Electric and Thermal Energy Consumption in Commercial Swine Facilities

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University of MN's Research and Outreach Centers

- University of Minnesota College of Food, Agriculture, and Natural Resource Sciences (CFANS)

- 10 ROCs in MN
  - Agronomy, animal science, climate, forestry, horticulture, invasive species, natural resources, plant health, renewable energy, soils, water

- RESEARCH for the public

West Central Research and Outreach Center (WCROC)

- Applied research in:
  - Agronomy
  - Animal science
  - Horticulture
  - Organics
  - Renewable energy





WCROC and Renewable Energy

- **Consumers demanding products with less environmental impacts**

- Increase utilization of renewable energy in production agriculture and support its further development

- Research/demonstration of large/small scale systems
  - Are these systems feasible, applicable, and economical for producers?

- Energy conservation, optimization

“Greening of Agriculture” Initiative

- Overall goal to reduce fossil-fuel consumption in ag production systems

- Research and results for producers to use as a guide

- Three focus areas:
  - Crops
  - Dairy
  - **Swine**

Meeting our goals

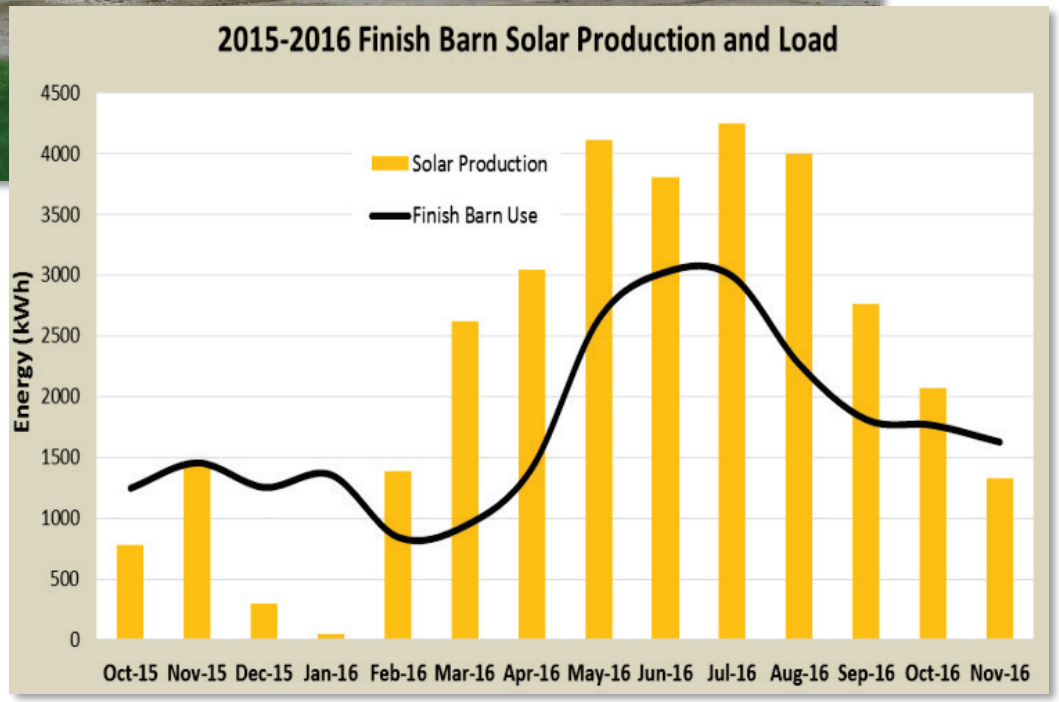
- Crops:
  - Cover crops
  - Organic
  - Livestock
- Dairy- net-zero goal:
  - Scroll compressor, plate cooler, VFD
  - Solar thermal
  - 50 kW PV
  - 2, 10 kW wind turbines (one with 4 kW PV)
  - 2 Polaris electric UTVs
  - Electric Chevy Bolt
  - Fast charger
  - More RE installments this summer

Greening of Ag- Swine

- At the WCROC:

- Renewable energy generation
- LED retrofit

- In the industry:
- Commercial barn energy monitoring



Solar Cooling of Sows

- Heat stress on sows
- 20 kW array
  - Powers chiller in farrowing barn
- Cool water (70˚F) circulated to Nooyen cooling pads
- Cool water (55˚F) supplied for drinking
  - Evidence lower water temps can increase feed intake
- Preliminary data shows reduced body temperatures and lower breathing rate

Commercial swine barn energy monitoring

- How much electric and thermal energy goes into producing one pig?

