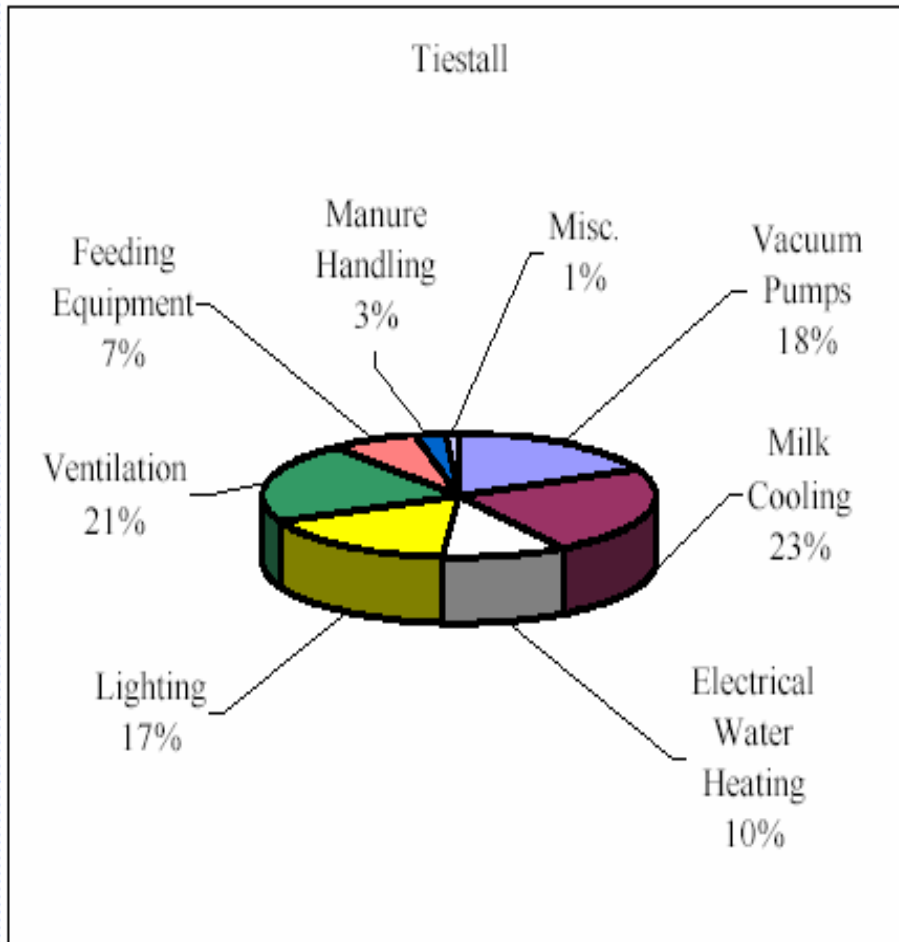
# Wisconsin Agricultural Energy Use, in Btu, by Type of Fuel, 1970-2003

(Trillions of Btu and Percent of Total)

Agricultural energy use has been nearly constant since the late 1980s due to offsetting increases in mechanization and automation and land taken out of production. End use energy used in Wisconsin agriculture is now almost 20 percent below the peak reached in 1980.



# NYS Dairy Farm Survey Electrical Usage



Source: Dairy Farm Energy Audit Summary, NYSERDA, July 2003

# What is needed to conserve energy?

- Adapt new technology
  - ◆ Variable Speed drives
- Upgrade older less efficient equipment
  - ◆ Reciprocating compressors to Scroll types
- Change management practices
  - ◆ Scheduled maintenance program

