

Energy Consumption on Minnesota Dairy Farms

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WCROC Existing Dairy

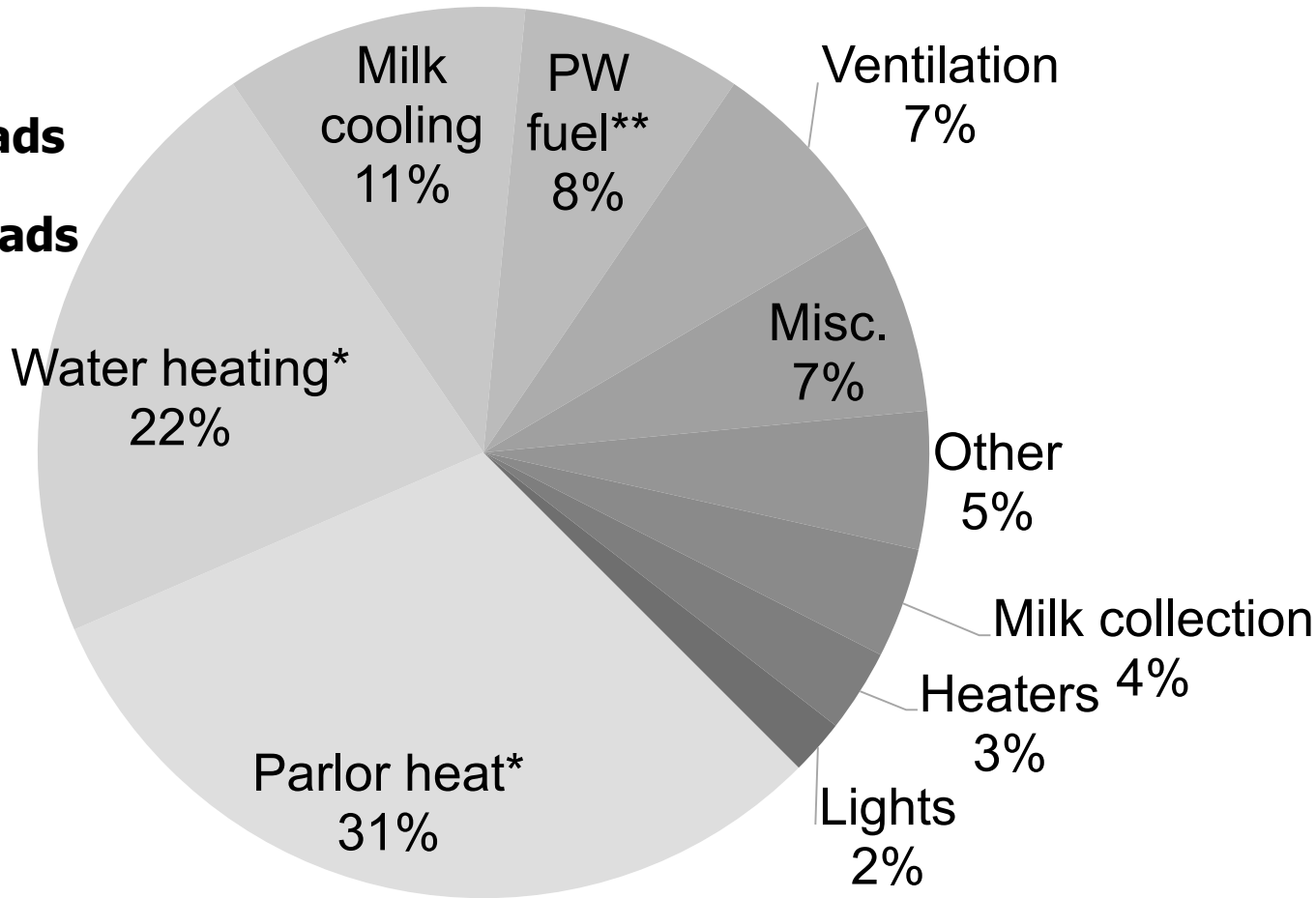
- **WCROC Dairy milks about 250 cows twice/day**
 - **Typical of a medium sized Minnesota dairy farm**
 - **Average 12,000 lbs/day milk**
 - **7,500 lbs/day conventional**
 - **4,500 lbs/day organic**



% of Total Energy Use (2,650 MJ/day)

