WEBINAR SERIES

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Optimized Controller for Dairy Cow Cooling

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Acknowledgements

This project was funded by California Energy Commission's Electric Program Investment Charge (EPIC) program with support from Southern California Edison

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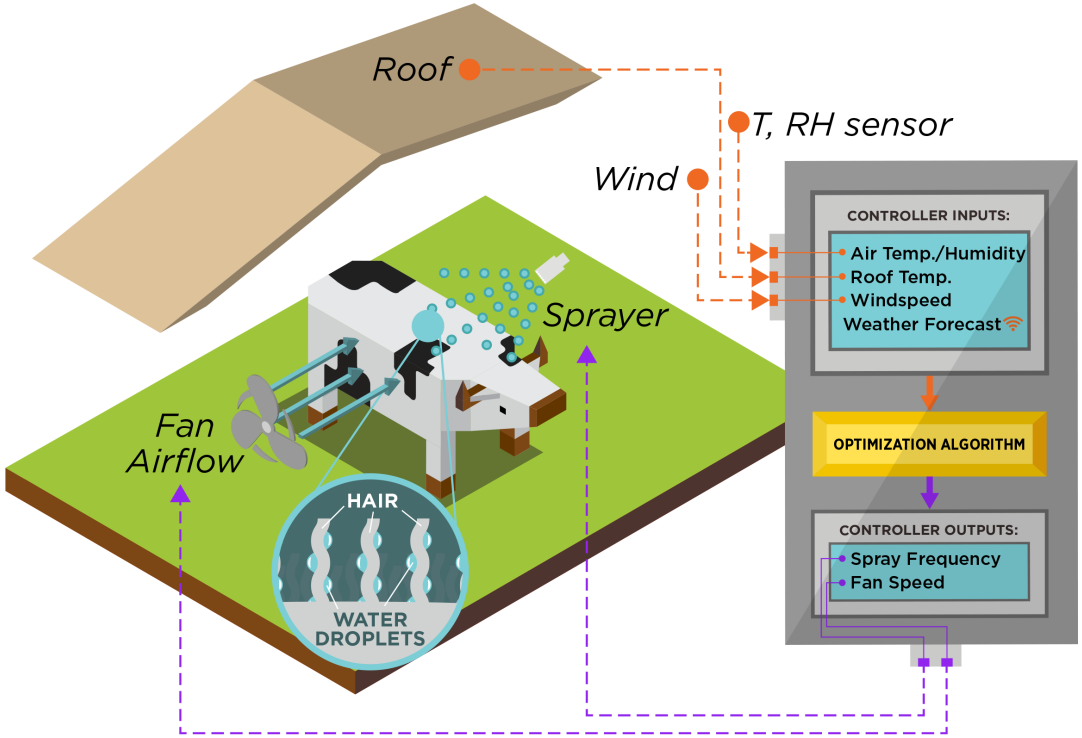
Baseline Scenario

- California has 1.8 million dairy cows
  - Cooling is required to mitigate heat stress which impacts health and milk production
- Typical configuration in a free stall barn (sample of six dairies)
  - Fans turn on to full speed when outdoor air temperatures reach 60 – 78°F
  - Sprayers turn on for ~1 minute cycles when outdoor air temperatures reach 72-85°F. Off times vary between 4 – 9 minutes.

The Problem and Potential

- Existing controllers do not account for the variations in how cooling of the cow is affected by:
  - Ambient temperature
  - Humidity
  - Fan Speed
  - Surrounding surfaces (e.g. roof temperatures).
- Too little cooling – heat stress. Too much cooling – waste.
- Fan power varies with cube fan speed. A 50% reduction in speed is approximately an 80% reduction in power.
- Excess water use also wastes electricity (for pumping). Excess water may increase incidence of certain diseases.