# Energy Conservation – Win/Win

## ◆ Results: Save Money!!

- Same or Better quality with improved processes

## ◆ Low Management Requirements

- High-Efficiency equipment saves energy with minimal maintenance

## ◆ Expansion / Re-modeling / Replacing

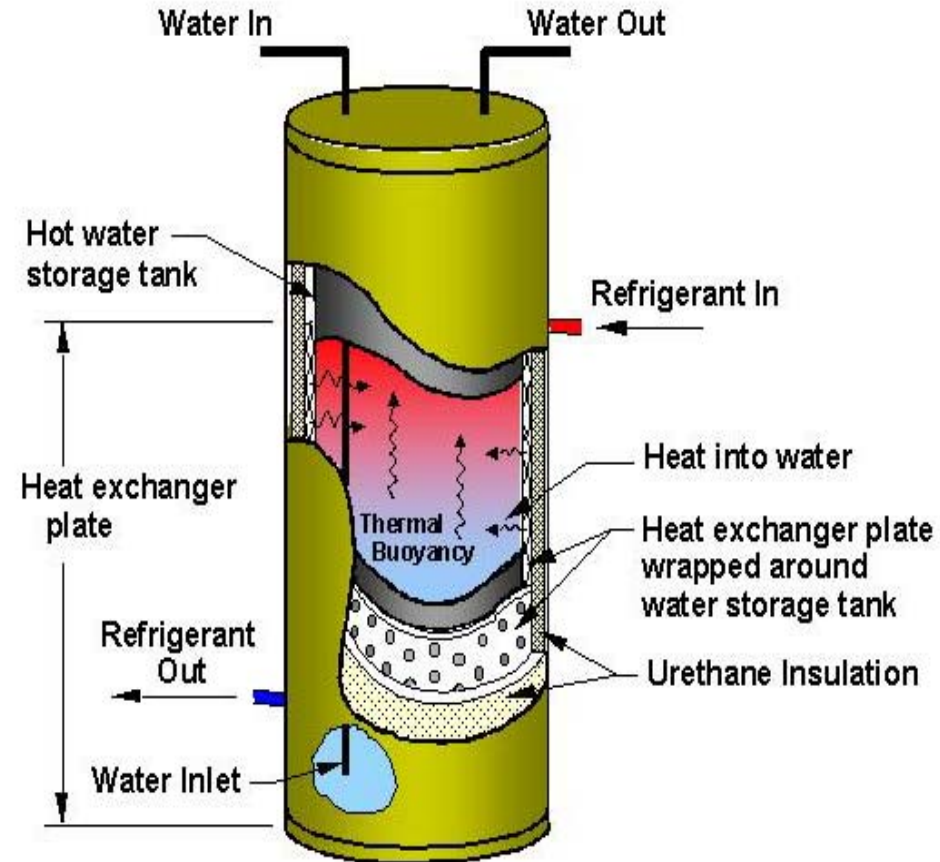
- Up-sizing for larger operation
- Becomes economical to upgrade
- Replace equipment because of old age

# Energy Conservation in Dairy Enterprises

- Refrigeration
- Vacuum systems
- Water Heating
- Ventilation
- Lighting
- Water Fountains



# Refrigeration Heat Recovery Unit



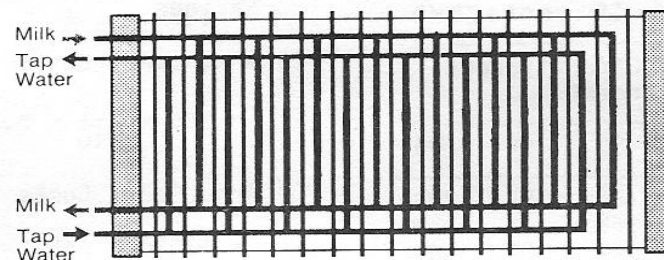
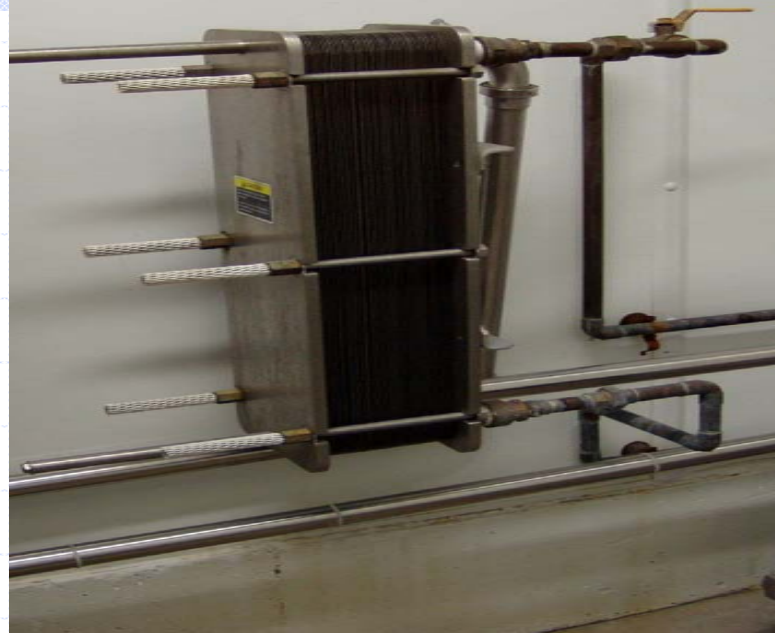
# Refrigeration Systems

- Refrigeration Heat Recovery (RHR)
  - ◆ Captures eject heat from refrigeration system
  - ◆ Potential to reduce water heating costs up to 50%
  - ◆ Increases compressor efficiency
  - ◆ Can accommodate 2 compressor units
  
- All-in-One Heat Recovery / Water Heater
  - ◆ Heater in tank reduces potential heat recovery
  - ◆ Electric water heating costs more.
  - ◆ Not Recommended – Turn off heating element and purchase a larger gas or oil water heater.



