Reducing Poultry House Power Usage

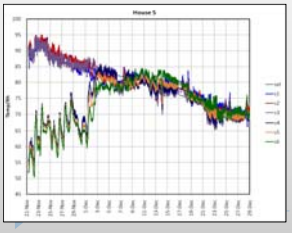
Michael Czarick
The University of Georgia

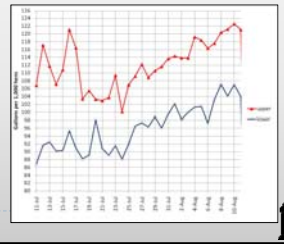
Reducing poultry house power usage

- The first step in reducing poultry house power usage is to know precisely how much power you are using on a daily or better yet an hourly basis
- A monthly power bill simply doesn't provide the level of detail we need to determine on how best to reduce a farm's power bill.

Think of it this way…

- Water usage and house temperature are important to us:
  - Would you be happy with only knowing your average monthly temperature or water consumption.
  - But, knowing daily water consumption and house temperatures can prove very beneficial (hourly is even better).

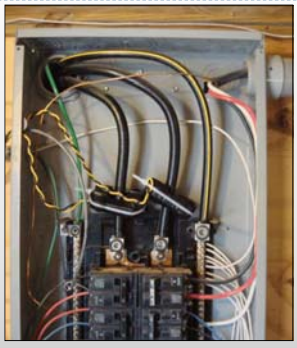




The same holds true for power usage

- We monitor daily water usage and house temperatures…why not daily power usage?
- Power usage is just as important to a producer's bottom line as temperature and water consumption are.

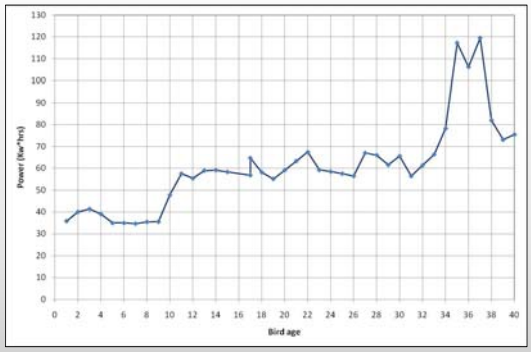
The fact is that monitoring house power usage is no more difficult than monitoring daily water consumption



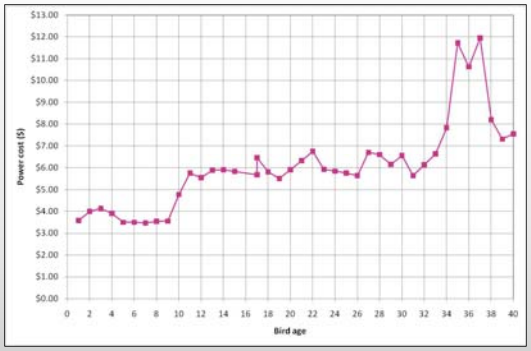
Davidge Controls – EZ meter

- Produces a "contact closure" for every 0.01 Kw of power usage.
  - Wired into houses environmental controller or stand alone mechanical display.
- Allows producers/servicemen to keep up with daily electricity usage

Daily power usage (winter flock)
(Small bird – 40' X 500')



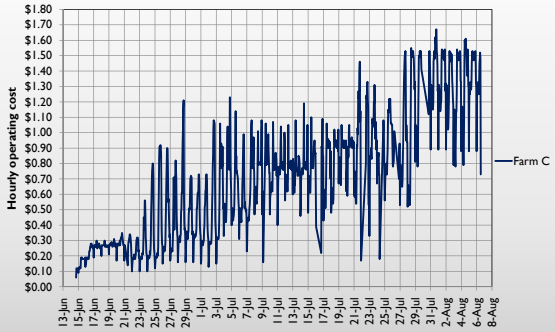
Daily operating cost @ $0.10 Kw*hr
(Small bird – 40' X 500')



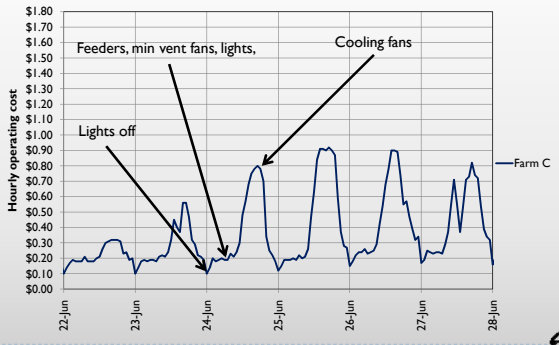
With a PC connected to a house controller even more detailed information is obtainable

- Hourly, 15 minute data

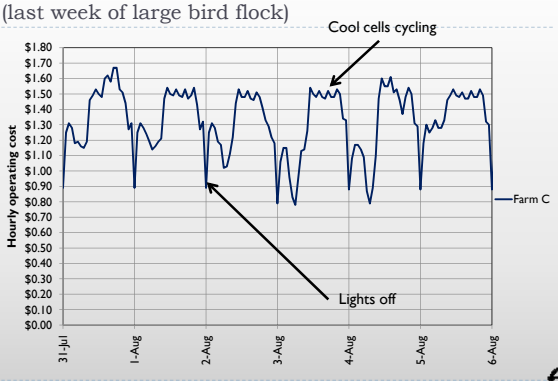
Hourly operating cost
(Large bird – 50' X 560')



Hourly operating cost
(second week of large bird flock)



Hourly operating cost
(last week of large bird flock)



Davidge Controls – EZ meter

- Produces a pulse for every 0.01 Kw of power usage.
  - Wired into houses environmental controller or stand alone mechanical display.
- Allows producers/servicemen to keep up with daily electricity usage
- Determine peak demand
  - When it occurs?
  - For how long?