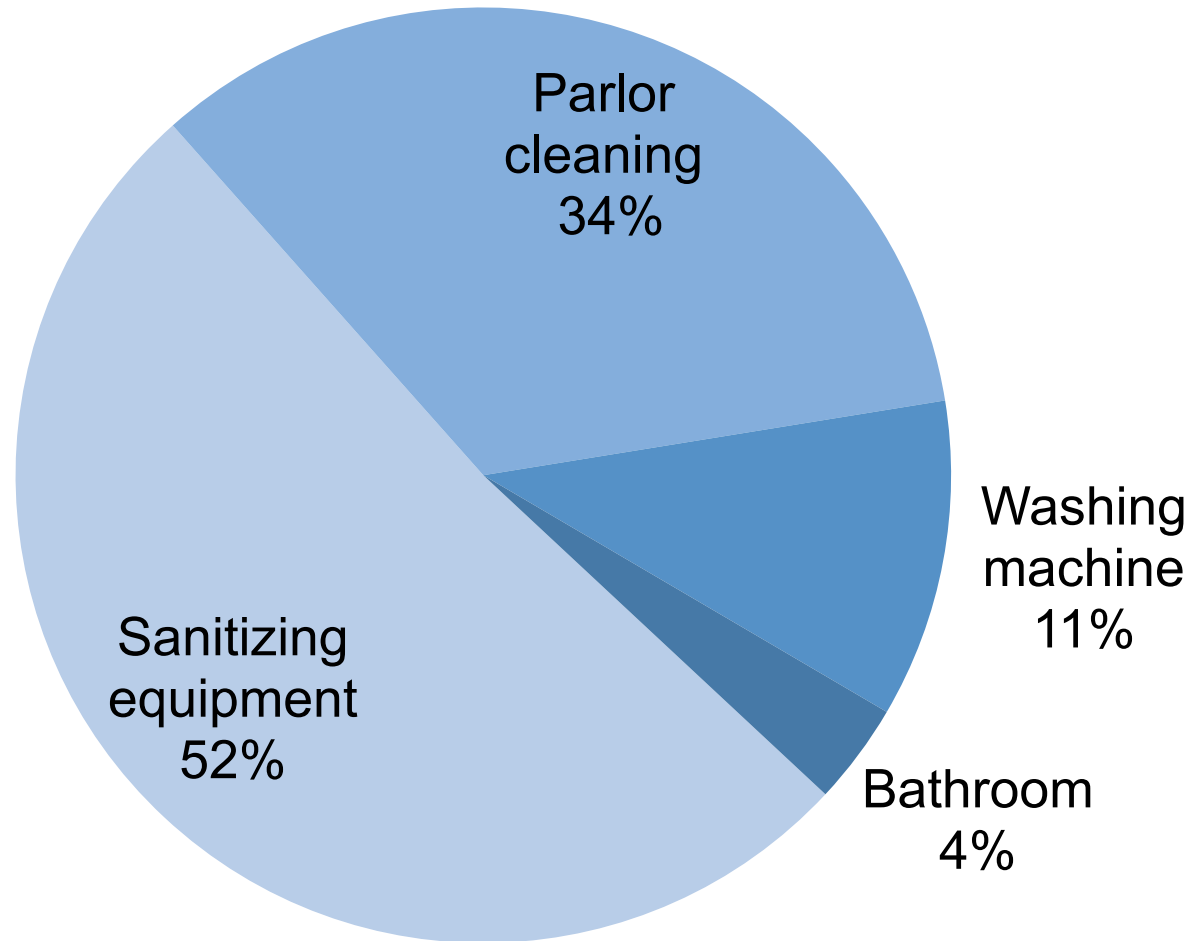
*Natural gas loads

**Diesel fuel loads



Water Usage

- 1,877,287 L/yr
- 2,103 L/day
- 1.39 L/kg milk



WCROC Conclusions

- **Milking is energy intensive**
 - **We use $\approx 110,000$ kWh/yr; $\Rightarrow 440$ kWh/cow/yr**
 - 3.5 kWh/cwt milk (~ 12 gal)
 - 300 kWh/day \Rightarrow \$30/day
 - **We use ≈ 4500 therms/yr of nat. gas ; $\Rightarrow 21$ therms/cow/yr**
 - 14 therms per day for furnace and water heater \Rightarrow \$11/day
 - **We use $\approx 220,000$ gal of hot H₂O /yr; $\Rightarrow 900$ gal/cow/yr**
 - 600 gallons of hot H₂O/day \Rightarrow 2.5 gpd hot H₂O (6 gpd total)/cow
 - Does NOT include drinking water
 - Hot water heated to $>160^\circ\text{F}$ to sanitize lines

Generation, Storage, and Utilization of Solar Energy



Project Objectives

- **Design and evaluate solar systems and battery storage for dairy facilities**
- **Evaluate shade potential of solar systems for dairy cattle**
- **Audit energy consumption on Minnesota dairy farms**
- **Field test electric vehicles**
- **Educate consumers, industry representatives, dairy producers and the general public to generate, store, and utilize electricity from solar energy technologies**



Farms

4 commercial freestall dairies in West Central MN

Farm A

- 9,500 cows
- Cross-ventilated barn
- 106 stall rotary parlor
- Built in 2017
- 12 truckloads of milk per day



Farm B

- 300 cows
- Naturally ventilated barn
- 6 Lely milking robots since 2016



Farms, continued

4 commercial freestall dairies in West Central MN

Farm C

- 200 cows
- Naturally ventilated barn
- Double-eight herringbone parlor
- 20% of milk diverted to on-site creamery

Farm D

- 400 cows
- Naturally ventilated barn
- Double-eight herringbone parlor
- Manure composting system
- In the process of transitioning to AMS