# Well Water Precoolers

- Uses well water as coolant
- Potential to reduce cooling requirements by 60%
  - ◆ Up to 40°F temperature reduction
- Water supply critical for savings potential
- Need 1" piping
  - ◆ 1:1 water:milk ratio Minimum
- Herd size > 100 to 150 cows



# Variable speed milk pump

- Makes pre-cooler more efficient by decreasing milk flow rate.
- Increases water:milk flow ratio
- Useful for low capacity water systems or large farms
- Typical 15°F increase in milk cooling



# Equipment Interactions

- ◆ Precooler energy savings = 1 unit
- ◆ Refrigeration Heat Recovery = 1 unit
  
- ◆ Precooler + RHR  $\neq$  2 units
  
- ◆ Hot water use drives the economics!!!
- ◆ Cheaper to refrigerate milk than heat water!
  
- ◆ Dairies with < 100 cows
  - Generally only use either / or not both
  - Cover water heating needs first

# Refrigeration Compressors

## ◆ Scroll Compressor Technology

- ◆ 15-20% more efficient than standard reciprocating compressor.
- ◆ If buying new or must replace compressor
  - Specify: Scroll compressors
- ◆ Can directly replace reciprocating compressors if:
  - Condenser unit is in well maintained condition
  - Capacity of new compressor is within 5% of existing compressor (BTU/Hr)
  - Requires new mounting holes & rewiring of controls
  - Incremental cost - \$300-\$500



# Condenser Unit Maintenance



# Condenser Unit Maintenance

- Clean condensing unit – 2X/yearly min.
  - Electrical Savings - 3 to 5% from cleaning alone
  - Use Condenser / Evaporator coil cleaner only
  - DISCONNECT POWER BEFORE CLEANING
- ◆ Keep brushes, vines, trees trimmed
- ◆ Open winter covers when weather warms
- ◆ Lubricate louvers and check proper operation of power opening louvers and exhaust fans
- ◆ Service - Check Refrigerant level and pressures yearly

# Water Heating

- ◆ Average water heater
  - 80% Thermal Efficiency
  - 60% Standby heat loss per day (2.5%/hour)
  - Overall efficiency: ~ 50 to 55%
  
- ◆ High Efficiency water heaters
  - Condensing types – 90%+ efficient
  - Low standby losses – 1% per hour (24%/day)
  
- ◆ Purchase well insulated water heaters
- ◆ Use Commercial Water Heaters
- ◆ Water heater Ratings:
  - Gas Appliance Manufacturers Association - [www.gamanet.org/](http://www.gamanet.org/)
  
- ◆ Use warm water directly from RHR for non-critical washing



# Variable Speed Vacuum Pump

- ◆ Typically reduces VP electrical usage by 60%.
  - Ranges from 30 to 80%.
- ◆ Pumps require minimum RPM
  - lubrication and cooling.
- ◆ Oversize pump head reduces potential savings.
  - Air volume per revolution
- ◆ Not Recommended for Rotary Vane Vacuum pumps.



# Variable Speed Vacuum Pumps

## ◆ General economic guidelines:

Minimum operational time for 5 year payback\*

- 5 HP Vacuum pump – 12 hours or more/day
- 7.5 HP Vacuum pump – 8 hours or more/day
- 10 HP Vacuum pump – 6.5 hours or more/day
- 15 HP Vacuum pump – 5 hours or more/day
- 20 HP and higher – 3.5 hours/day

\* Based on estimated installed cost of equipment and electric cost at \$0.085/kWh

Typically Justified if milking 3 times per day

# Ventilation - Box fans

## ◆ All fans are not created equal

- ◆ Efficiency test data - > 21 CFM/watt @0.05" SP
- ◆ 36" and larger fans
- ◆ HE fans ~ 20% higher energy efficiency

## ◆ Performance data

- BESS Lab (U of IL) -  
[www.bess.uiuc.edu/index2.htm](http://www.bess.uiuc.edu/index2.htm)
- Air Movement & Control Assoc  
[www.amca.org](http://www.amca.org)





# HVLS Fans in Freestall barn



# High Volume Low Speed Fans (HVLS)

- ◆ One 24 foot HVLS fans =  
six 48" high-speed box type stirring fans
- ◆ Uses 1 -2 HP per HVLS fan  
versus 6 HP for six high 48" speed fans.
- ◆ Saves up to 3.3 kWh per hour of operation
- ◆ Observations:
  - Dryer floors
  - Reduced bird traffic
  - Less flies
- ◆ Disadvantage:
  - Expensive / long paybacks

# Ventilation System Maintenance

- ◆ Dirty louvers can decrease fan efficiency by 40%
  - Clean and lubricate louvers (use graphite not grease)
  - Clean guards and fan blades
  
- ◆ Belt slippage - decreased airflow rates up to 30%
  - Check and tighten belts every 3 months
  - **Retrofit existing fans with self tightening devices for belts.**
  
- ◆ Always use Totally Enclosed motors
  - Required by electrical codes for farm use.
  