	Farm A	Farm B	Farm C
Peak (15 minute)	11.6 Kw	12 Kw	17.2 Kw

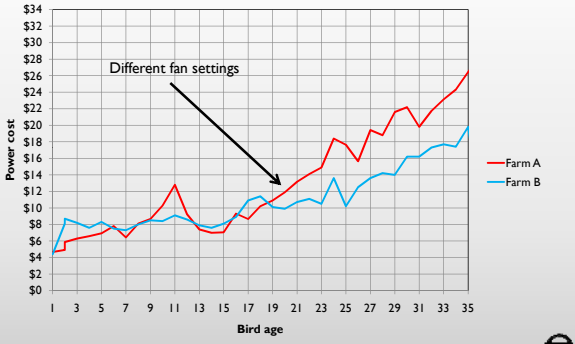
Davidge Controls – EZ meter

- Produces a pulse for every 0.01 Kw of power usage.
  - Wired into houses environmental controller or stand alone mechanical display.
- Allows producers/servicemen to keep up with daily electricity usage
- Determine peak demand
- Determine power usage of different electrical components.
  - Between flocks just turn on the lights, fans, feeder, etc. for an hour and record hourly power usage.

Davidge Controls – EZ meter

- Produces a pulse for every 0.01 Kw of power usage.
  - Wired into houses environmental controller or stand alone mechanical display.
- Allows producers/servicemen to keep up with daily electricity usage
- Determine peak demand
- Determine power usage of different electrical components.
  - Between flocks just turn on the lights, fans, feeder, etc. for an hour and record hourly power usage.
- Test different management strategies to result power use

Power usage comparison



Davidge Controls – EZ meter

- Produces a pulse for every 0.01 Kw of power usage.
  - Wired into houses environmental controller or stand alone mechanical display.
- Allows producers/servicemen to keep up with daily electricity usage
- Determine peak demand
- Determine power usage of different electrical components.
  - Between flocks just turn on the lights, fans, feeder, etc. for an hour and record hourly power usage.
- Test different management strategies to result power use
- Cost = $200

Poultry farm power users:

- Lights
- Exhaust fans
- Pumps (well, cool cell)
- Feeding system
- Circulation fans
- Misc.





Reducing lighting costs

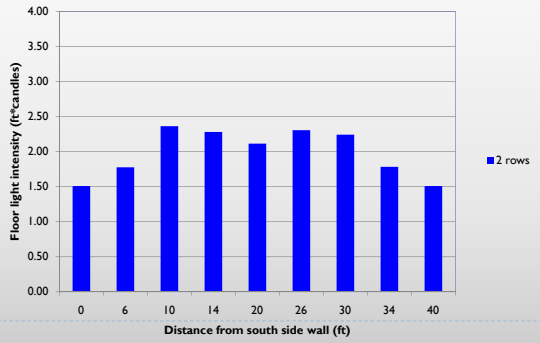
- Do not use incandescent bulbs!
  - Incandescent bulbs are the least efficient lighting system available for use in poultry houses.

Energy efficiency of various light sources

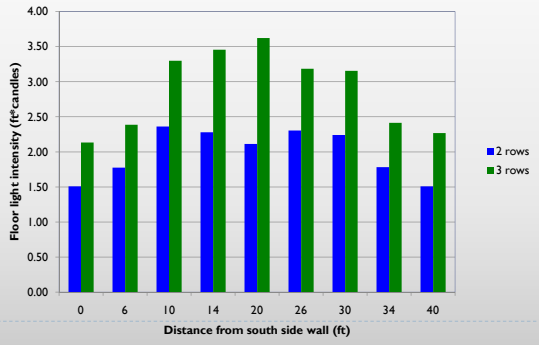
- Incandescent bulbs
  - 15 lumens per watt
- Compact fluorescent bulbs
  - 65 lumens per watt (75% greater)
  - Traditionally the biggest problem is that compact fluorescent light bulb are not dimmable.
  - But, there are some new bulbs that are dimmable to some extent

New dimmable compact fluorescents (23 watt – 1,550 lumens)

Floor light intensity (1,550 lumen fixtures – 20' on center)



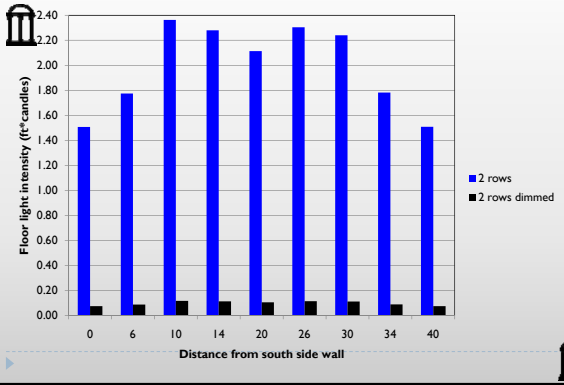
Floor light intensity (1,550 lumen fixtures – 20' on center)



New dimmable compact fluorescents (23 watt – 1,550 lumens)

Capable of a 95% reduction in light intensity

Light intensity with and without dimming



Downside

- Bulb life has been an issue
  - Fairly high initial failure rate…then levels off.
- Need specific dimmers
  - Good news is that a $20 dimmer works well.
- Must have at least a 24 hour burn in period
- Must not dim below 90-95%

Another dimmable option are cold cathode compact fluorescent bulbs.

- Very dimmable
- Low light output
  - 8 watt = 350 lumens
- Dual lighting system is required.

Dual lighting system option

- Y or T adapter with pull string.
  - Place a 1,550 lumen on one side
  - A dimmable fluorescent on the other side

Energy efficiency of various light sources

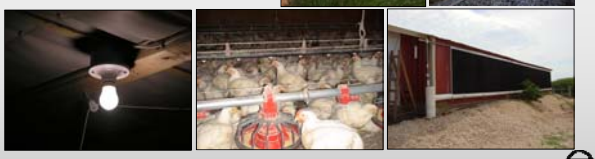
- Incandescent bulbs
  - 15 lumens per watt
- Compact fluorescent bulbs
  - 65 lumens per watt (75% greater)
- LED
  - 50 - 75 lumens per watt (75% greater)
- A lot of interest in LED lighting

LED's

- Very dimmable
- Very long life
- Same energy efficiency as fluorescents
- Low light output = 300 lumens
  - Must have a good reflector
  - Dual lighting system
- Very expensive at this time (+$50).
- Probably will be the lighting system of the future, but the fluorescents are better option for today.

Poultry farm power users:

- Lights
- **Exhaust fans**
- Pumps (well, cool cell)
- Feeding system
- Circulation fans
- Misc.