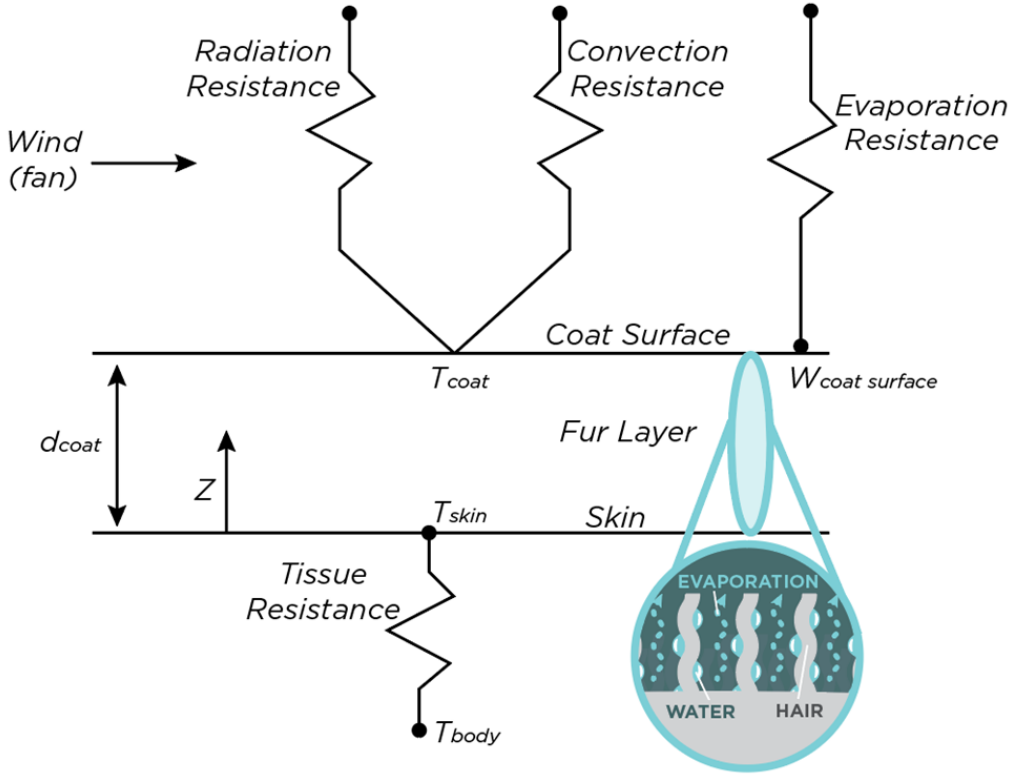
Controller Overview



Goal: Use real-time weather conditions combined with a control algorithm based on a *heat and transfer model of dairy cow fur drying* to optimize:

- Water use (sprayers)
- Electricity use (fans)
- Cow health/safety

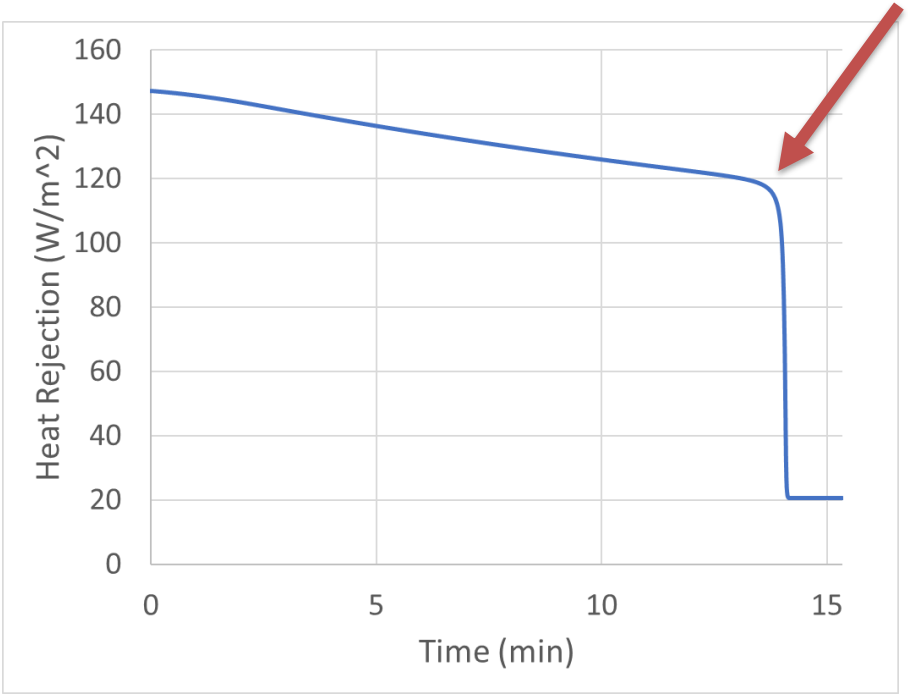
Model Details



Model estimates fur drying time: used to optimize water spray rate to keep cow fur wet