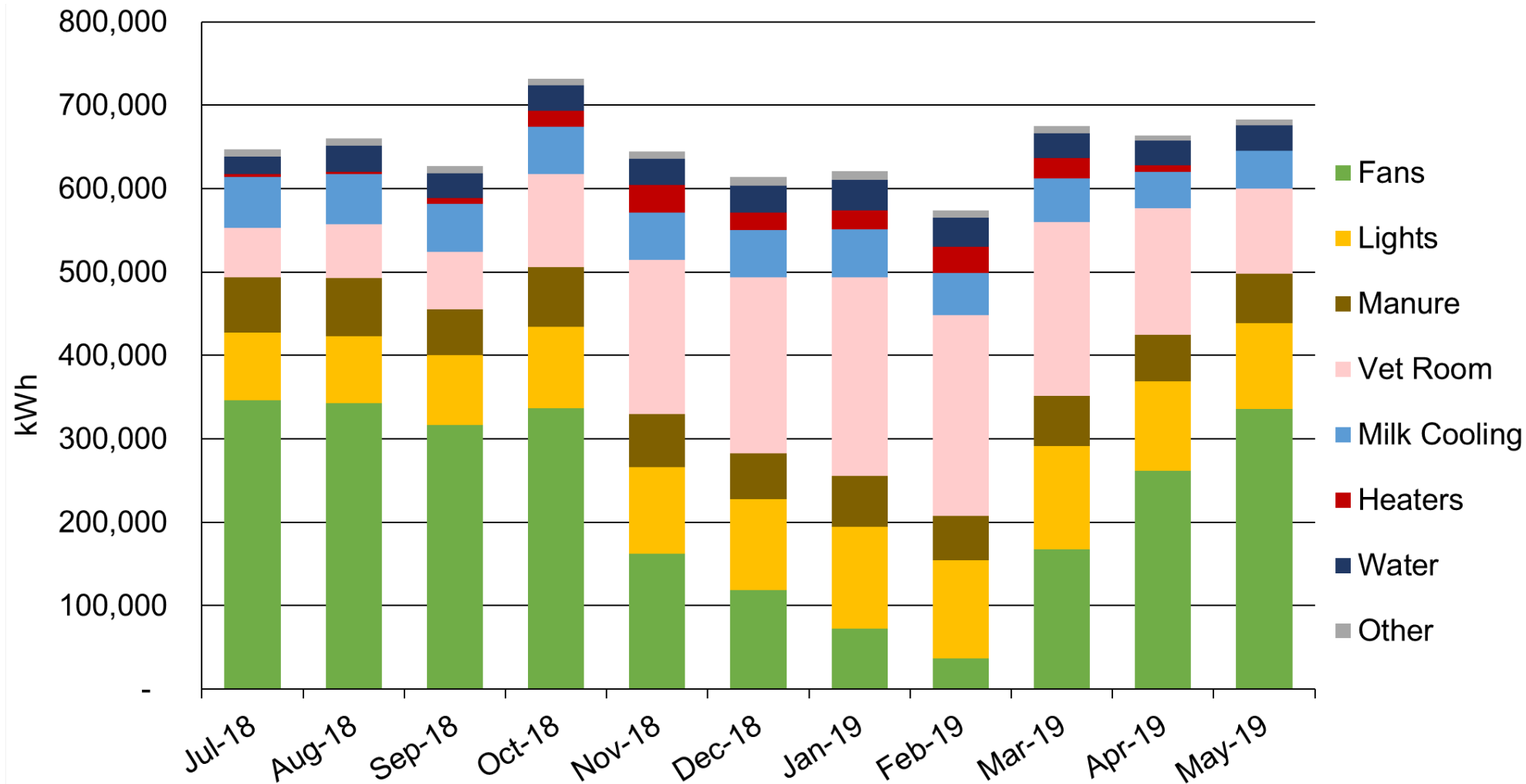


Data Collection

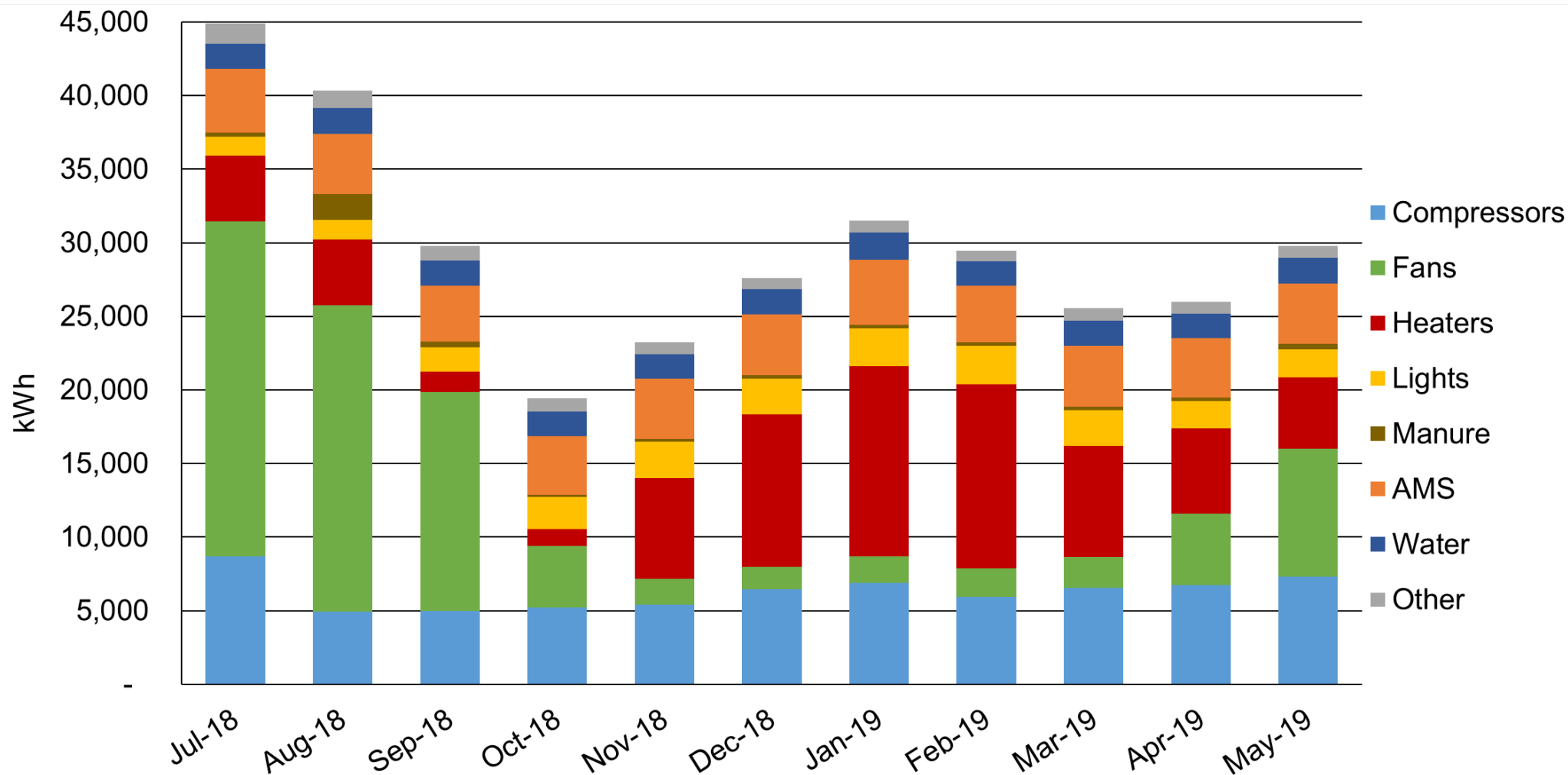
- **Baseline electricity usage of specific loads**
 - **Ex.: lights, fans, heaters**
- **Data loggers (eGauge) and sensors installed within circuit panels**
 - **292 total electrical loads**
- **Data were collected from July 2018 to May 2019**
 - **1 minute data were downloaded once per month**



