

Electric and Thermal Energy Consumption in Commercial Swine Facilities

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WCROC Renewable Energy

- Modern production ag relies heavily on fossil-fuels
 - Electricity, propane, natural gas, diesel, gasoline
- **Consumers are demanding products with less environmental impacts**

Goals of WCROC RE Program:

- Increase utilization of renewable energy in production agriculture
- Research and demonstrate large/small scale systems
 - Are these systems feasible, applicable, and economical for producers?
 - Share our findings

Greening of Agriculture Initiative

- Goal is to reduce fossil-fuel consumption in ag production systems:
 - Renewable energy generation
 - Energy conservation
 - Energy optimization
- Perform research to develop results for producers to use as a guide
- Three focus areas:
 - Crop production
 - Dairy production
 - **Swine production**
- Funded through Xcel Energy's Renewable Development Fund and the Minnesota Environment and Natural Resources Trust Fund

Modern Pork Production

- Pork production systems have changed dramatically
- Most farms were farrow to finish, now specialize for each life cycle stage:
 - Breed-to-wean
 - Bred/lactating sows and piglets from farrow to weaning (~12#)
 - Nursery
 - Pigs from weaning (~12#) to feeder weight (~50#)
 - Finishing
 - Feeder pigs from ~50# to market weight (~280#)
- Each type of unit has differing environmental requirements
 - Differing uses of electricity
 - Differing amounts of fuel for heating/ washing



Commercial Swine Barn Energy Monitoring

- First study of its kind to monitor **specific** electric loads
- Unique in that it parses out usage past the utility meter
- Baseline data collection and analysis
 - Electricity
 - Fuel (propane and natural gas)
 - Pig production
- Big questions:
- Where is energy being used in commercial swine barns?
 - What areas of energy use have potential to be reduced?
- How much electric and thermal energy goes into producing one pig?



Commercial Swine Barn Energy Monitoring

- Six units within an hour of Morris, MN
- Production units representative of Midwest pork production systems:
 - Two breed-to-wean barns
 - Two nursery barns
 - Two finishing barns



Photo Credit: Pig Progress



Photo Credit: www.gannett-cdn

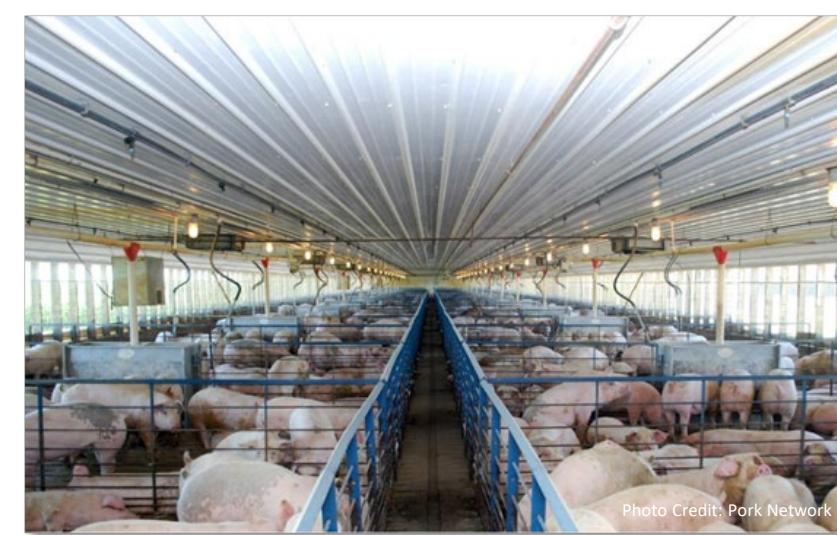


Photo Credit: Pork Network

- Where is electric energy being used within these units?