For the last year we have been studying power usage on three farms:

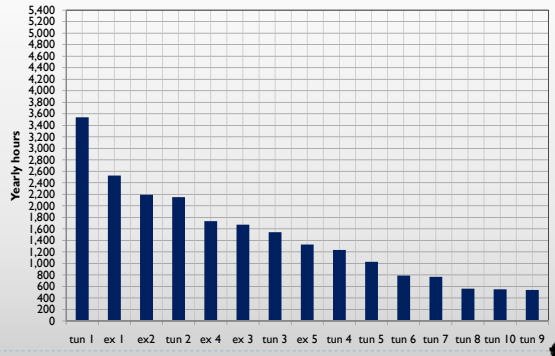
	House size	Bird size	36" fans	Tunnel fans
Farm A	40' X 500'	40 day	5	10 – 48" slant wall
Farm B	40' X 500'	40 day	5	9 – 48" slant wall
Farm C	50' X 560'	55 day	5	10 – 52" cone

- One or two houses on each farm were equipped with power data loggers.
- Computer recorded power usage and individual fan runtime every 15 minutes.

Exhaust fan runtime

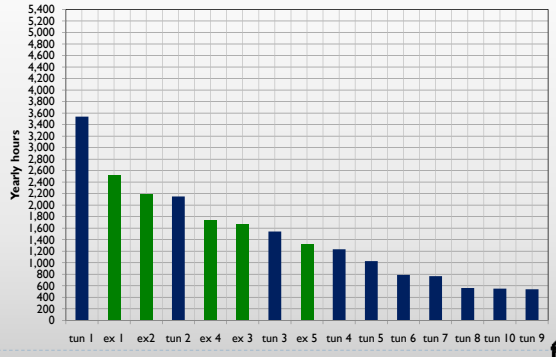
Small bird program – seven flocks

(Farm A)



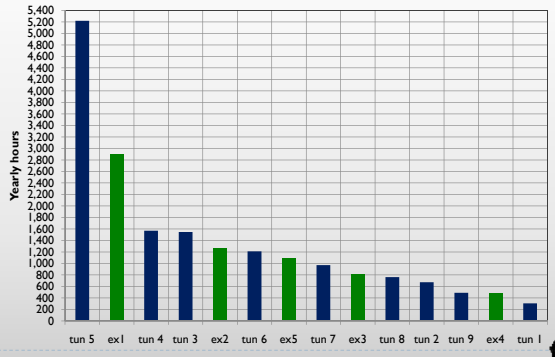
Small bird program – seven flocks

(Farm A)



Small bird program – seven flocks

(Farm B)

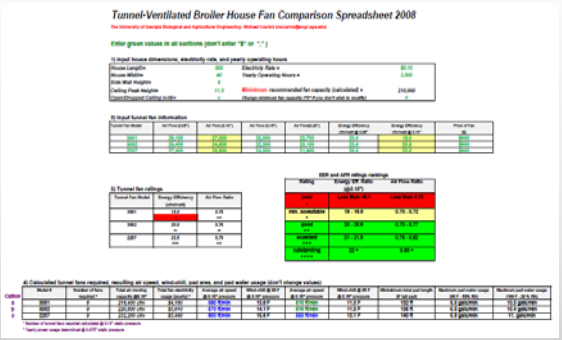


Primarily used a 48" fan for minimum ventilation

Summary:

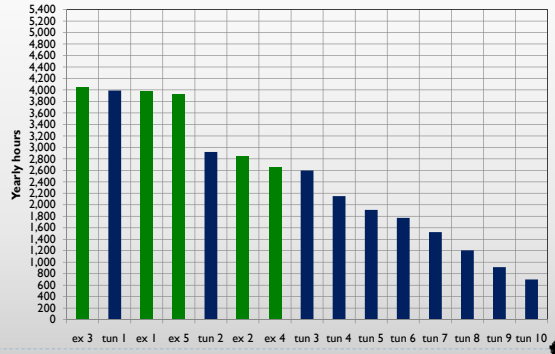
	Farm A	Farm B	Farm C
Average 36" fan runtime	1,890 hours	1,160 hours	
Average tunnel fan runtime	1,270 hours	1,360 hours	
Total air moved	329 million cubic feet	302 million cubic feet	

Fan operating cost spreadsheet

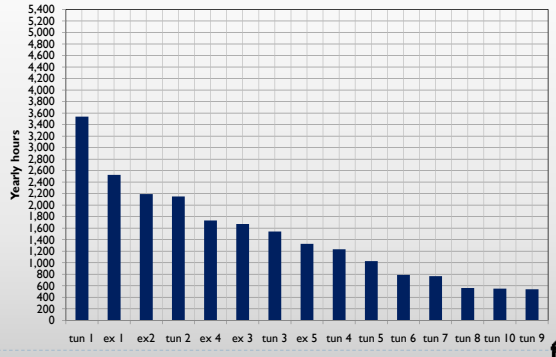


Large birds in a 50' X 560' house (+40%)

Large bird program – six flocks
(Farm C)



Small bird program – seven flocks
(Farm A)

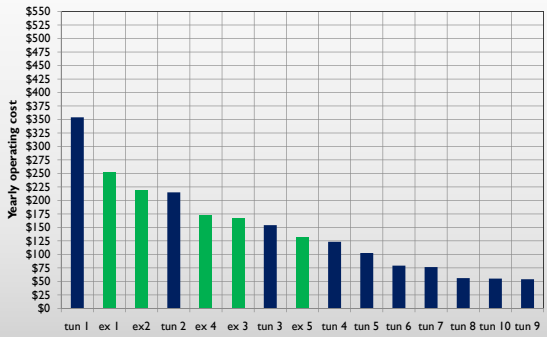


Fan runtime summary:

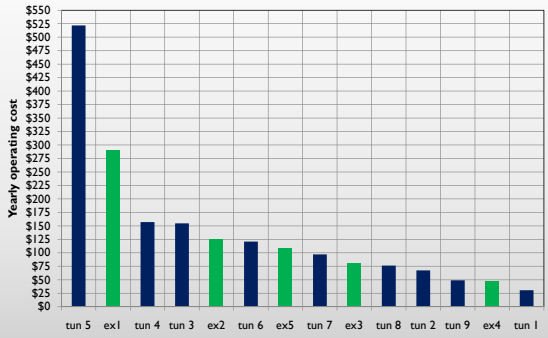
	Farm A	Farm B	Farm C
Average 36" fan runtime	1,890 hours	1,160 hours	3,380 hours (roughly twice)
Average tunnel fan runtime	1,270 hours	1,360 hours	1,852 hours* (30% more)
Total air moved	329 million cubic feet	302 million cubic feet	647 million cubic feet