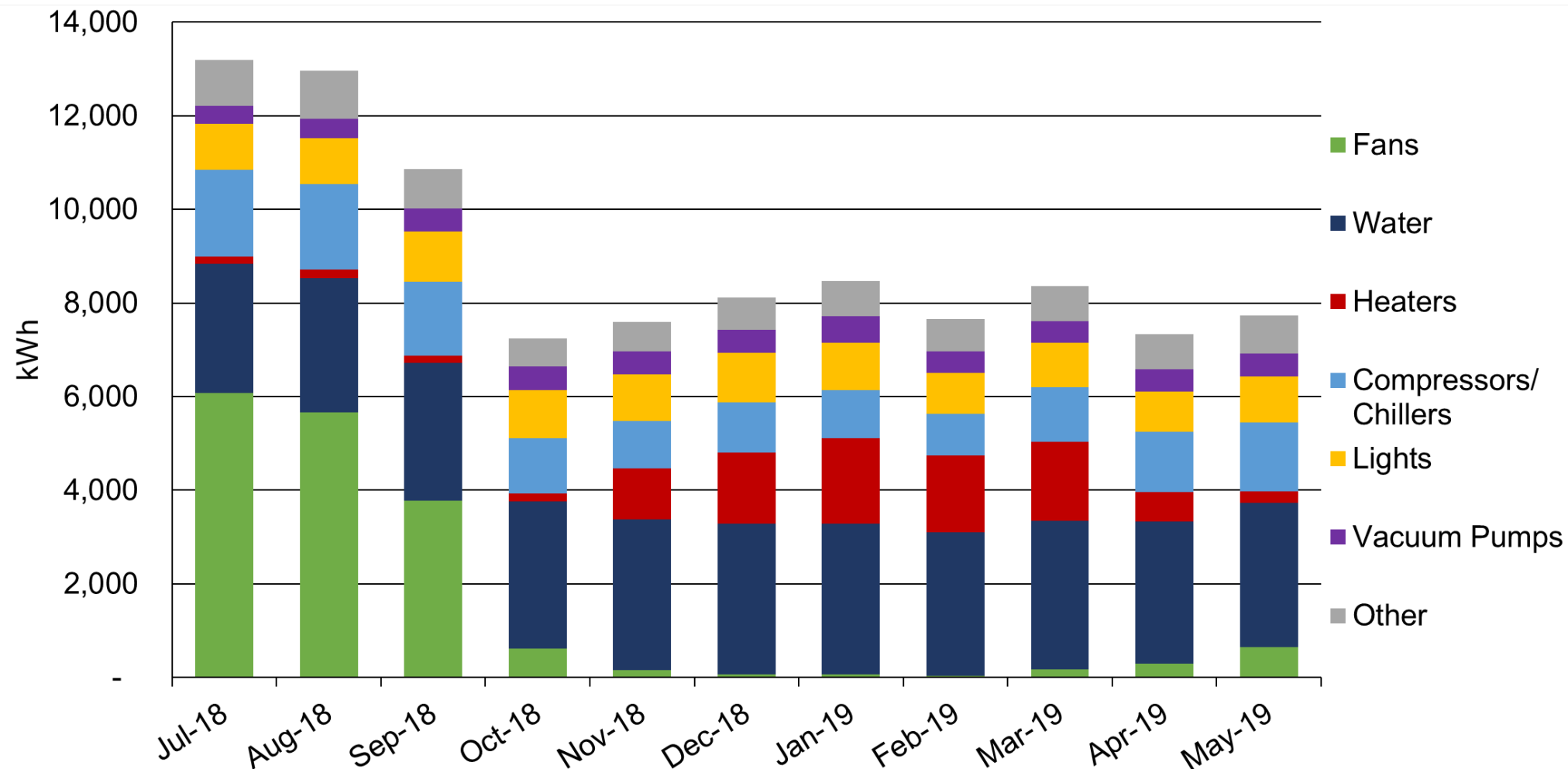
Farm A Total kWh/month



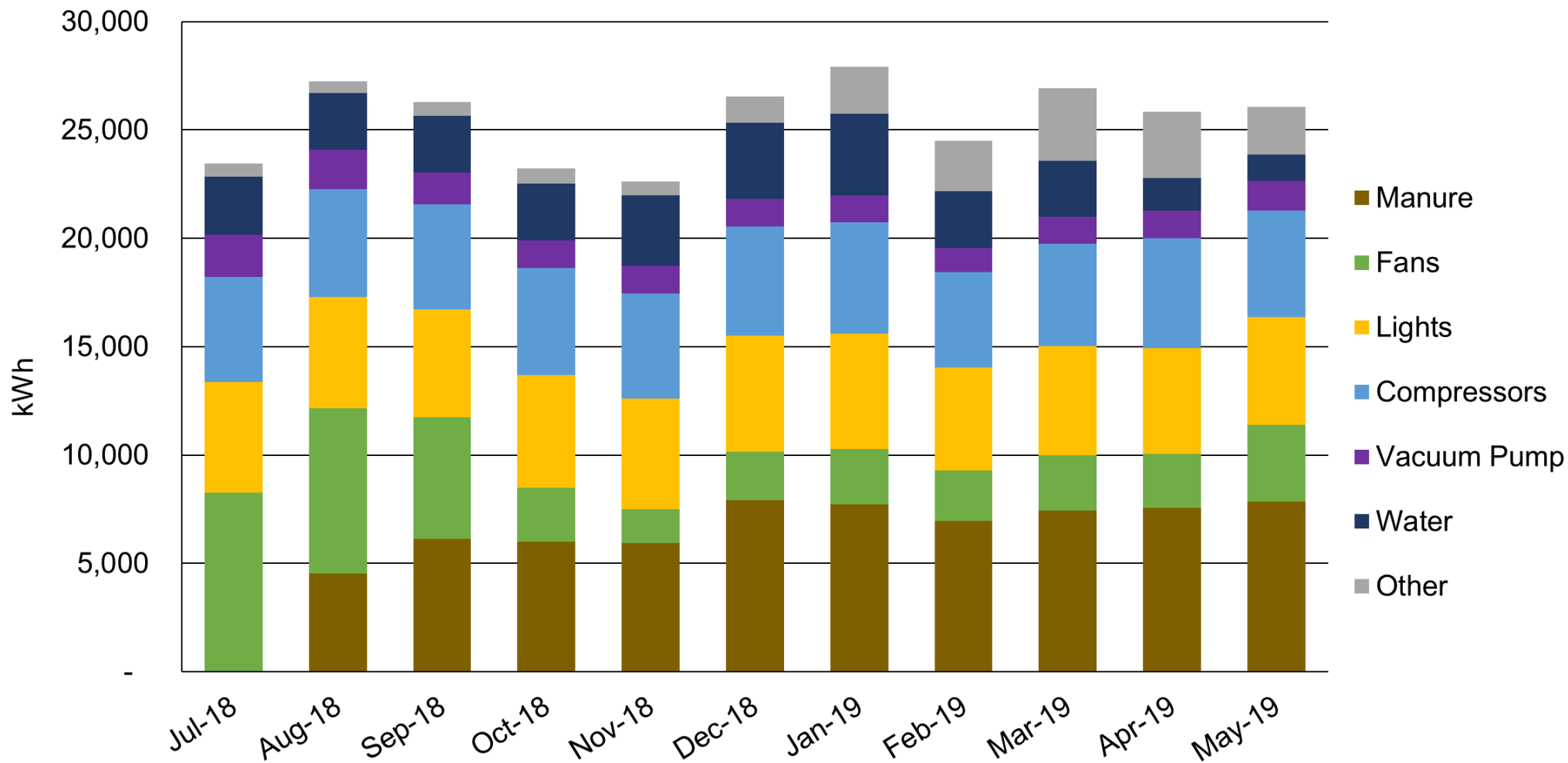