Electrical usage data collection

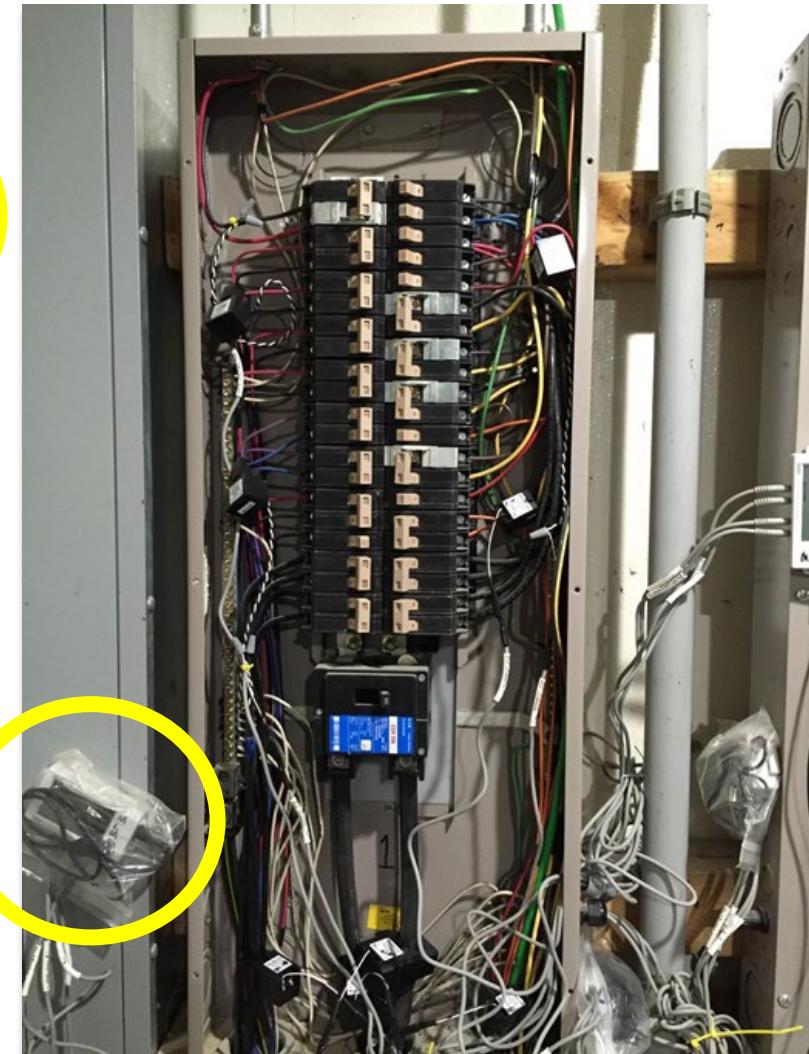
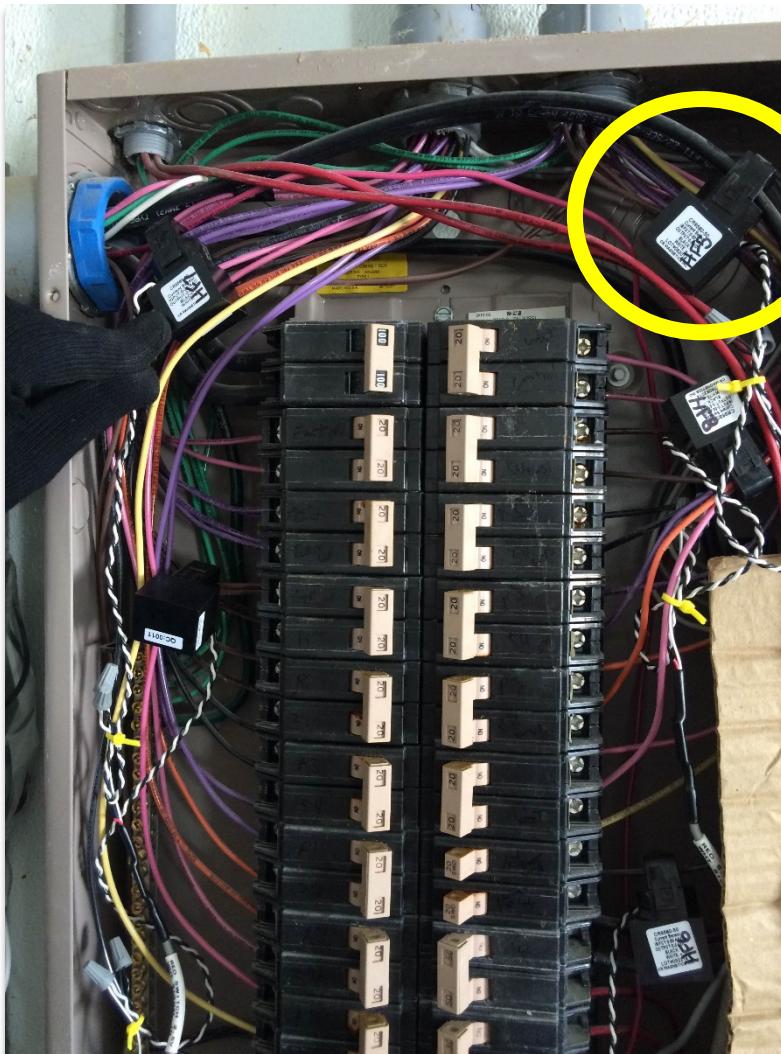
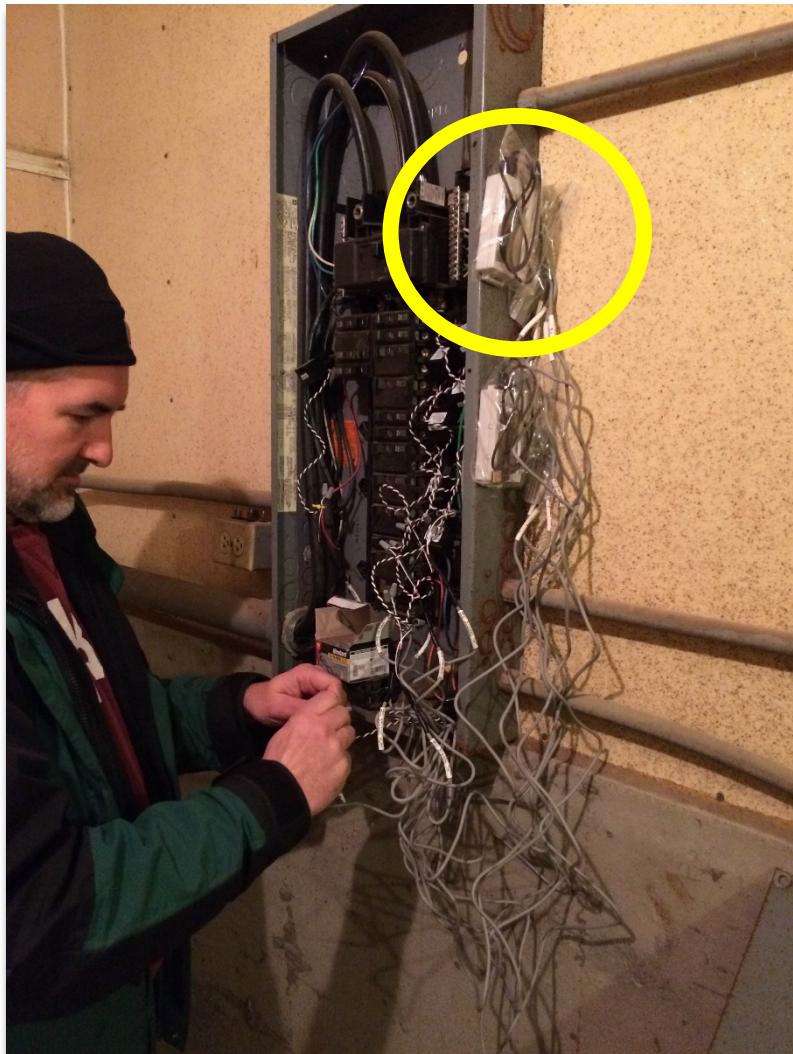
- Collected electric use of specific loads
 - Ex. pit fans, ventilation fans, heat lamps, pressure washers, lights, heaters, feedline augers, etc.
- Data loggers and sensors
 - Recorded and stored electrical use
 - Data were collected from each barn on a monthly basis



Photo Credit: KTS



Data loggers and sensors



Thermal (fuel) usage data collection

- Propane tank fills collected from producer
- Natural gas usage collected from natural gas utility



Breed-to-Wean Results (2015-2016)

- Breed-to-Wean Barn A

- ~2,500 sows
- Average 58,420 weaned pigs produced per year
- South Gestation unit curtain-sided
- North Gestation, farrowing rooms power-ventilated

- Breed-to-Wean Barn B

- ~3,300 sows
- Average 87,670 weaned pigs produced per year
- Gestation unit cross-ventilated
- Farrowing rooms power-ventilated