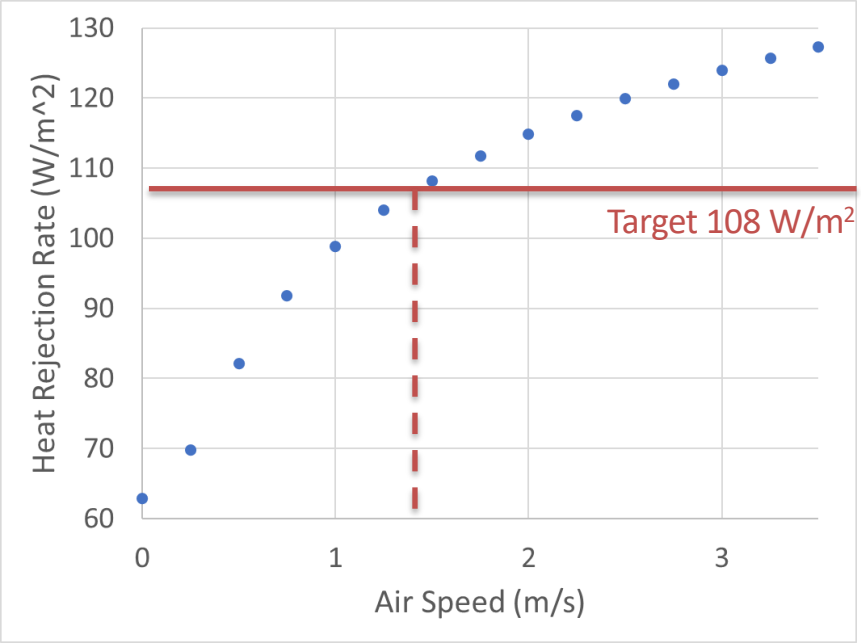
Model estimates total heat rejection rate: used to set fan speed to meet minimum threshhold

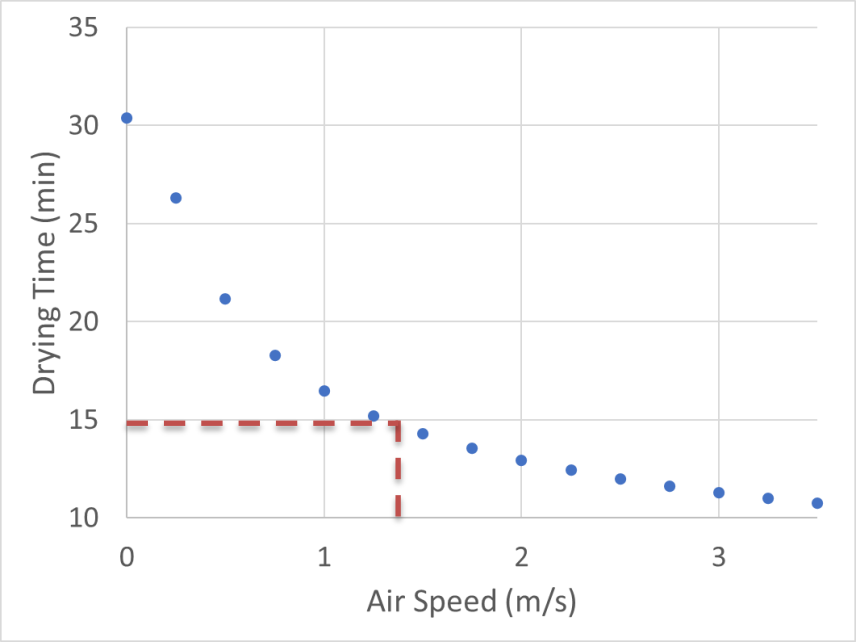
Heat Rejection Rate as Cow Dries



- Environmental conditions:
  - Air temperature 93.2 °F
  - Air speed 3 m/s
  - Humidity 0.01 kg water/kg air
  - Roof temperature 95 °F