Farm B Total kWh/month



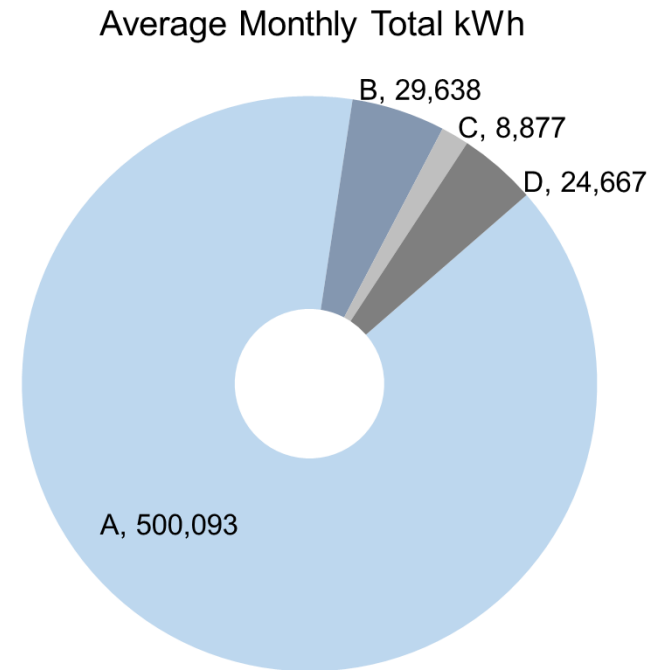
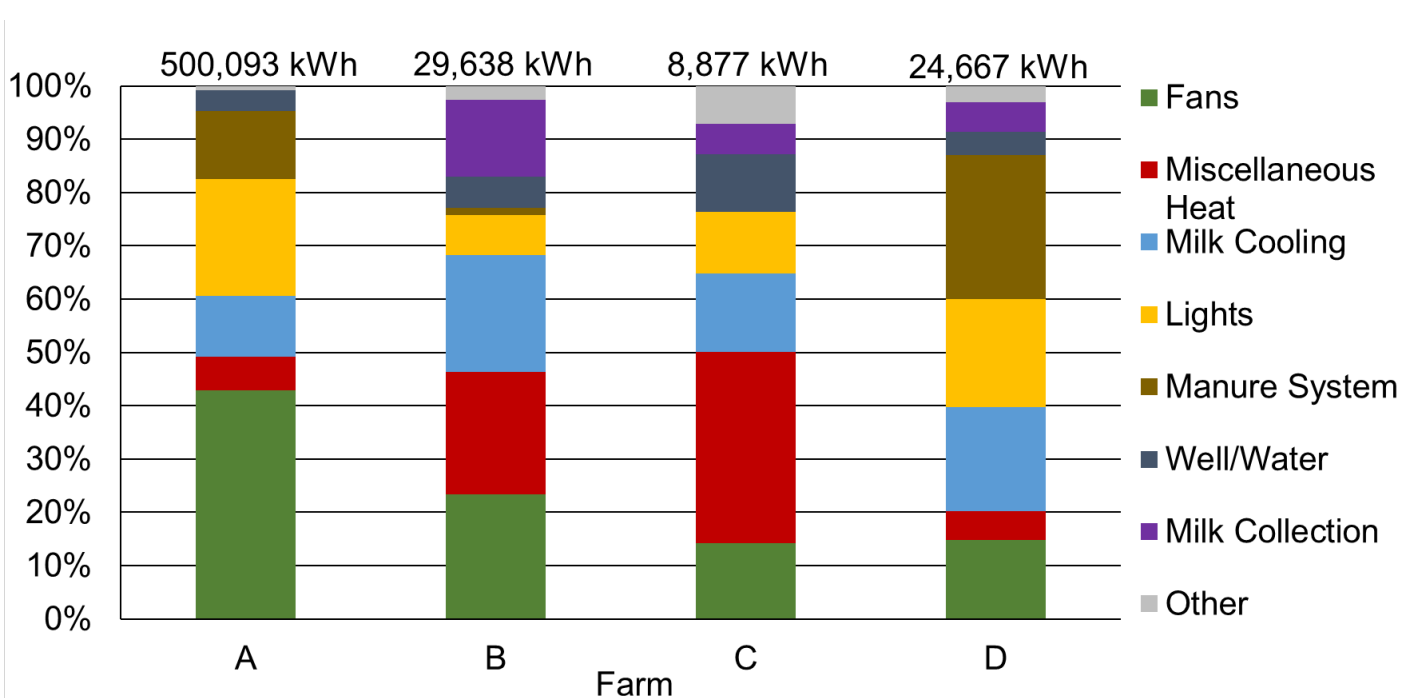
Farm C Total kWh/month