- Electrical use

- Average use 62,000 kWh/month
- **Average of 11.36 kWh per weaned pig**

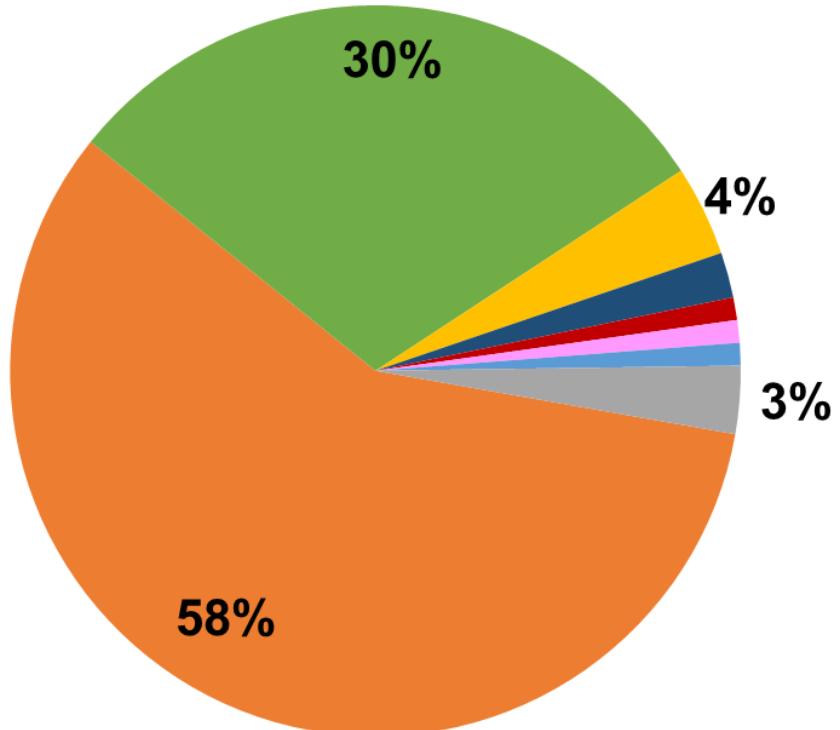
- Electrical use

- Average use 97,700 kWh/month
- **Average of 11.91 kWh per weaned pig**

Breed-to-Wean Electricity Use

Breed-to-Wean A

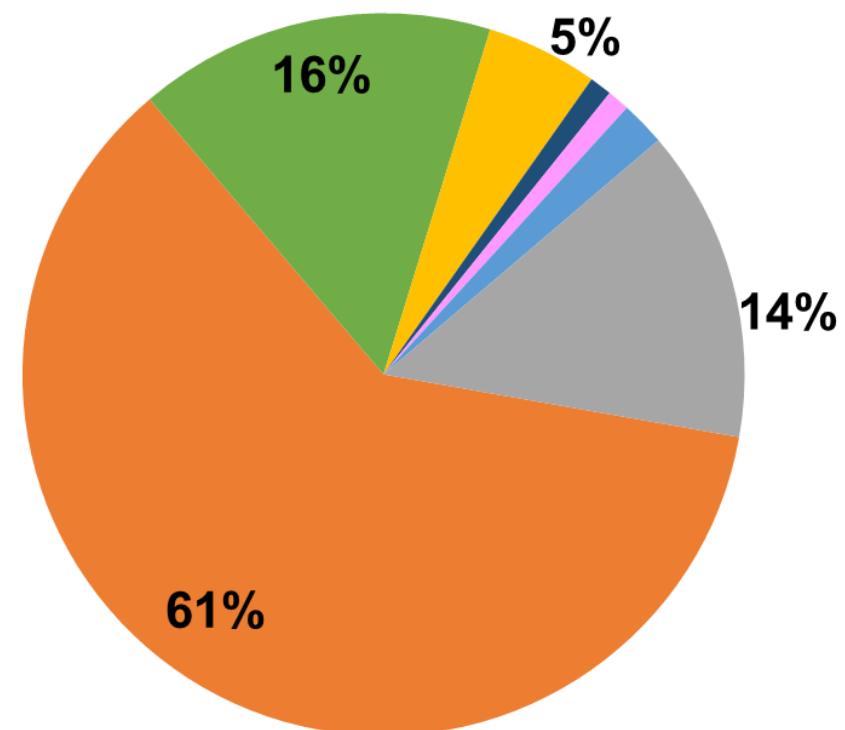
(663,371 kWh/yr)



- Heat Lamps
- Pressure Washers
- Well

Breed-to-Wean B

(1,044,265 kWh/yr)