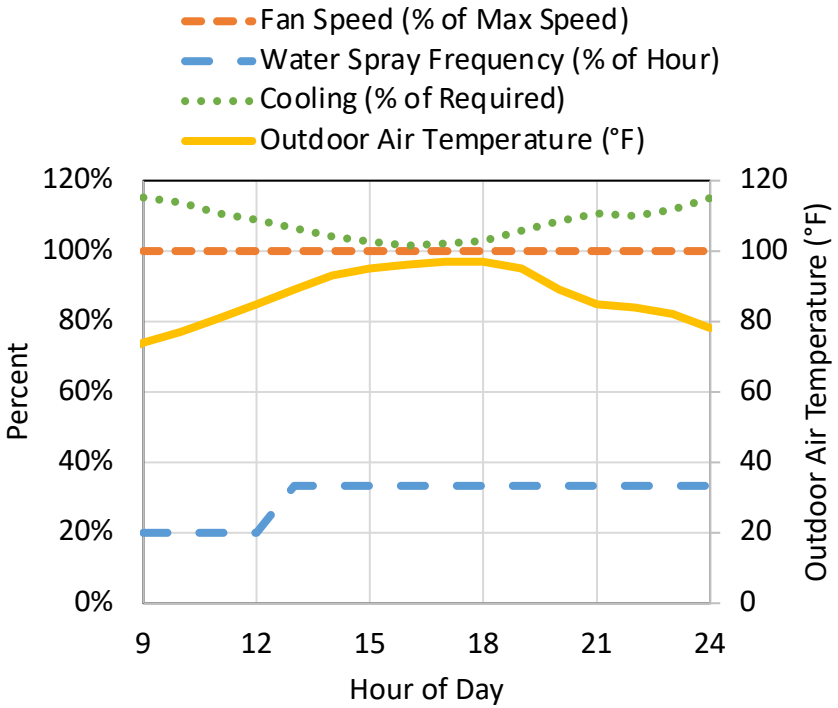
Parametric Analysis

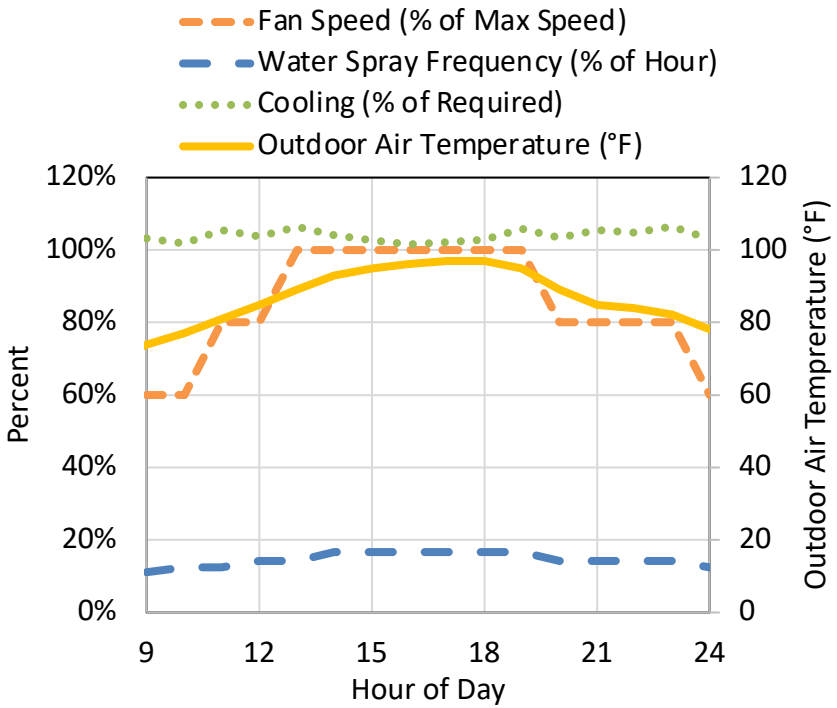




Air temperature 93.2 °F
Humidity 0.01 kg water/kg air
Result changes as outdoor conditions change!

Optimized Controller – Example Day





Annual savings forecast: 20% Electricity Savings, 40% Water Savings

Field Test Summer/Fall 2020

- Dairy located in Tulare County, CA.
- Existing system cools 50 cows. Existing panel fans have been added to VFD.
- Limited to temperature and humidity control. Control based on simplified correlation from model.
- Controls deployed with SMC supervisor (adaptable to a wide variety of control hardware).

Next Steps

- Controls could be implemented in off-the-shelf products
- Industry partner needed to license and deploy controls to dairy industry – expansion of controls company into dairy space?
- Utility program to incentivize commercialization and adoption
- Seeking feedback on technology – please share your thoughts!

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