Fan operating cost

Yearly operating cost @ 0.10 Kw*hr
(Farm A)



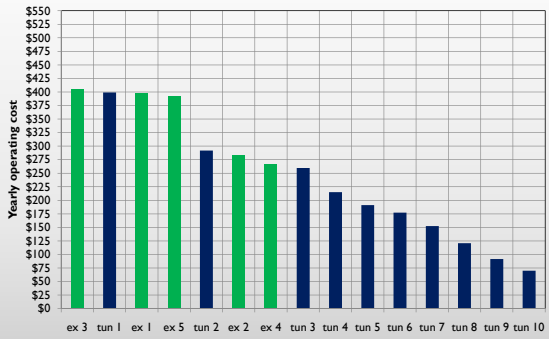
Yearly operating cost @ 0.10 Kw*hr
(Farm B)



Fan operating cost summary:

	Farm A	Farm B	Farm C
36" fan operating cost	$520	$320	
Tunnel fan operating cost	$1,210	$1,290	
Total fan operating cost	$1,730	$1,610	

Yearly operating cost @ 0.10 Kw*hr
(Farm C)



Fan operating cost summary:

	Farm A	Farm B	Farm C
36" fan operating cost	$520	$320	$1,010
Tunnel fan operating cost	$1,210	$1,290	$2,220
Total fan operating cost	$1,730 $0.09 per ft2	$1,610 $0.08 per ft2	$3,230 $0.12

Total house power usage

Operating cost

	Farm A	Farm B
36" fan operating cost	$520	$320
Tunnel fan operating cost	$1,210	$1,290
Total fan operating cost	$1,730	$1,610
Total power usage	$2,700	$2,710

Operating cost

	Farm A	Farm B
36" fan operating cost	$520	$320
Tunnel fan operating cost	$1,210	$1,290
Total fan operating cost	$1,730	$1,610
Total power usage	$2,700	$2,710
Fan power %	64%	59%

All houses had fluorescent lighting

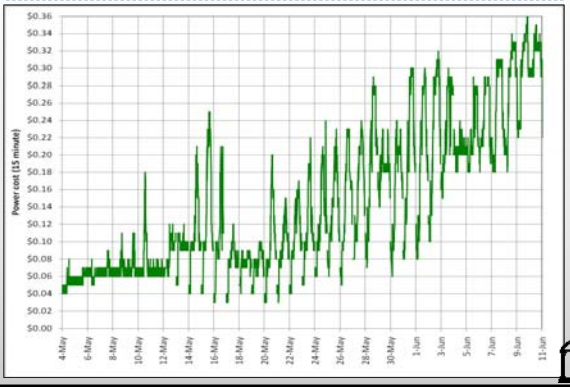
Operating cost

	Farm A	Farm B
36" fan operating cost	$520	$320
Tunnel fan operating cost	$1,210	$1,290
Total fan operating cost	$1,730	$1,610
Total power usage	$2,700	$2,710
Fan power %	64%	59% Large birds = +70%?

All houses had fluorescent lighting

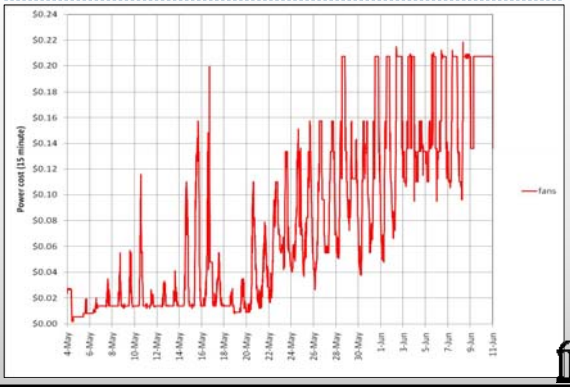
Small bird house (May – June flock)

Total 15 minute power cost



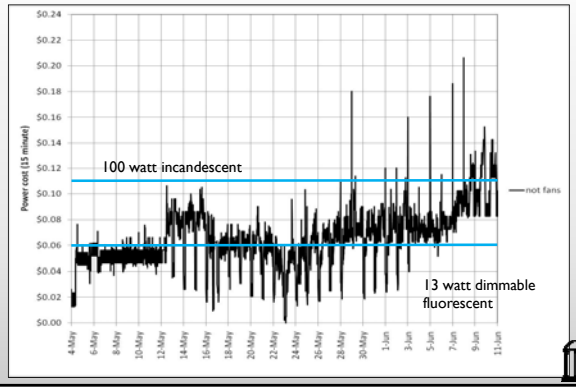
Small bird house (May – June flock)

Fan 15 minute power cost

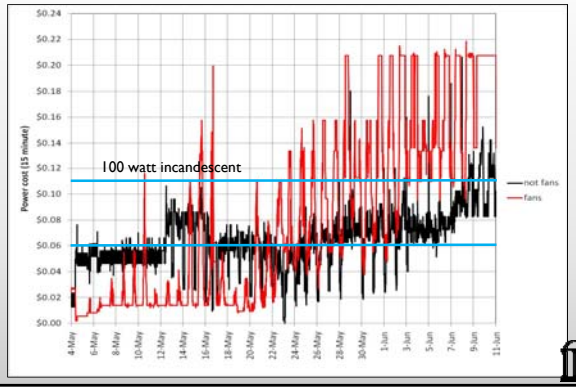


Small bird house (May – June flock)

Everything except fans 15 minute power cost

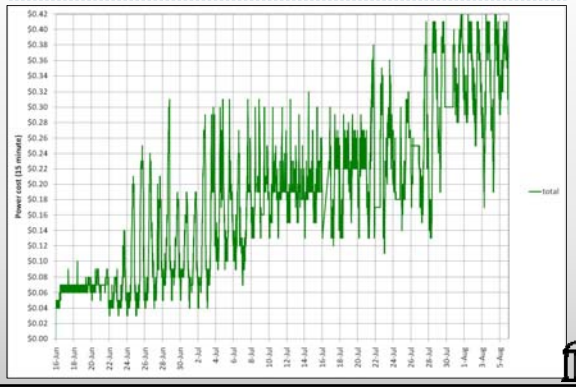


Small bird house (May – June flock)