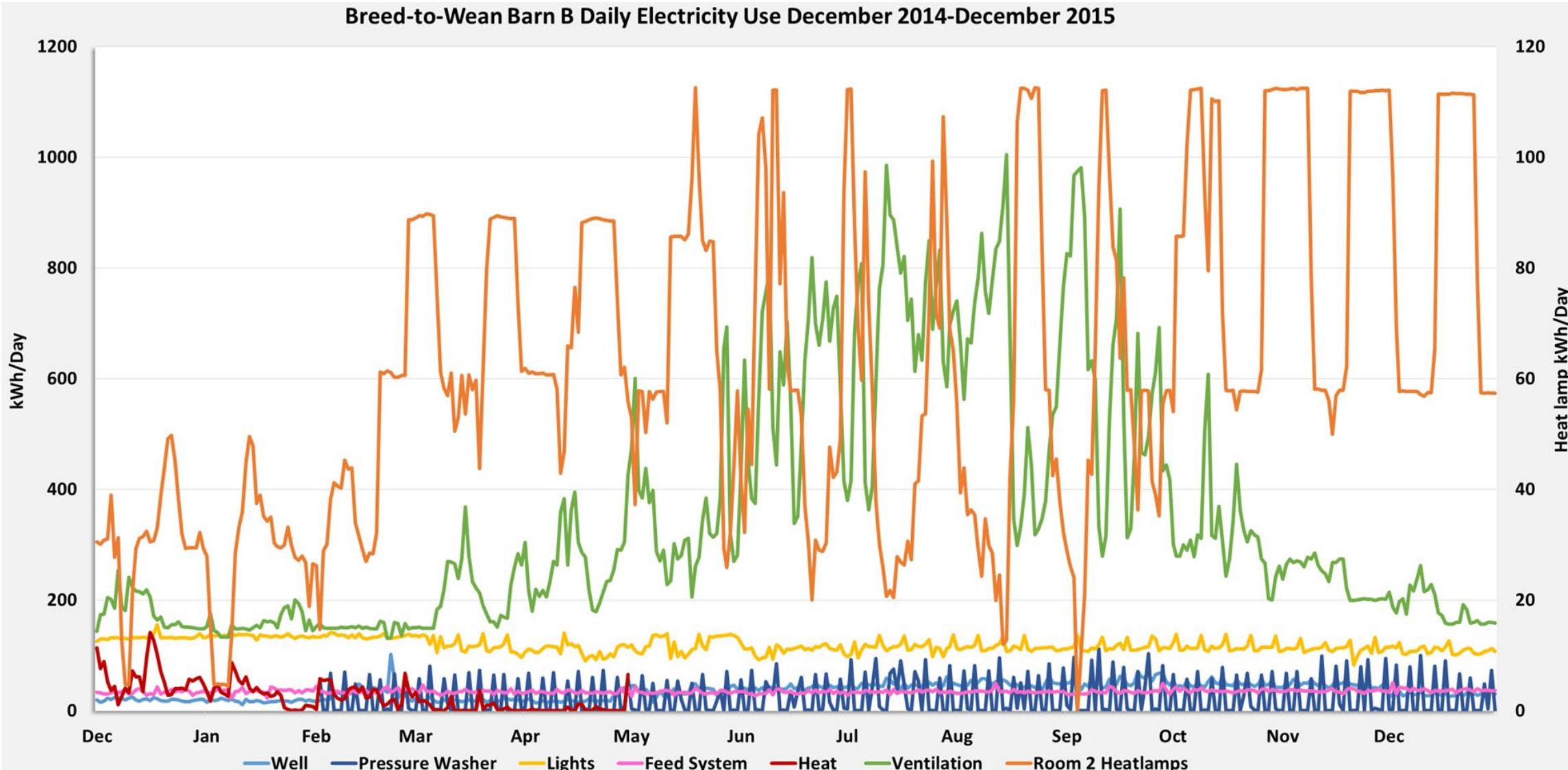
- Ventilation
- Heat
- Manure System

- Lights
- Feed System
- Miscellaneous



Breed-to-Wean Barn B Electricity

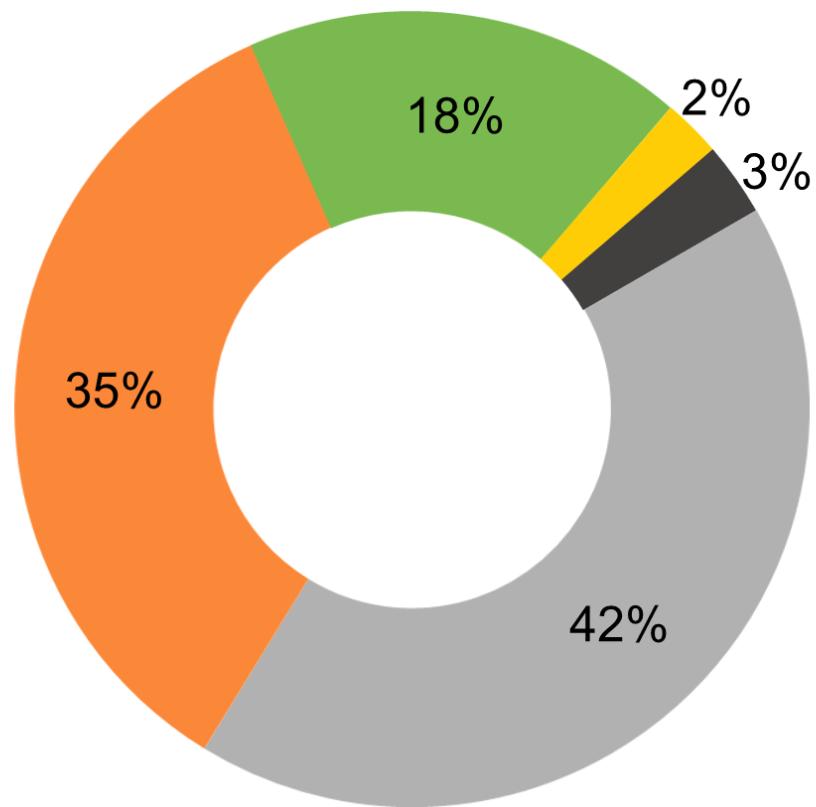
Breed-to-Wean Barn B Daily Electricity Use December 2014-December 2015



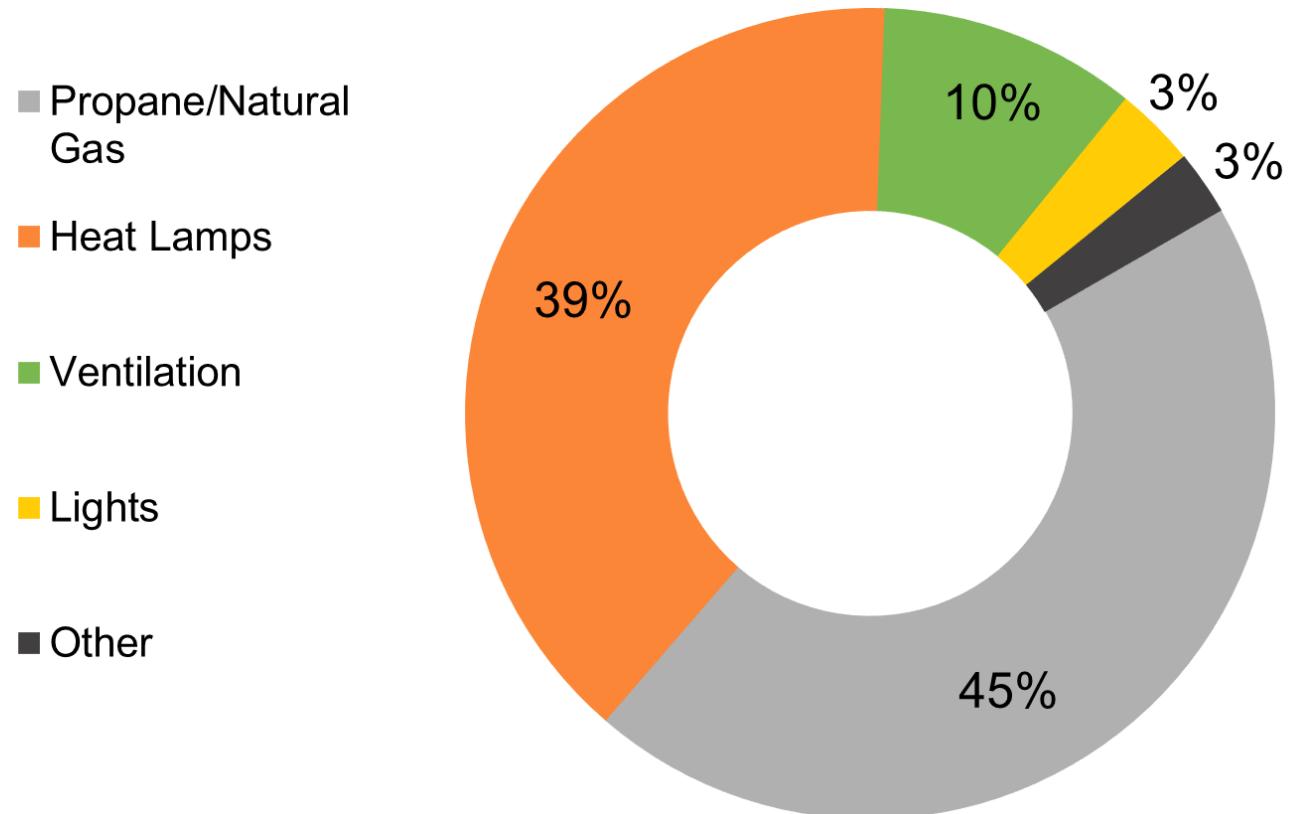
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Breed-to-Wean Total Energy Use

Breed-to-Wean Barn A
(3,285 MMBtu/yr)



Breed-to-Wean Barn B
(5,539 MMBtu/yr)



Nursery Results (2015-2016)

- Nursery Barn A

- ~3,000 head
- Average 19,100 feeder pigs produced per year
- Nursery rooms power-ventilated

- Electrical use:

- Average use 3,900 kWh/month
- **Average of 2.38 kWh per feeder pig**

- Nursery Barn B

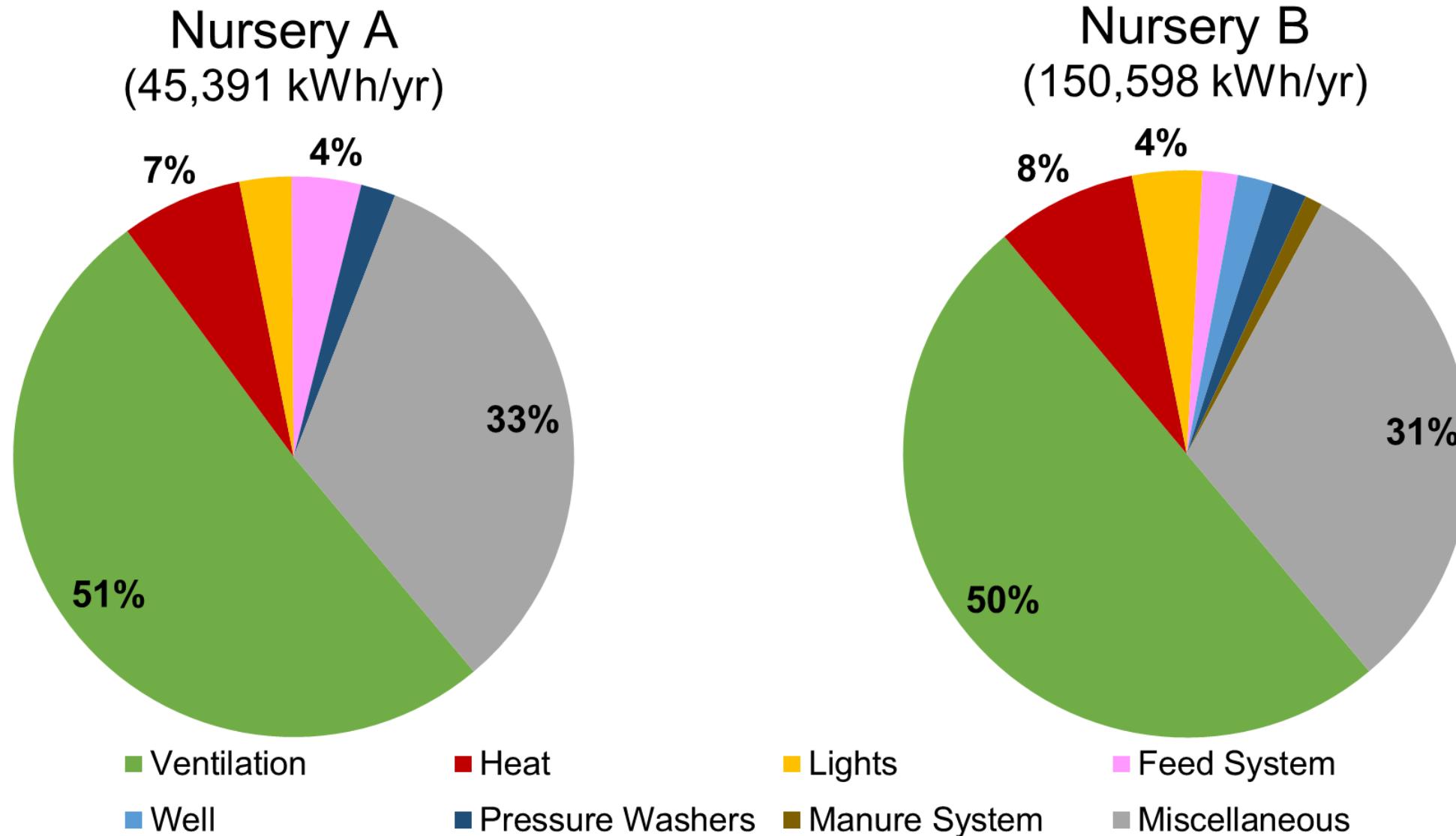
- ~12,000 head
- Average 71,650 feeder pigs produced per year
- Nursery rooms power-ventilated

- Electrical use

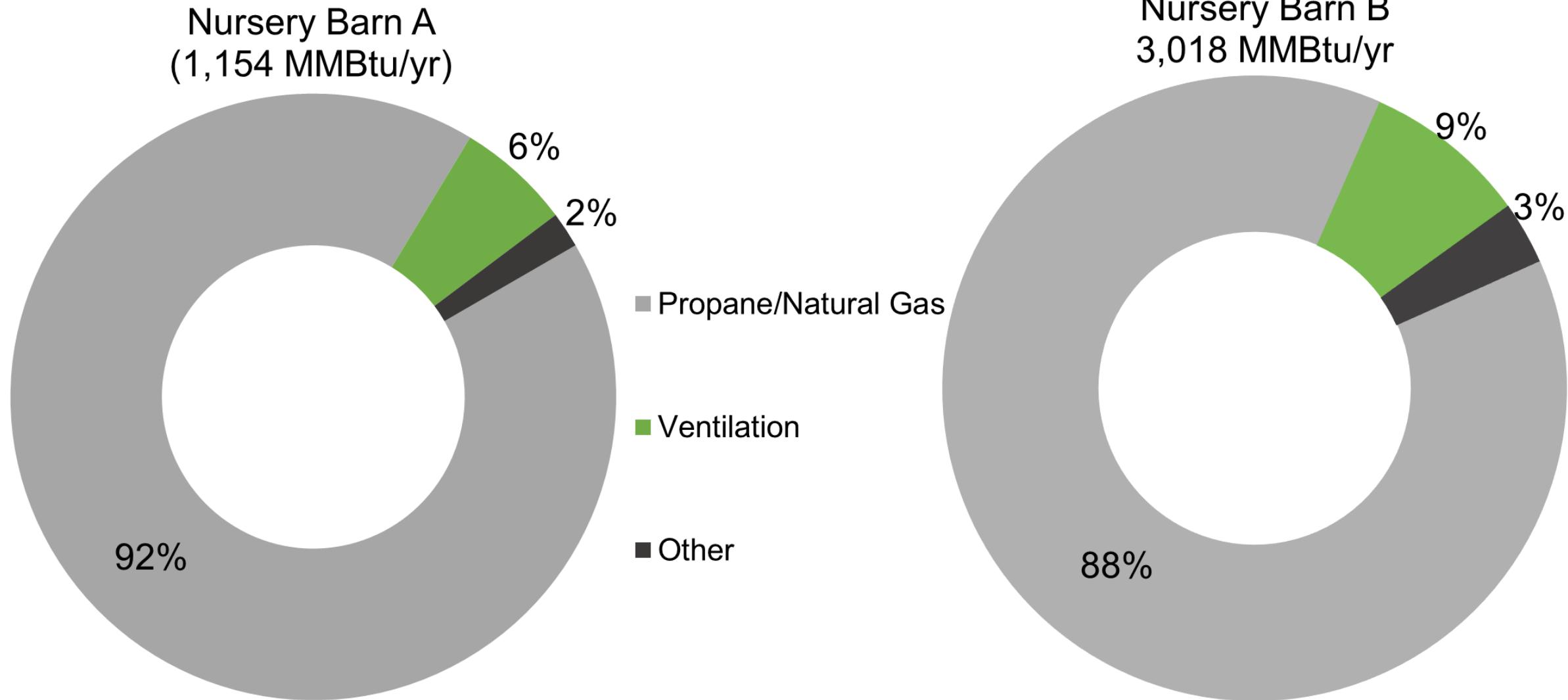
- Average use 12,650 kWh/month
- **Average of 2.10 kWh per feeder pig**



Nursery Electricity Use



Nursery Barn Total Energy Use



Finishing Results (2015-2016)

- Finishing Barn A

- ~2,400 head
- Average 6,300 market hogs produced per year
- Rooms are tunnel-ventilated

- Finishing Barn B

- ~1,060 head
- Average 2,800 market hogs produced per year
- Rooms are curtain-sided