- ◆ Clean dirt off Thermostats
- ◆ Clean dirt off motor – for motor cooling
- ◆ Clean air inlets
- ◆ Clean brush, limbs, weeds away from fan openings

# Lighting

## ◆ High-efficiency lighting

- ◆ Compact Fluorescent Lamps (CFL)
  - Cold starting to 0°F
  - Direct replacement for Incandescent bulbs
- ◆ T-8 Fluorescent (1" diameter)
  - cold starting to 0°F
  - No Flicker
- ◆ High Pressure Sodium – highest efficiency
- ◆ Pulse Start Metal Halide
  - good color rendering
- Proper fixture types –
  - ◆ Moisture Resistant Rated for dairy barns





# Comparison of Lamp Types

Lamp type	Lumens/watt	Average life (hrs)	Color	CRI	CCT (K)	Starting Temp. (F)	Instant On	Wattage range
Incandescent	7-20	1000	White	100	2800	>- 40°F	Yes	25-200
Halogen	12-21	2-6000	White	100	3000	>- 40°F	Yes	45-500
Mercury Vapor	26-39	24,000	Bluish	15-50	3800-5700	-22°F	No *	50-1000
Compact Fluorescent	45-55	6000 to 10,000	White	82	2700	32°F or 0°F	Yes *	14-29
T-12 HO Fluorescent	30-70	9000 – 12,000	White	52-90	3000 – 5000	-20°F	Yes	25-110
Metal Halide	41-79	10,000 - 20,000	Bluish	65-70	3000-4300	-22°F	No *	150 -1000
Pulse Start Metal Halide	60-74	15,000 - 32,000	Bluish	62-75	3200-4000	-40°F	No *	100 - 750
T-12 (1.5") Fluorescent	62-80	9000 to 12,000	White	52-90	3000-5000	50°F	Yes	30-75
T-8 HO Fluorescent	81	18,000	White	75	3000-5000	-20°F	Yes	86
High Pressure Sodium	66-97	24,000	Yellow-orange	22-70	1900-2100	-40°F	No *	35-1000
T-8 (1.0") Fluorescent	76-100	15,000 - 20,000	White	60-86	3000-5000	50°F or 0°F	Yes	25-59

\* Requires warm-up to reach full output

# Lighting Controls –

## Is lighting required all night?

- ◆ Control with Clock / timer
- ◆ DPN Half-night photo sensor
  - Thomas & Betts Corp product
    - ◆ Contact electrical supply house
    - ◆ PN: DPN124 2.6 TMGN
- ◆ Motion / Photo Sensors
  - For short duration outdoor lighting
    - ◆ less than 25-30% of night time hours when using incandescent or halogen lamps.
  - Payback 1-2 years
- ◆ Replace Mercury Vapor Lamps
  - High Pressure Sodium – 3-4 X more efficient
  - Pulse Start Metal Halide
    - ◆ 2X efficient, good color rendering