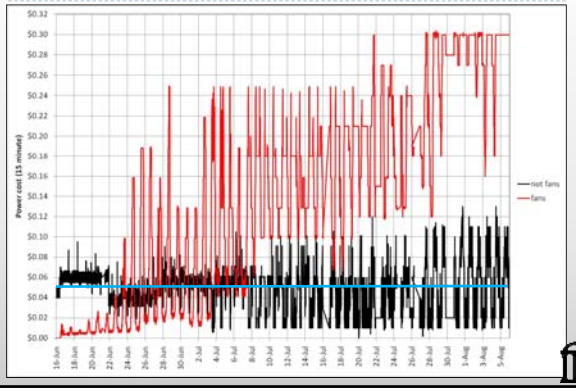


Large bird house (July – August flock)

Total 15 minute power cost



Large bird house (June – August flock)



How do we reduce fan operating cost?

- The best way is to install in a very energy efficient fan to begin with.
  - Minimum specifications:
    - 20.8 cfm/watt @ 0.10"
    - Air flow ratio of 0.76

Top 7%

Test #	Manufacturer	Model	Cone	Shutter	Cfm @ 0.05"	Cfm/watt @ 0.05"	Cfm @ 0.10"	Cfm/watt @ 0.10"	Air Flow Ratio
07206	Acme	BDB34J	Y	A	25,100	27.7	23,300	24.8	0.76
07206		BDB34J1	Y	A	27,400	25.4	25,900	22.7	0.81
02207		BDBV34J2-C2	Y	A	27,400	25.5	25,800	22.5	0.79
02210		BDBV34J-C2	Y	A	26,100	25.8	24,400	22.4	0.77
02217		BDBV34J2-C3	Y	A	27,100	25.2	25,400	22.2	0.79
02214		BDBV34J-C3	Y	A	25,900	25.3	24,200	22.2	0.76
04274		DDPSV34J-C	Y	A	25,500	25.4	23,600	22.1	0.77
04278		DDPUV34J-C	Y	A	26,500	25.2	24,700	21.6	0.76
00245		BDB34J-C	Y	A	26,100	24.2	24,500	21.4	0.79
00207		DDPS40J-C	Y	A	26,400	23.9	19,100	21.3	0.77
02209		BDBV34J1-C2	Y	A	27,100	24.0	25,500	21.1	0.77
99142		DDPS40J-C	Y	A	21,400	23.2	20,300	20.9	0.83
06141	Aerotech	WFS41T1CEJ	Y	A	27,000	25.0	26,000	22.3	0.77
07106		WFS41V1CD	Y	B	27,000	24.6	25,900	21.7	0.77
06139		WFS41T1CDP	Y	P	27,400	24.2	25,600	21.7	0.76
06115		WFS41T1C1	Y	A	27,300	23.6	25,400	20.9	0.77
05216	American Cooler	MNBRDD52LE	Y	B	24,100	26.1	22,200	22.6	0.76
05211		MNBRDD52LE	Y	B	25,900	25.4	22,100	22.1	0.76
05216		MNBRC52L	Y	A	25,900	24.6	24,300	21.7	0.77
05219		MNBRDD52L	Y	B	25,100	24.2	23,300	21.4	0.76
07230		NBRDD52L-S02	Y	D	24,600	24.3	23,000	21.3	0.76
05234		MNBRDD52L	Y	B	24,900	23.6	23,100	20.9	0.77
04336	Chem-Tone	49452-22	Y	B	21,200	24.8	19,700	21.6	0.76
04326		49515-22	Y	B	21,100	24.4	19,600	21.3	0.77
05192		49511-22	Y	B	26,400	23.9	24,600	21.2	0.76
05146		49519-22	Y	B	26,400	23.6	24,500	20.4	0.76
05259	Hood Hard	6663-7132	Y	B	26,700	24.3	25,200	21.8	0.80
04343		6663-0606	Y	A	27,000	23.3	25,300	20.0	0.78
04336p	Pro Tem Systems	A49451-22	Y	B	21,200	24.8	19,700	21.6	0.76
04329p		A49515-22	Y	B	21,100	24.4	19,600	21.3	0.77
05192p		A49511-22	Y	B	26,400	23.9	24,600	21.2	0.76
05146p		A49519-22	Y	B	26,400	23.6	24,500	20.4	0.76
05203	ValCo	HO6481340941A	Y	A	25,900	25.4	20,300	23.1	0.76

Table 1. Alphabetical listing of best performing tunnel fans as tested by BESS Labs (Top 7%)
(A=Aluminum Shutter, G=Galvanized Shutter, P=Plastic Shutter, R=Roll Seal Shutter, B=Butterfly Shutter, D=Door)
*new test for 2008.

Tunnel fan comparison
(50' X 500' house)

Fan	Cfm @.10"	Energy Efficiency (cfm/watt)	Number of Fans	Air Speed (ft/min)	Yearly $ $0.10 kw*hr ($0.15 kw*hr)
Fan A	25,400	22.2	11	590	$3,150 ($4,730)
Fan B	25,400	17.1	11	590	$4,100 ($6,150)

- Fan A would save:
  - $950 per year at $0.10 per kw*hr
  - $1,420 per year at $0.15 per kw*hr

Installing fewer fans doesn't necessarily reduce operating costs…

Fan	Cfm @.10"	Energy Efficiency (cfm/watt)	Number of Fans	Air Speed (ft/min)	Yearly $ $0.10 kw*hr ($0.15 kw*hr)
Standard	23,300	19.4	12	590	$3,600 ($5,400)
High flow	26,300	17.1	11	610	$4,650 ($6,980)

Standard fan would save:
- $1,050 per year at $0.10 per kw*hr
- $1,580 per year at $0.15 per kw*hr

Don't forget to install energy efficient 36" fans

- They are responsible for 30% or more of your total fan operating cost.