- Electrical use

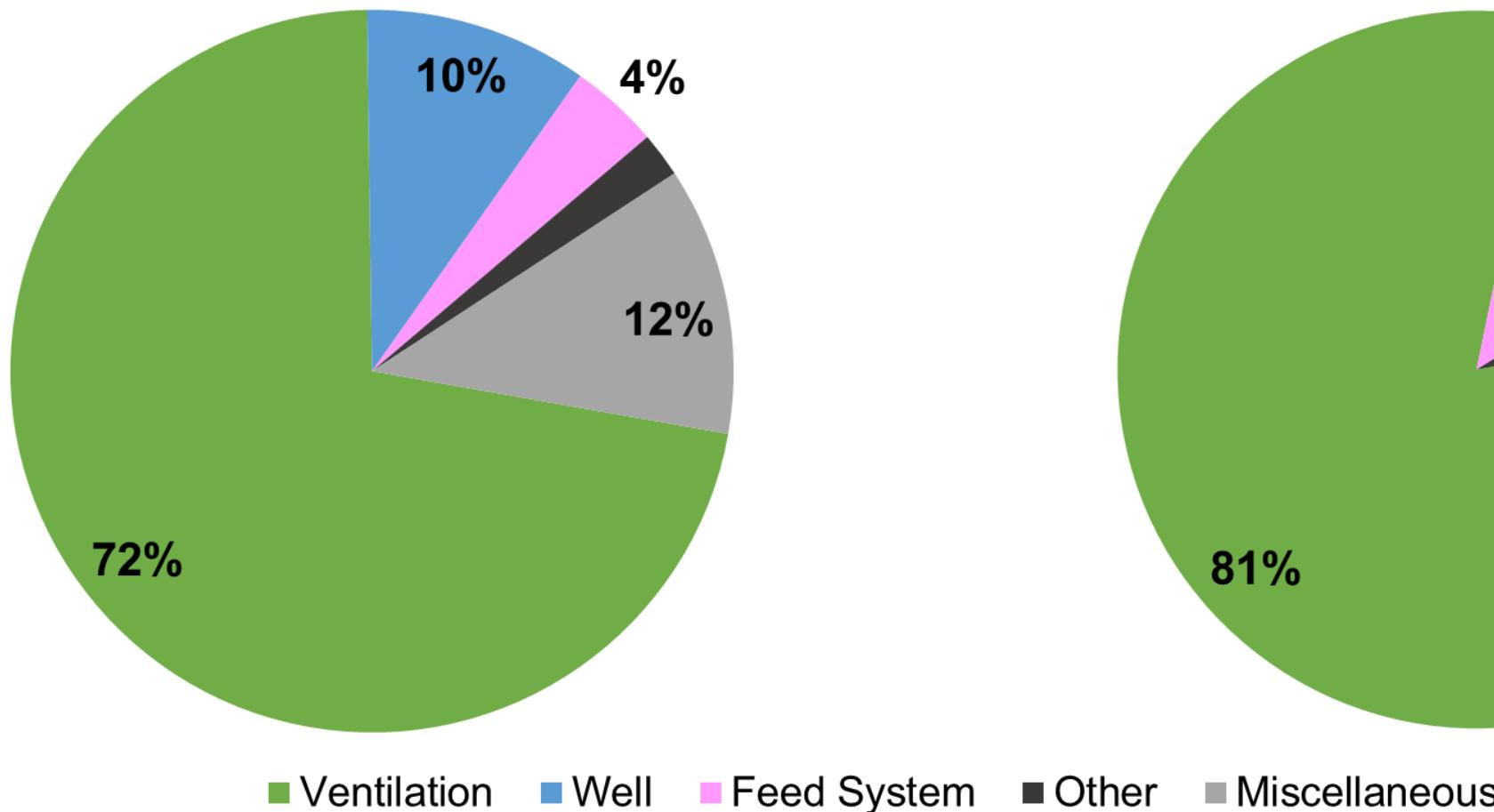
- Average use 7,300 kWh/month
- **Average of 14.40 kWh per finished pig**

- Electrical use

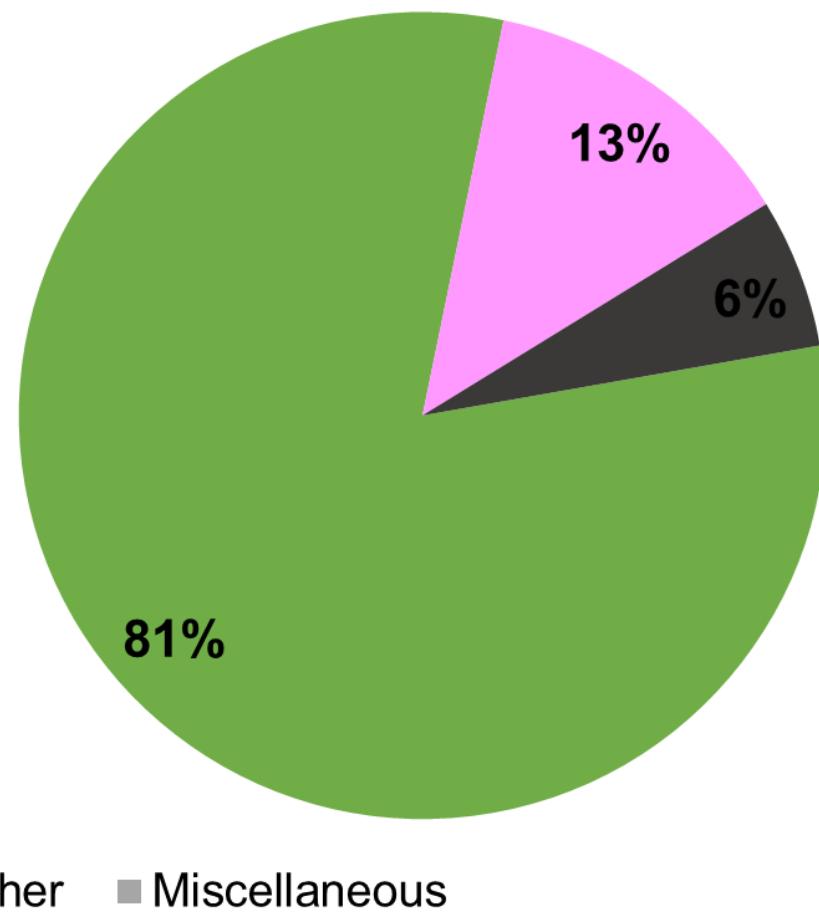
- Average use 900 kWh/month
- **Average of 4.12 kWh per finished pig**

Finishing Results

Finishing Barn A
(91,140 kWh/yr)



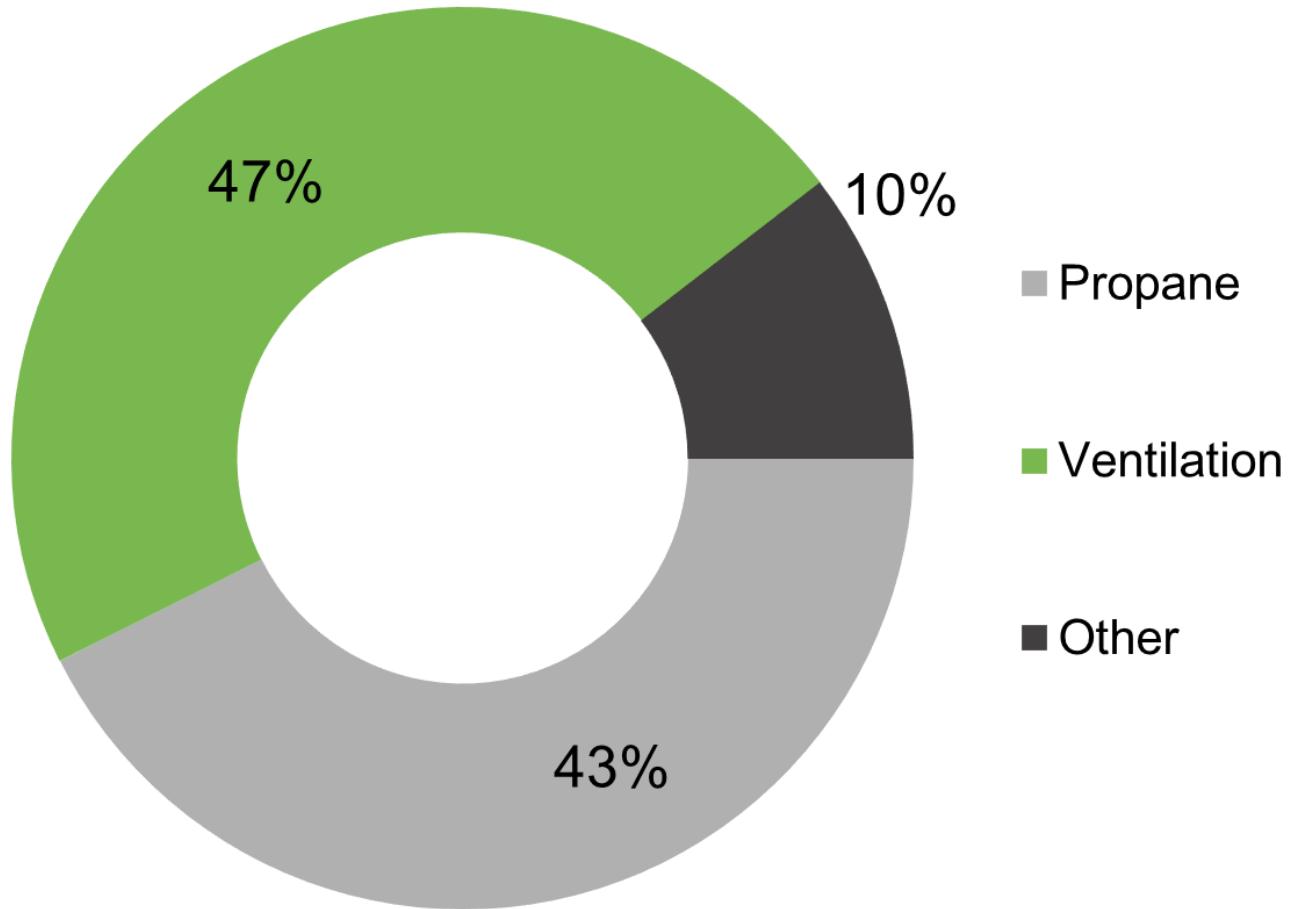
Finishing Barn B
(11,591 kWh/yr)