- Where and how is energy being used within each phase of production?
  - Breed-to-wean, nursery, finishing

- Each phase has different environmental requirements
  - Electricity uses
  - Amounts of fuel

- First study to monitor **specific** electrical loads

Commercial swine barn energy monitoring

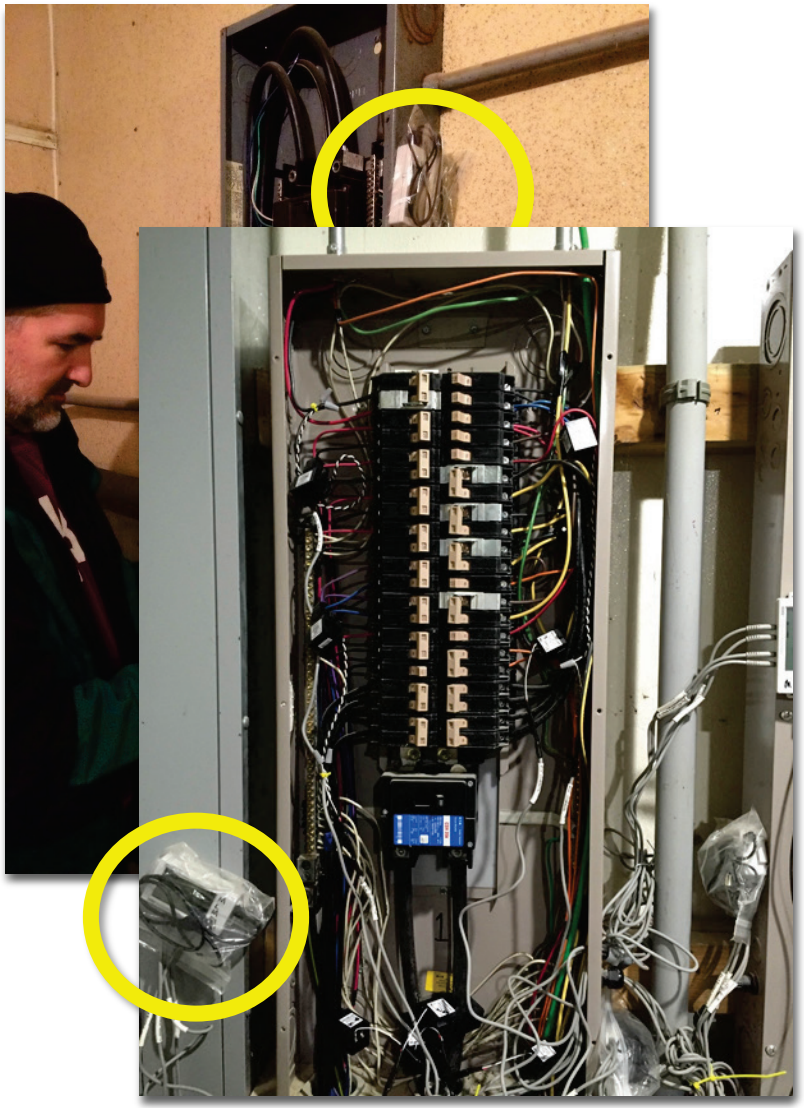
- Six barns within an hour of Morris, MN

- Production barns representative of Midwest pork production systems:
  - Two breed-to-wean barns (BWA and BWB)
  - Two nurseries (NBA and NBB)
  - Two finishers (FBA and FBB)

- Baseline data collection and analysis
  - Electricity
  - Fuel (propane)
  - Pig production

Data collection

- Electricity usage of specific loads
  - Ex. pit fans, heat lamps, pressure washers, lights, etc.
- HOBO Data loggers and sensors
- Propane tank fills collected from producer