Farm D Total kWh/month



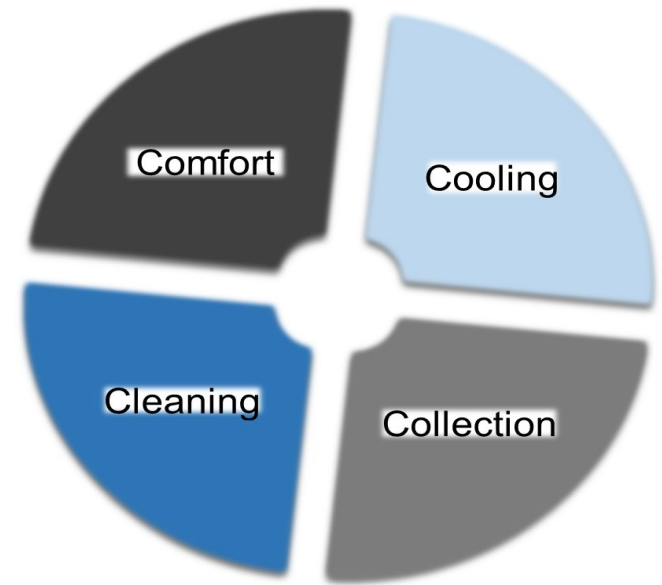
Average Monthly Total Electricity (% of total kWh)