Finishing Barn Total Energy Use

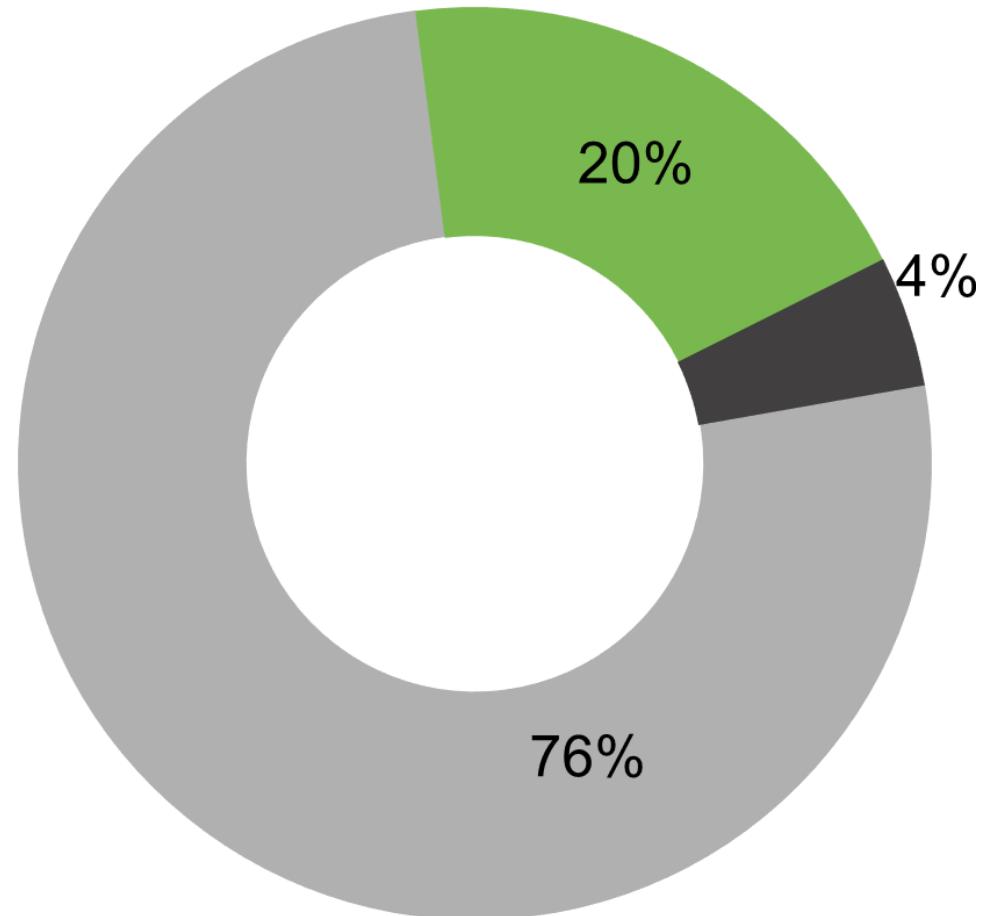
Finishing Barn A

(477 MMBtu/yr)