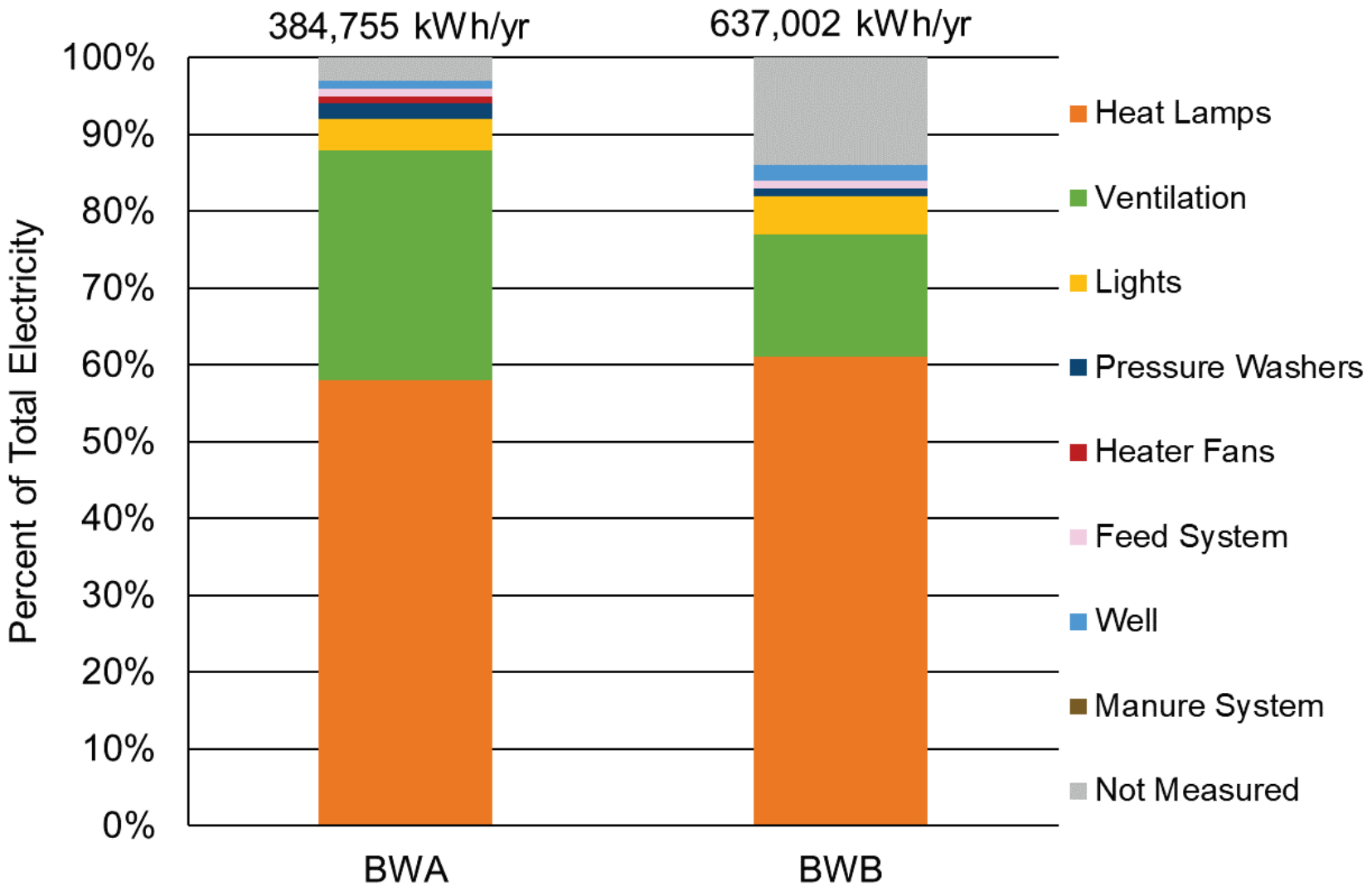


Breed-to-Wean Results

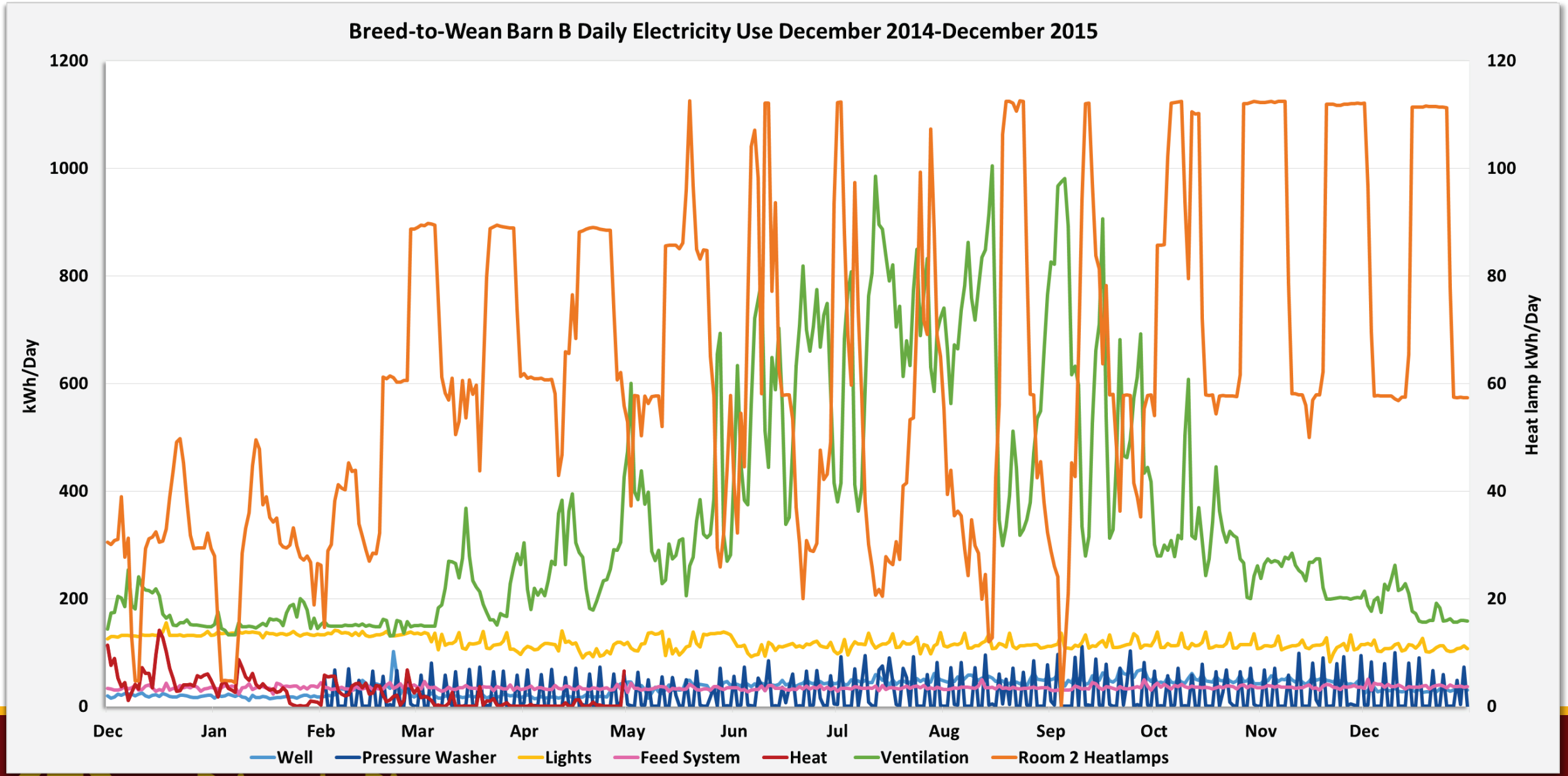
- Breed-to-Wean Barn A
  - ~2,500 sows
  - Average 58,420 weaned pigs produced per year
  - South Gestation unit curtain-sided
  - North Gestation, farrowing rooms power-ventilated
- Electrical use (2015-2016)
  - Average use 62,000 kWh/month
  - **Average of 11.36 kWh per weaned pig**

- 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 (2015-2016)
  - Average use 97,700 kWh/month
  - **Average of 11.91 kWh per weaned pig**