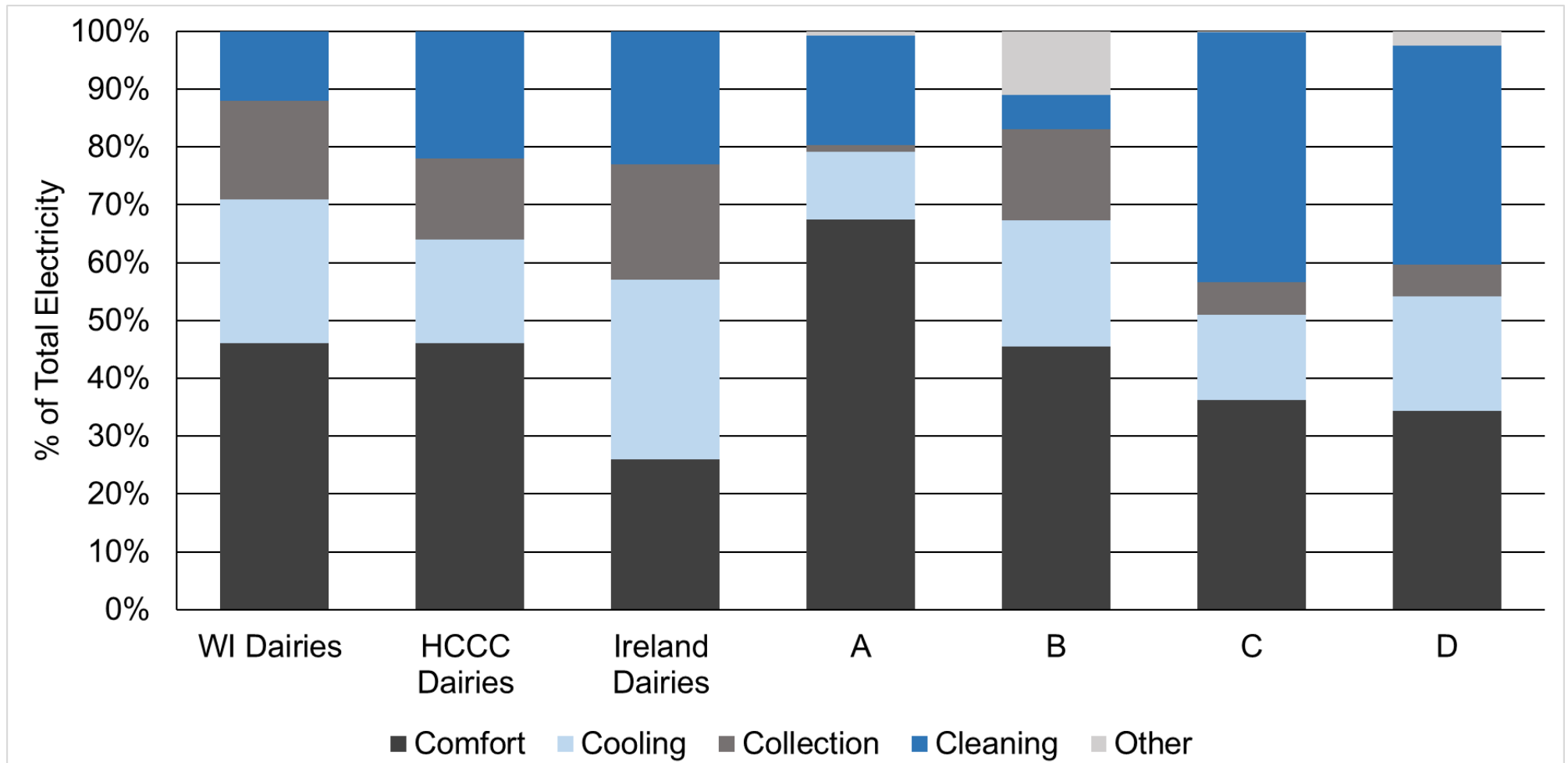
"4 Cs" of electricity use

Results compared to other measures

- **Dairies in Wisconsin (Vanderlin, 2004)**
- **30 dairies from Hastings Co-op. Creamery Co. (MN Department of Commerce, 2015)**
- **7 robotic dairies in Ireland (Shortall, 2017)**



4 Cs of Electricity Use



Summary

- **Consumers and market chains will likely continue demanding**
 - **Reduced carbon footprint**
 - **More environmental sustainability**
- **Focus on areas of high energy use to meet demands**
 - **Ventilation fans**
 - **Proper sizing, settings, and maintenance of fans can save 15%**
 - **Lights**
 - **Converting to LEDs**
 - **Utilizing timers/photoelectric sensors**
 - **Generator block heaters**