It is important to realize that…

- Many 36" fans have an energy efficiency rating of around 15 cfm/watt (exterior shutters)
- There are some (with cones) that are around 18 cfm/watt to 19 cfm/watt

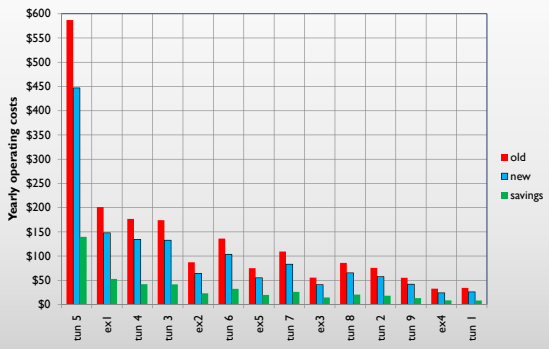

What about our existing houses?

- Fans installed 15-20 years ago…
  - Had an energy efficiency of around 17 cfm/watt...which has probably dropped to 15 cfm/watt.
  - Installing a modern fan with a +22 cfm/watt could decrease 36" fan operating cost 35% or more.

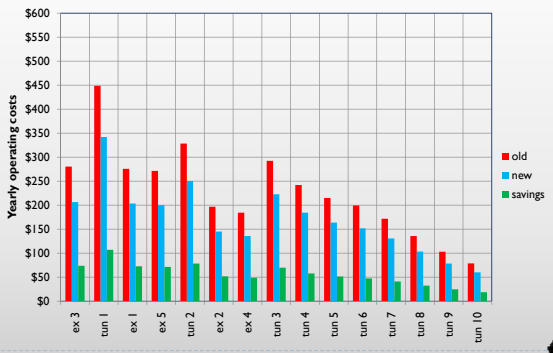
Is it cost effective to replace fans based solely on power savings?


- How much could we save if:
  - Replaced old 36" fans (14 cfm/watt) with new 36" fans (19 cfm/watt)
  - Replaced old 48" fans (16 cfm/watt) with new 48" fans (21 cfm/watt)

Small bird house @ $0.10 per Kw*hr



Large bird house @ $0.10 per Kw*hr



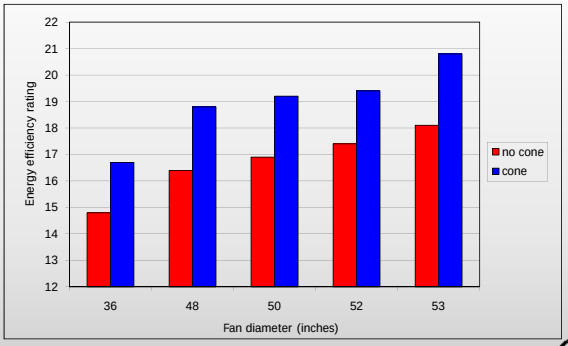
Payback will be tend to be close to 10 years

- For the most used fans could be as little as five years if power rates are higher than $0.15 per Kw*hr…
- For the most part hard to justify the cost if the fan is in reasonable shape from an air moving capacity standpoint.

One way to reduce operating cost is to use what fans you do have more efficiently…

- Switch from 36" fans to larger fans quickly
  - 36" fans tend to be 10 to 30% less energy efficient than larger tunnel fans.

All fans tested by BESS Laboratory
(energy efficiency @ 0.10")



One way to reduce operating cost is to use what fans you do have more efficiently

- Switch from 36" fans to larger fans quickly
  - 36" fans tend to be 10 to 30% less energy efficient than larger tunnel fans.
- Cost of operating two 36" fans (15 cfm/watt) for 2,000 hours (one year) @ $0.10:
  - $266
- Cost of operating one 48" fan (21 cfm/watt) for 2,000 hours (one year) @ $0.10
  - $190

Replacing fan motors

- Make sure you replace the motor with a high efficiency motor (+85%)
  - ½ hp – there are 65% motors out there.
  - 1 hp - 75% tends to be the low end.
- Replacing a +85% efficient motor with a 75% efficient motor will increase power usage by 10 to 15%

Keep you shutters and screens clean

- Dirty shutters can increase the static pressure the fans are working against by 0.05" or more
  - Fans use a little more power at higher pressures.
  - More fans are required to move a given amount of air.

Energy efficiency typically drops 10% with a 0.05" increase in working static pressure

Make sure your belts are worn

- A fan with a worn belt is more energy efficient than one with a new belt.

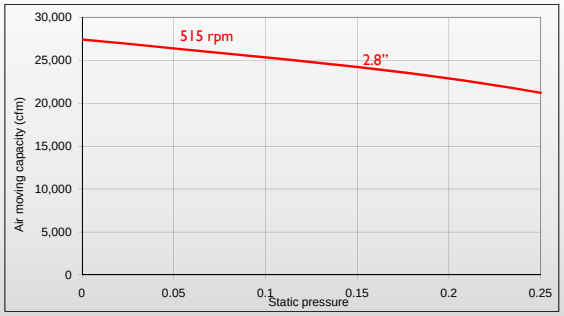
Fan performance laws

Fan performance laws

- Cfm is proportional to fan speed
  - Fan speed is reduced 10%...fan output is reduced 10%

ACME DDPS50

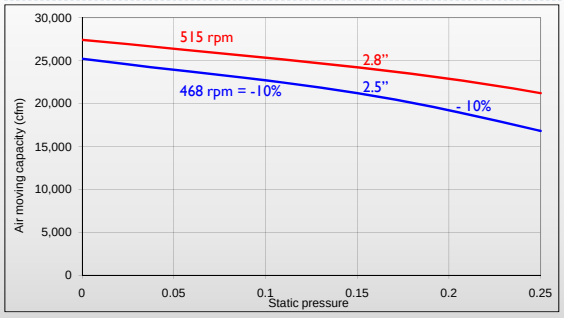
Air moving capacity vs pressure



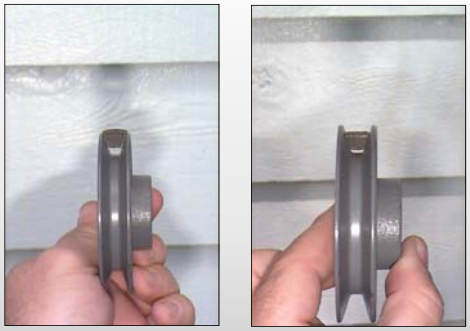
ACME DDPS50

Install a slightly smaller motor pulley

Air moving capacity vs pressure

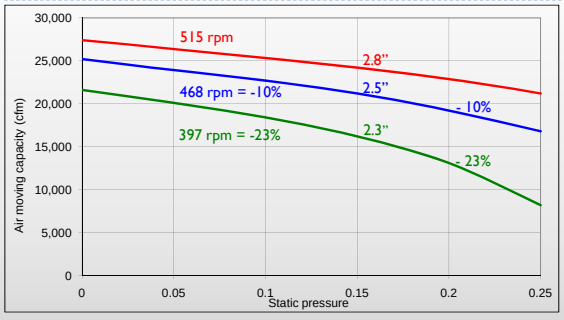


A worn belt has the same effect as installing a smaller motor pulley.



