

Green Enterprise Computing Data

Maria Kazandjieva, Brandon Heller, Omprakash
Gnawali *, Philip Levis, Christos Kozyrakis

Stanford University, * U of Houston



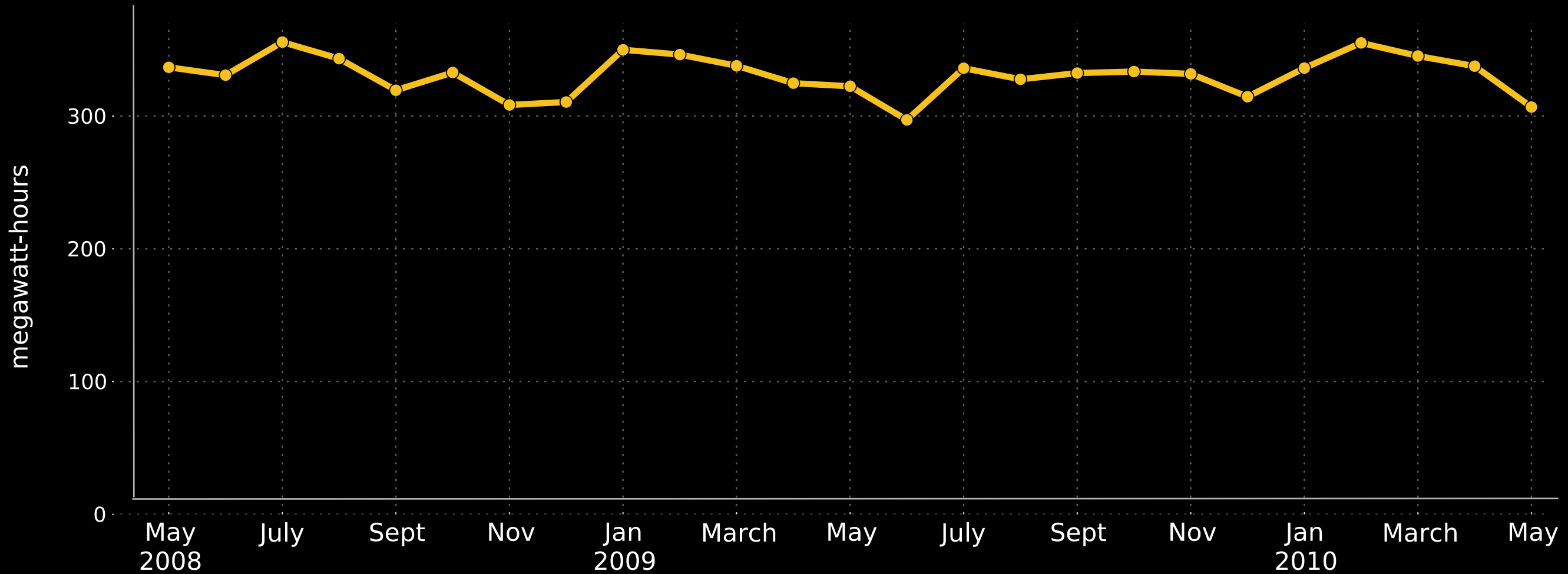
STANFORD UNIVERSITY
Facilities Operations
Utilities Division

UTILITY CONSUMPTION REPORT

GATES COMPUTER SCIENCE

December 2011			
Consumption	Daily Average	Daily Avg Difference	Cost
359,035 kWh	11,582	4.43%	\$39,314