Solar Shading for Organic Cows

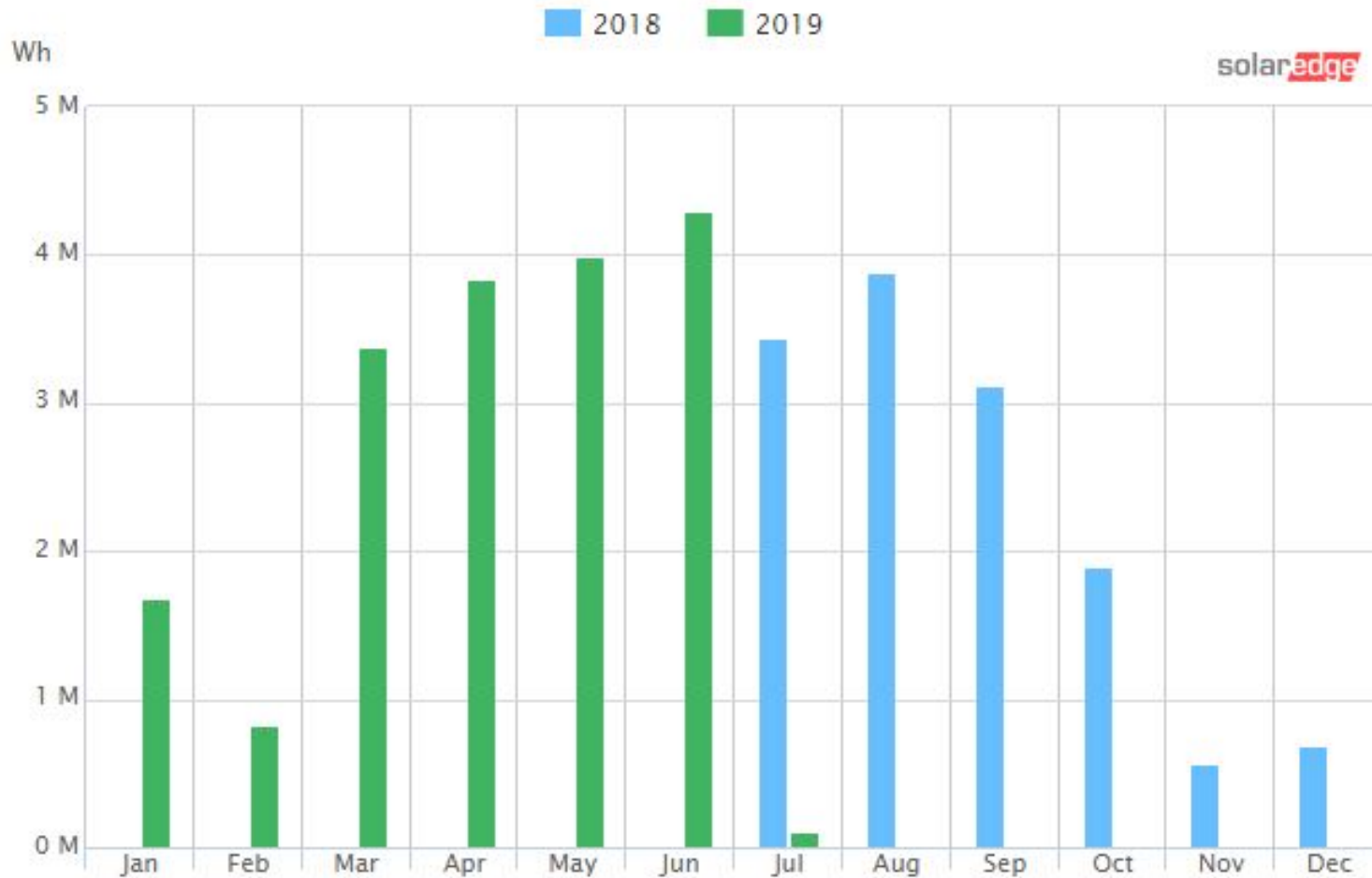




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30 kw Solar System



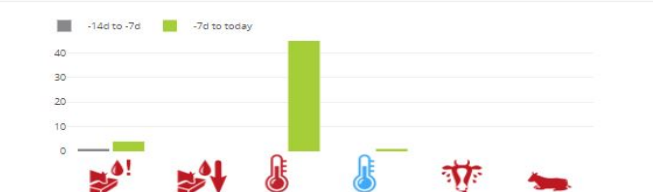
Herdsmen's action list



Insemination	1
Check for pregnancy	0
Dry-off	0
Calvings	0

Health status

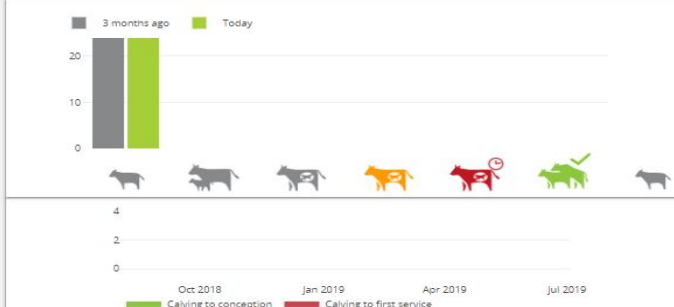
Whole herd



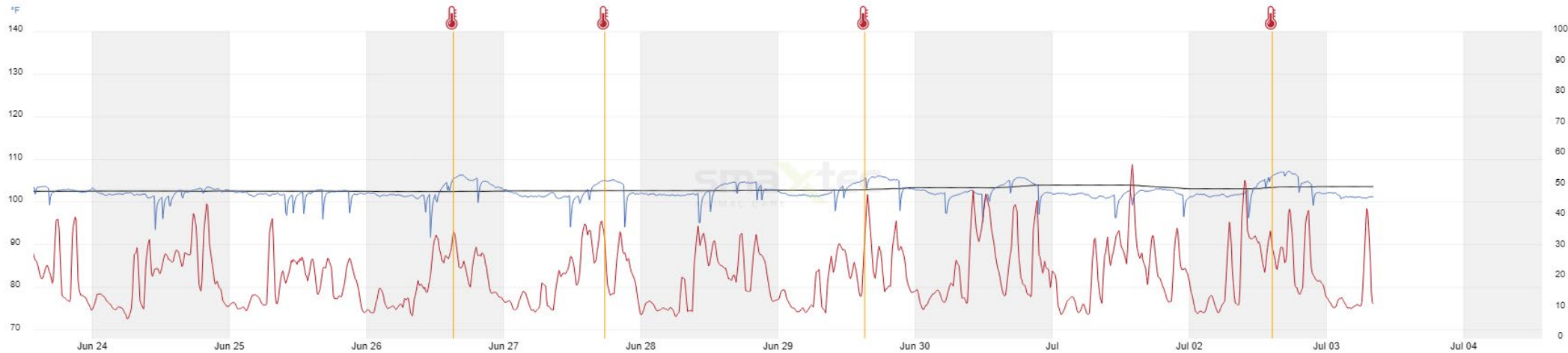
Check health	23
Suspicious fresh cows	0
Drinking status	1
Temperature increase	23
Temperature drop	0
Drop in activity levels	0

Fertility status

Whole herd



Fresh cows (DIM < 30)	0
Open cows	24
Pregnant	0
Suspicious cycle	6
Cows not in heat	0





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