Breed-to-Wean Results



Breed-to-Wean Barn B

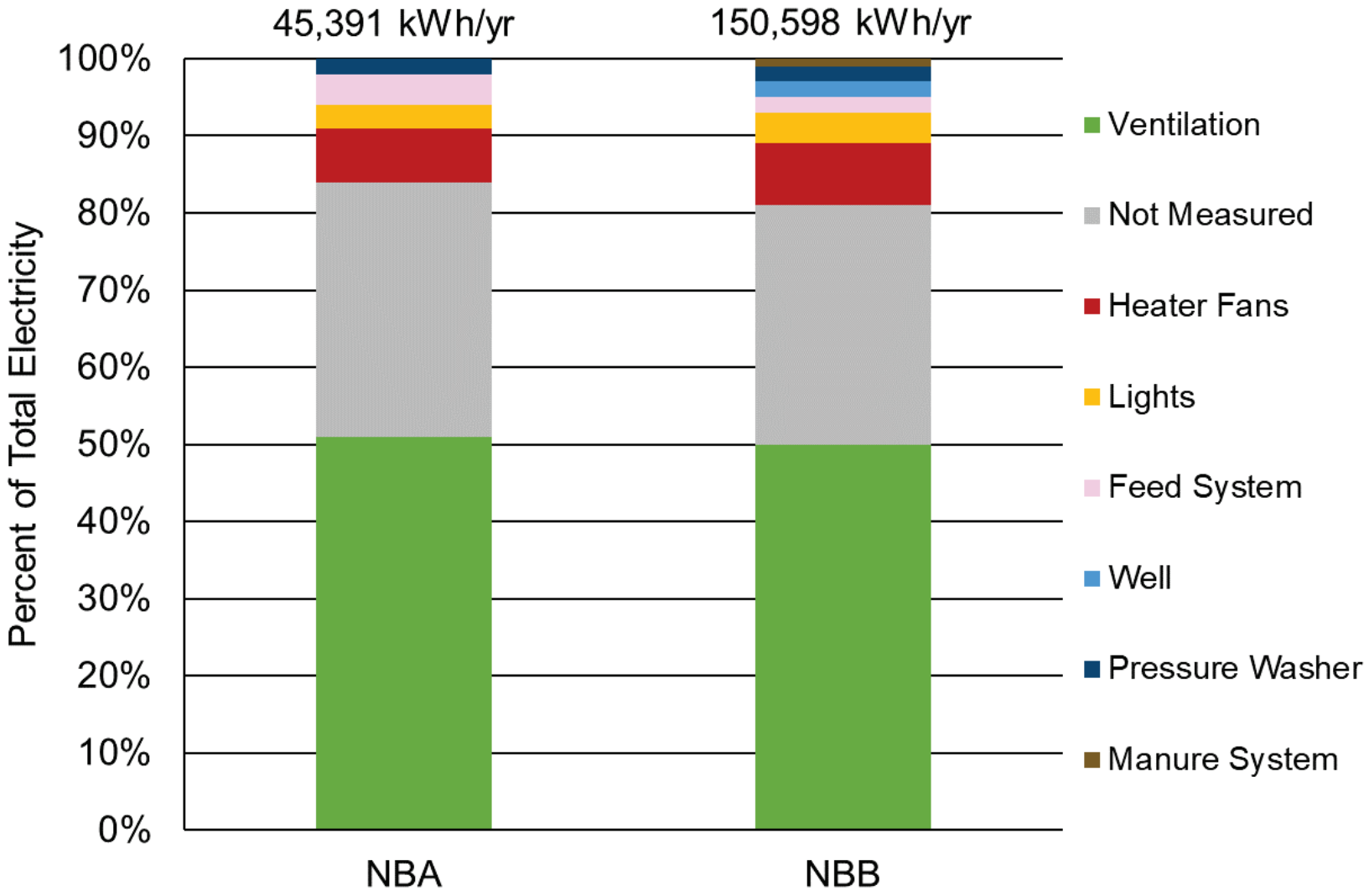


Nursery Results

- Nursery Barn A
  - ~3,000 head
  - Average 19,100 feeder pigs produced per year
  - Nursery rooms power-ventilated
- Electrical use (2015-2016)
  - 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 (2015-2016)
  - Average use 12,650 kWh/month
  - **Average of 2.10 kWh per feeder pig**