1/8" too low is the same as reducing pulley diameter 1/4"

How about installing an even smaller motor pulley?



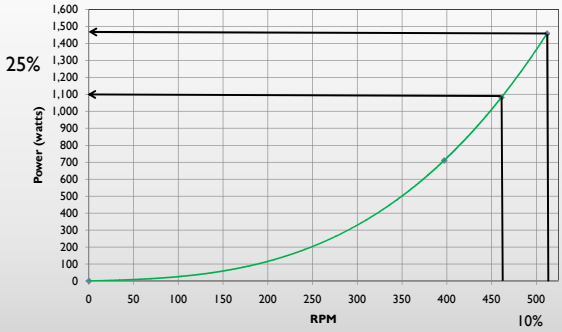
This could prove to be a problem during hot weather for our birds, but….

What would happen to our power bill?

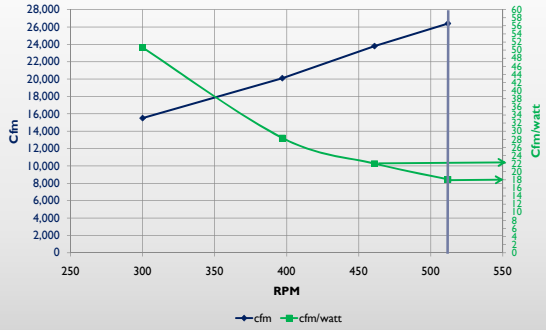
Fan performance laws

- Cfm is proportional to fan speed
  - Fan speed is reduced 10%...fan output is reduced 10%
- Fan speed and power usage are exponentially related
  - Slow a fan down 10 percent power usage is reduce 25-30%

Power usage vs. Fan speed



What would happen to our Cfm/watt?

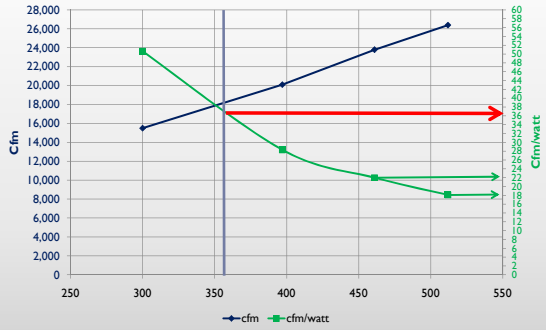


Brings up an interesting question

- Would we be better off not to replace the "worn belts" on our houses and install 10% more fans?

Fan	Cfm @.10"	Energy Efficiency (cfm/watt)	Number of Fans	Air Speed (ft/min)	Yearly $ $0.10 kw*hr ($0.15 kw*hr)
Standard	23,300	19.4	12	590	$3,600 ($5,400)
High flow	26,300	17.1	11	610	$4,650 ($6,980)

What about slowing down a fan even further?



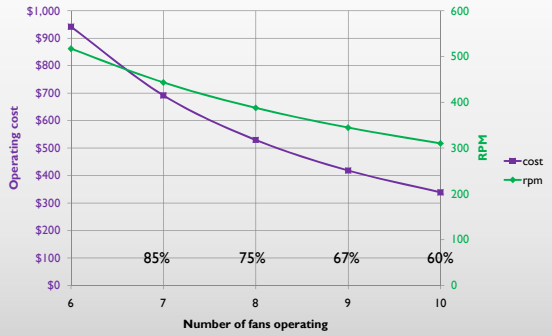
Variable speed exhaust fans

- Using more fans at a lower speed to reduce operating cost.

Example:

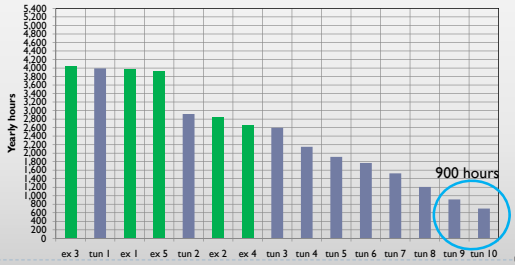
- Instead of using six DDSP50 fans at full speed to move 100,000 cfm (mild weather) why not use
  - 7 fans operating at 85%, or
  - 8 fans operating at 75%, or
  - 9 fans operating at 67%, or
  - 10 fans operating at 60%

Cost to move 160,000 cfm for 1,000 hours



In theory…

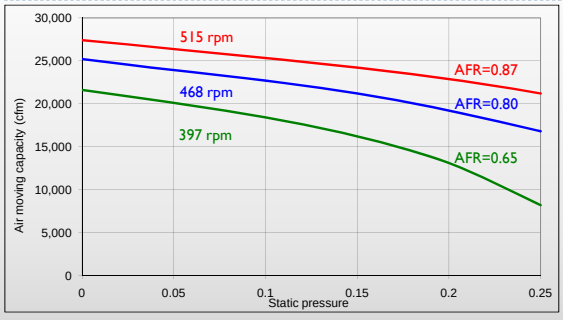
- Your fans would only be running at full speed (lowest energy efficiency) just on the hottest days with market age birds.



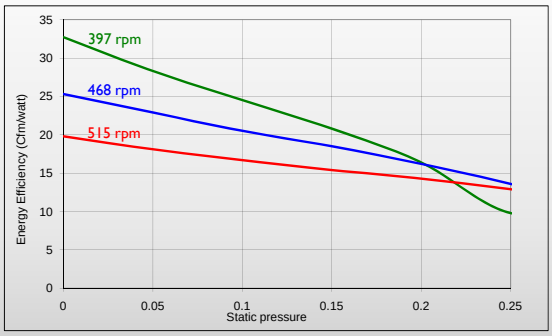
There are a few problems/challenges to be aware of…

- As you slow a fan down it has a harder time moving air at higher static pressures.