## Full Cut-off Reflectors

More light in target area

- Lower wattage needs
- 47% more light on ground

Standard HID Fixture  
with Refractor



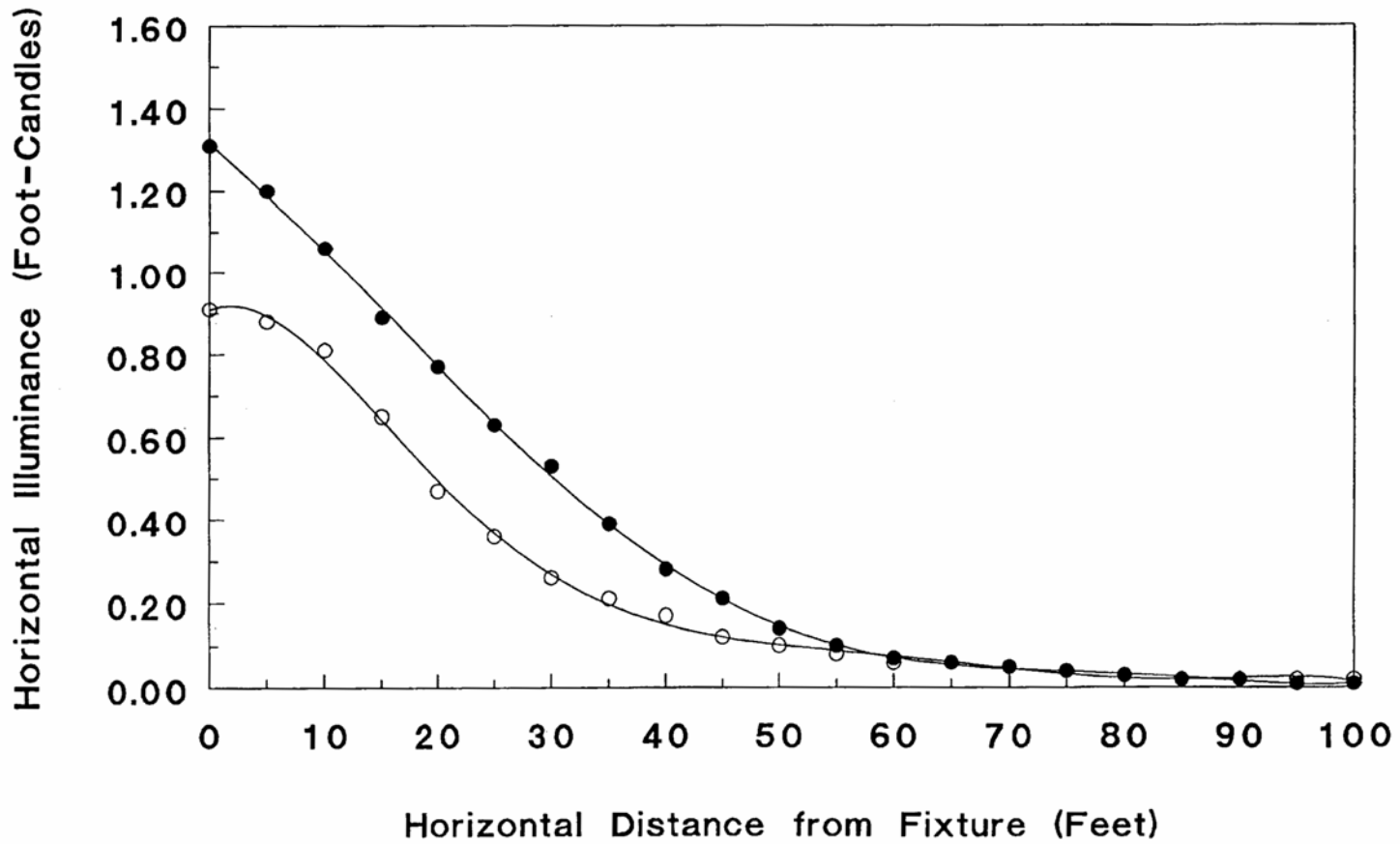
Hubbell SkyCap  
or  
GE Skyguard

# Light Distribution of MV Luminaire

## NEMA Type: Shielded vs. Unshielded

○ 175W MV  
Unshielded

● 175W MV  
Shielded



Hubbell Skycap Retrofit (25' MH) results in 47% more light on the ground in the zone 0 - 100 ft.



# Livestock Waterers

- ◆ Electrical Safety!!!!
- ◆ And Energy Savings



# Frost-Free Livestock Water Fountains



## ◆ Save \$60 to \$100/yr Plus

- ◆ Poorly maintained waterer can use \$200+ in electricity/yr
- May not be suitable for low numbers of animals
  - ◆ Check manufacturers recommendations
  - ◆ May require a low wattage heater
- Requires daily maintenance during sub-zero temperatures
  - ◆ Check that covers / balls are not frozen open or closed

# Energy Conservation in Agriculture Publications

- ◆ A3784-1 – Energy Efficient Dairy Farms
- ◆ A3784-2 – Heating Water on Dairy Farms
- ◆ A3784-3 – Well Water Precoolers
- ◆ A3784-4 – Refrigeration Systems
- ◆ A3784-5 – Variable Speed Vacuum Pumps
- ◆ A3784-6 – Ventilation and Cooling EC
- ◆ A3784-7 – Variable Speed Milk Pumps
- ◆ A3784-14 – Energy Efficient Lighting

Available from UW Extension Publications  
<http://cecommerce.uwex.edu/>



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Wisconsin Energy Efficiency and Renewable Energy

[www.uwex.edu/energy](http://www.uwex.edu/energy)