Nursery Results

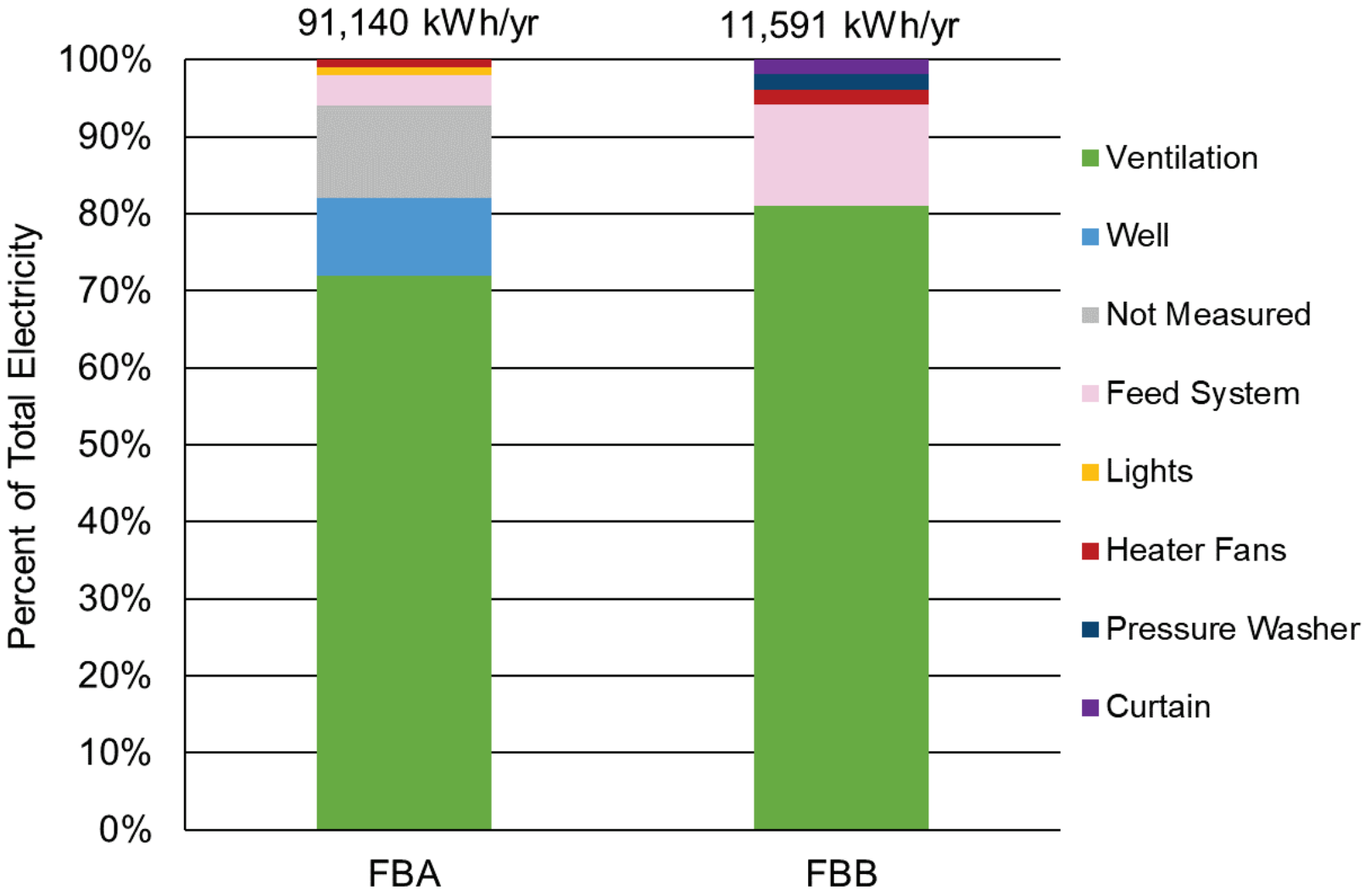


Finishing Results

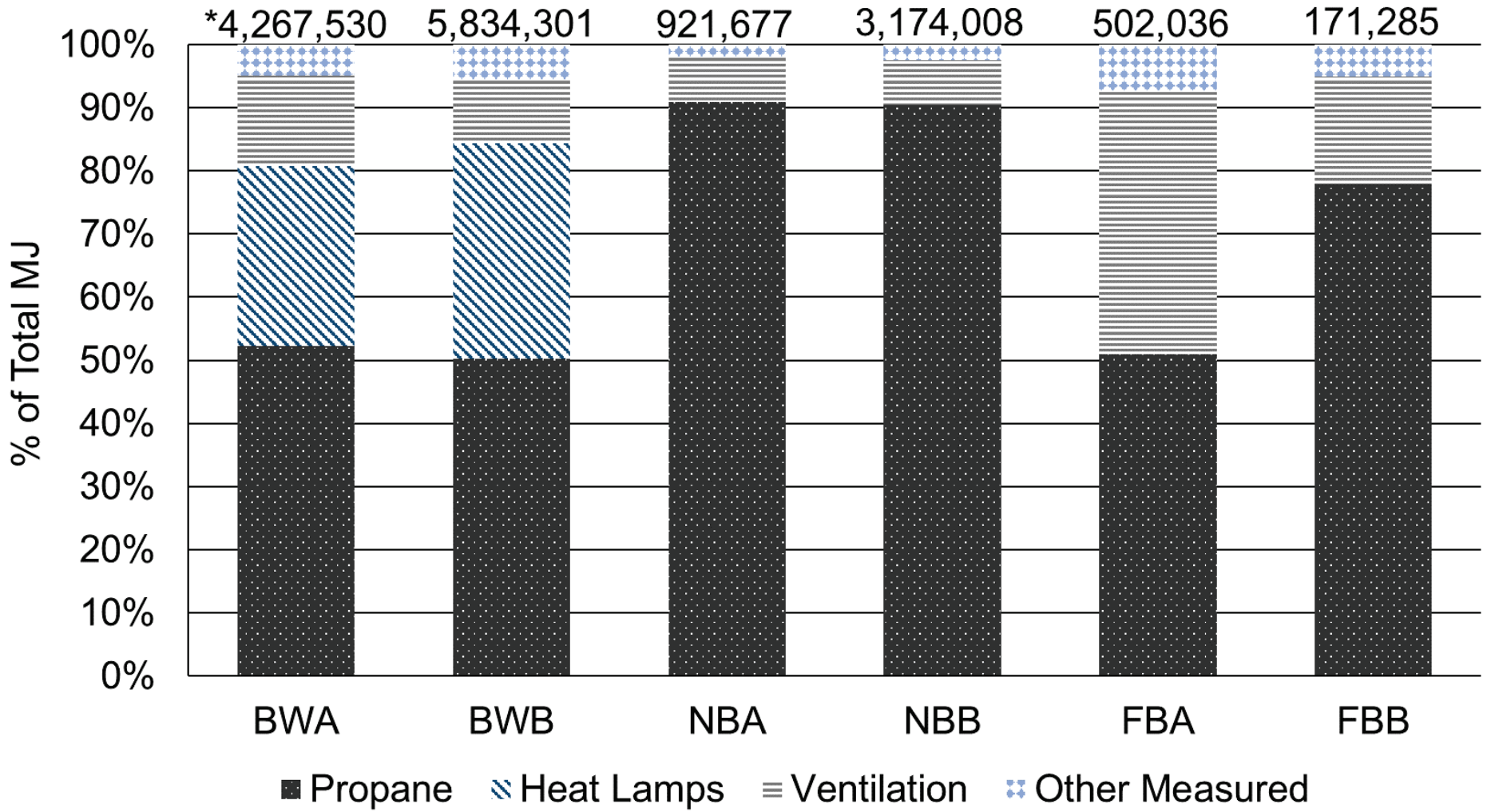
- Finishing Barn A
  - ~2,400 head
  - Average 6,300 market hogs produced per year
  - Rooms are tunnel-ventilated
- Electrical use (2015-2016)
  - Average use 7,300 kWh/month
  - **Average of 14.40 kWh per finished pig**

- Finishing Barn B
  - ~1,060 head
  - Average 2,800 market hogs produced per year
  - Rooms are curtain-sided
- Electrical use (2015-2016)
  - Average use 900 kWh/month
  - **Average of 4.12 kWh per finished pig**

Finishing Results



Total annual electrical and thermal energy use



*Total MJ of energy used annually by each barn.

Conclusions

- Results comparable to other industry measures:
  - Unpublished data from a system with 70,000 sows:
    - Avg across all sows 9.7 kWh/weaned pig
    - Barns within system ranged from 5-12 kWh/pig
  - Nursery (Brumm, 2015):
    - ~1.8 kWh per feeder pig
    - ~0.31 gal lp per feeder pig
  - Unpublished data from a tunnel-ventilated finisher:
    - 11.2 kWh per market hog

Our findings:		
Barn	kWh/pig	Gal. lp/pig
BWA	11.36	0.34
BWB	11.91	0.31
NBA	2.38	0.43
NBB	2.1	0.41
FBA	14.4	0.34
FBB	4.12	0.49

Summary

- Consumers and market chains will likely continue demanding:
  - Reduced carbon footprint
  - More environmental sustainability
- Approaches for producers to meet consumer demands
- Producers have the tools to reduce fossil fuel use on the farm:
  - More efficient piglet heating systems
  - Improved ventilation systems/ better maintenance!
  - Reduced nocturnal temperatures for nursery and finishing? (Johnston et al)
  - Higher efficiency lighting
  - Renewables on the farm

Acknowledgements

- Participating producers

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Questions?