Air flow ratio

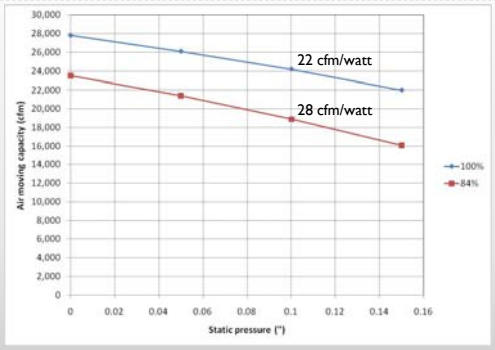


Cfm/watt vs. Static pressure

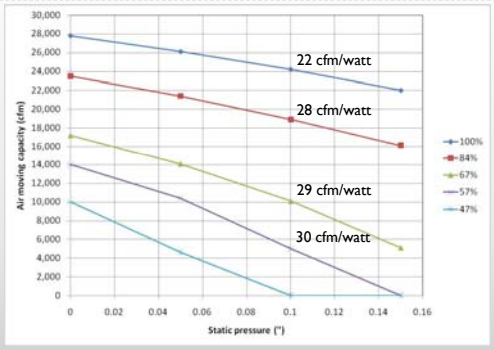


What about other fans…

Choretime 52”



Choretime 52”



There are limits to how much you can reduce fan speed.

- 40% reduction is likely the maximum you can reduce fan speed and still be able to move some air.

Variable speed exhaust fans

- To take full advantage of variable speed fans you would need to operate the house at relatively low static pressure (i.e. 0.05”).

Variable speed exhaust fans

- To take full advantage of variable speed fans you would need to operate the house at relatively low static pressure (i.e. 0.05").
  - Need to have very good inlets to obtain proper air mixing at such low pressures especially in wider houses.

Attic inlet systems tend to require lower operating static pressures.

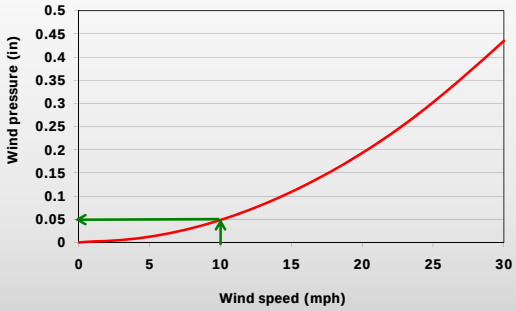
Variable speed exhaust fans

- To take full advantage of variable speed fans you would need to operate the house at relatively low static pressure (i.e. 0.05").
  - Need to have very good inlets to obtain proper air mixing at such low pressures especially in wider houses.
  - Need to have circulation fans

Variable speed exhaust fans

- To take full advantage of variable speed fans you would need to operate the house at relatively low static pressure (i.e. 0.05").
  - Need to have very good inlets to obtain proper air mixing at such low pressures especially in wider houses.
  - Need to have circulation fans
- Ventilating on windy days with a variable speed fan can be a challenge

Pressure vs. Wind Speed

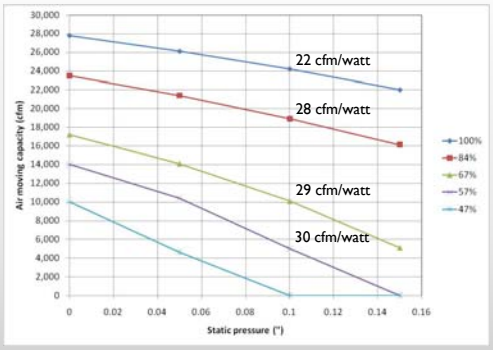


Efforts may be required to reduce the effect of the wind…

Variable speed exhaust fans

- To take full advantage of variable speed fans you would need to operate the house at relatively low static pressure (i.e. 0.05").
  - Need to have very good inlets to obtain proper air mixing at such low pressures especially in wider houses.
  - Need to have circulation fans
- Ventilating on windy days with a variable speed fan can be a challenge
- Might have to install motorized fan shutters.

Choretime 52"



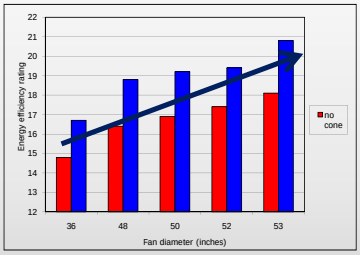
Other issues…

- Variable speed controller can cost $750 or more per fan

Other issues…

- Controllers would have to be modified to take full advantage of variable speed fans.

What about variable speed controllers on very large tunnel fans?



72" fans?

72" tunnel fans were developed for use in the dairy industry.

Performance example:

- ACME BDR72M
  - 48,500 cfm @ 0.10"
  - 20 cfm/watt @ 0.10"

Single Phase		CFM vs. Static Pressure (Inches w.g.)							
Model	HP	.00		.05		.10		.15	
		CFM	C/W	CFM	C/W	CFM	C/W	CFM	C/W
BDR54L	2	30000	20.4	29300	19.5	28600	18.6	27300	17
DDP54L	2	30537	18.7	29383	17.0	27814	15.2	26211	13.6
BDR72M	3	53490	25	51000	23	48500	20	45600	19

Estimated Air flow ratio = 0.83

Using large fans in a 66' X 600'

- The house require approximately 360,000 cfm of tunnel fan capacity.
  - 7 – 72" fans = 350,000 cfm

What if…

- We installed 4 – 36" fans for minimum ventilation and 7 - 72" fans for tunnel?
  - Then install a variable speed controllers on the 72" fans?
- A project of this scope is really not practical right now…
  - Lots of questions still to answer, research to be done.
  - But, it could theoretically substantially reduce operating cost.

mczarick@engr.uga.edu
(706) 542-9041

The University of Georgia
Cooperative Extension Service
College of Agriculture / Athens, Georgia

www.poultryventilation.com