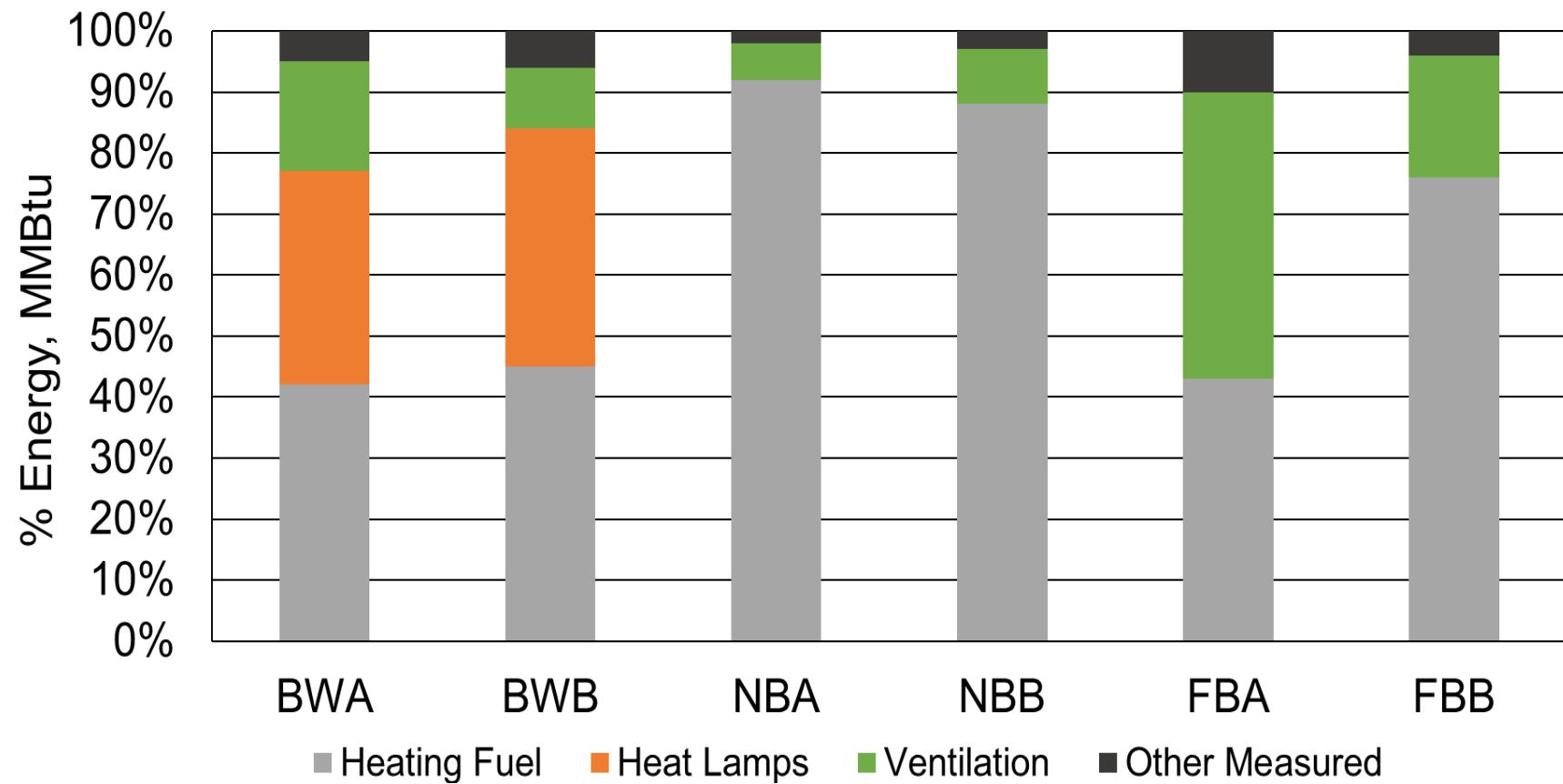
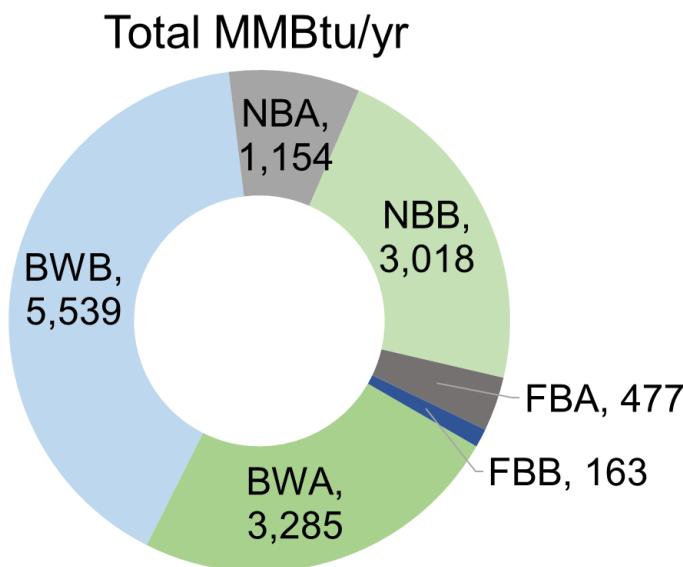


Finishing Barn B

(163 MMBtu/yr)



Total Energy Use



Results

Electric and Thermal Cost to Produce 1 Pig

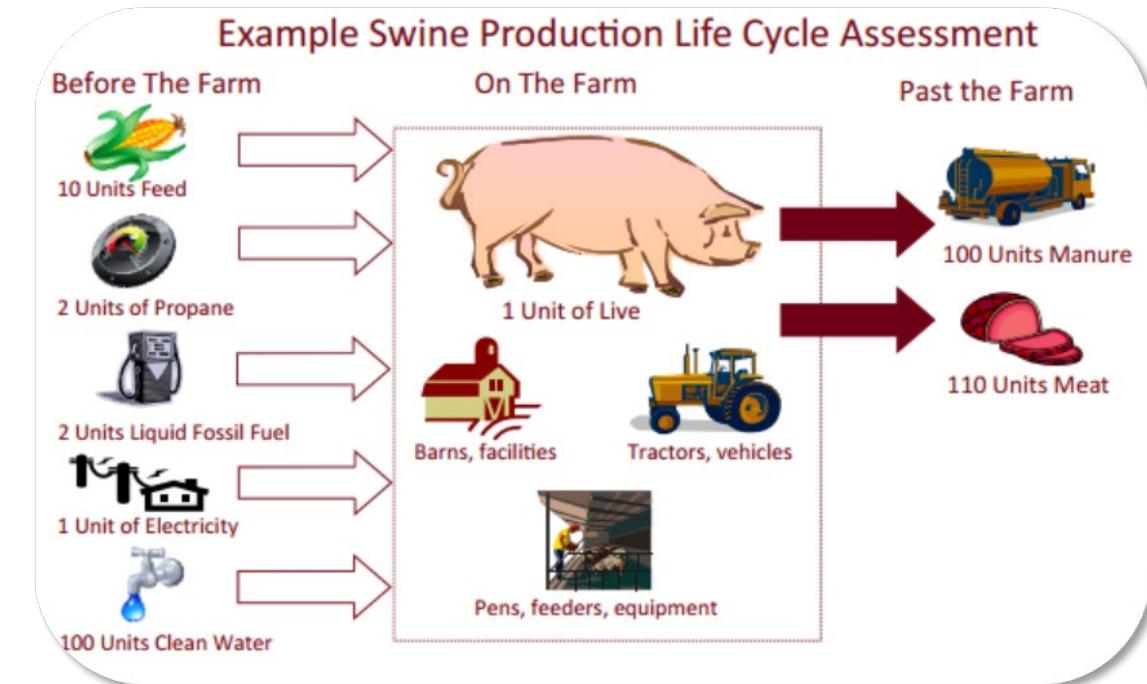
Barn	kWh/pig	Gallons of propane/pig	Therms of natural gas/pig	Total energy cost/pig
BWA	11.36	0.21	0.08	\$1.46
BWB	11.91	0.31	x	\$1.57
NBA	2.38	0.33	0.26	\$0.88
NBB	2.10	0.41	x	\$0.71
FBA	14.40	0.34	x	\$1.85
FBB	4.12	0.49	x	\$1.00

Discussion and Conclusions

- Results comparable to other industry measures:
 - Production system with 70,000 sows
 - Avg across all sows of 9.7 kWh/weaned pig (**11.6 kWh/pig**)
 - Units within system ranged from 5-12 kWh/weaned pig
 - 5 kWh/weaned pig system very efficient
 - Nursery (Brumm, 2015)
 - ~1.8 kWh per feeder pig (**2.2 kWh/pig**)
 - ~0.31 gal propane per feeder pig (**0.37 gal propane/pig**)
 - Tunnel-vented finisher (personal communication)
 - 11.2 kWh per finished pig (**14.4 kWh/pig**)
- Bottom line- confident our findings capture an accurate depiction of Midwest production units
- Findings point to areas within barns where there is potential to reduce usage

Application of Data

- Energy modeling of energy efficiency measures
 - LED lighting
 - Heat lamp controllers
 - Night temperature setbacks
 - Daylight harvesting (windows and light sensors)
- Life Cycle Assessment (LCA) input
- Producers have the tools to reduce fossil energy use:
 - More efficient piglet heating systems
 - Proper maintenance of ventilation systems
 - Reduced nocturnal temperatures (Johnston et al.)
 - Higher efficiency lighting
 - Renewables



Acknowledgements

- Participating producers
- Funding provided by the MN Environment and Natural Resources Trust Fund as recommended by the Legislative Citizen Commission on Minnesota Resources



Questions?

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