Data Every Month



300 megawatt-hours = 300 U.S. homes

Data Every 15 Minutes



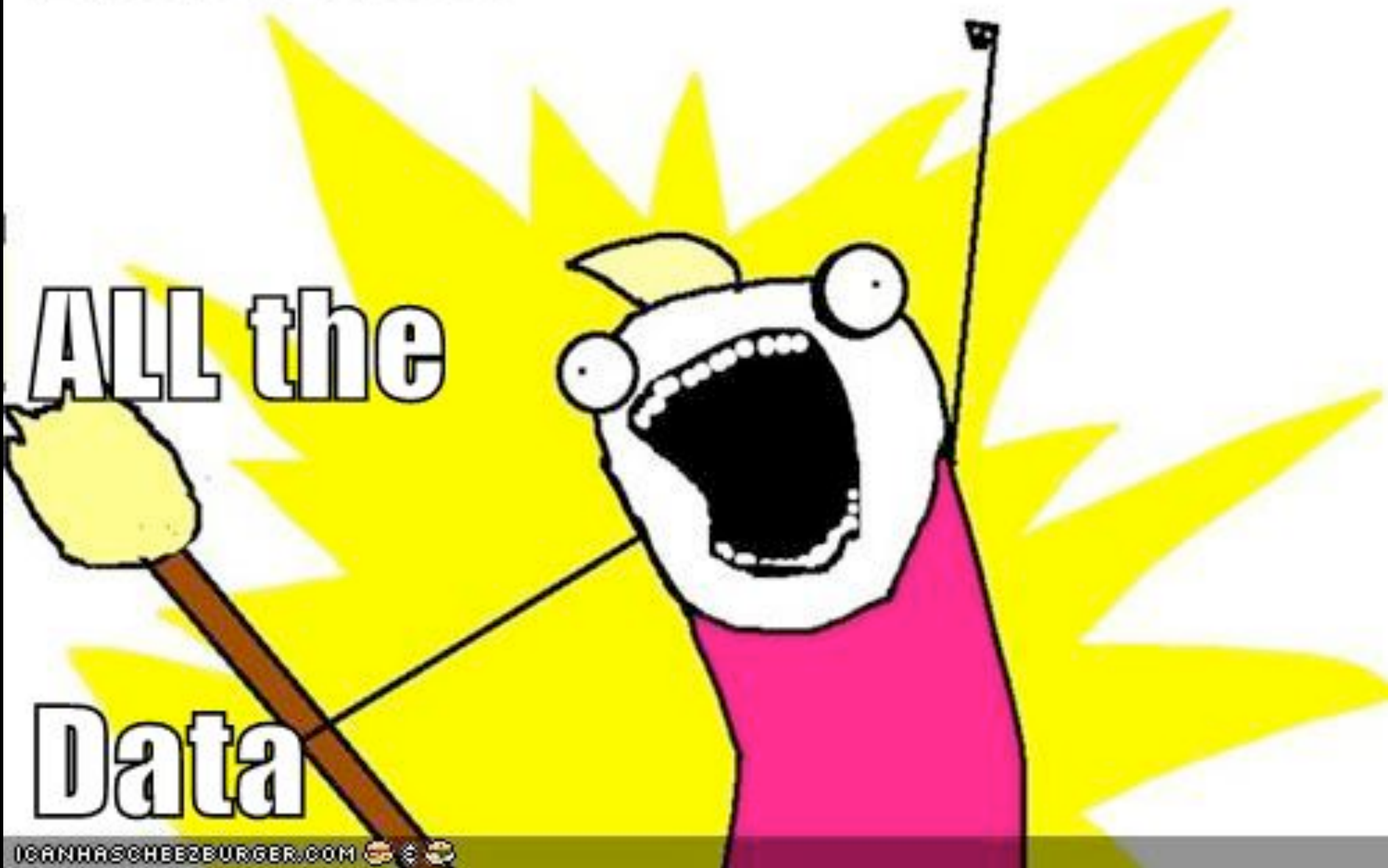
This Work

1. Collect dense, long-term power measurements
2. Analyze the energy use of computing systems
(in an office building)
3. Derive methodology lessons and provide advice

Release

ALL the

Data

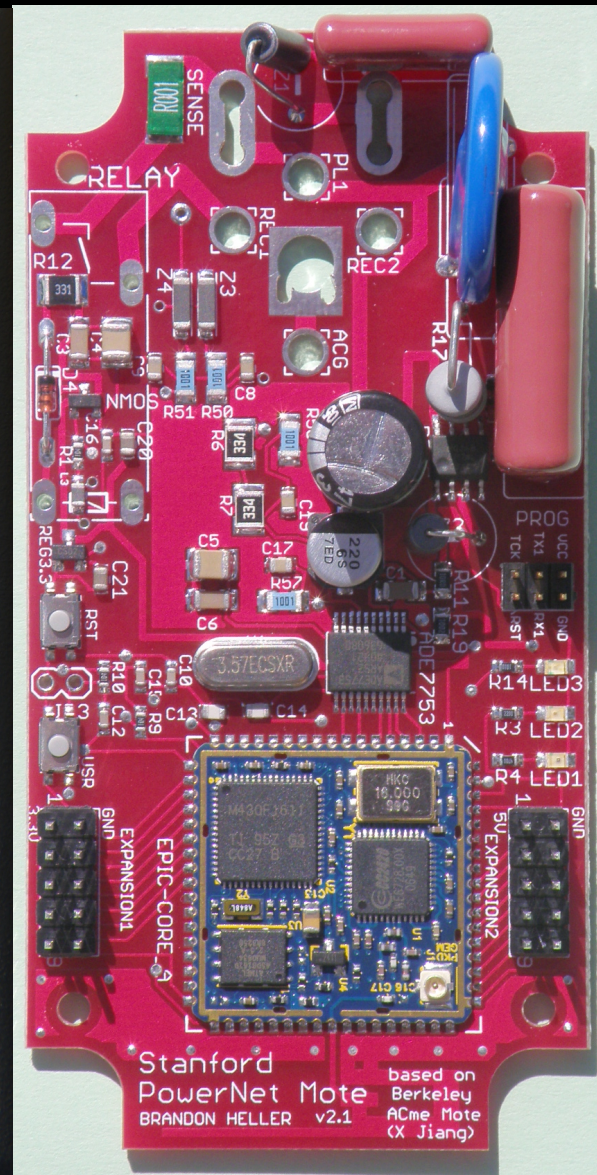


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This Work

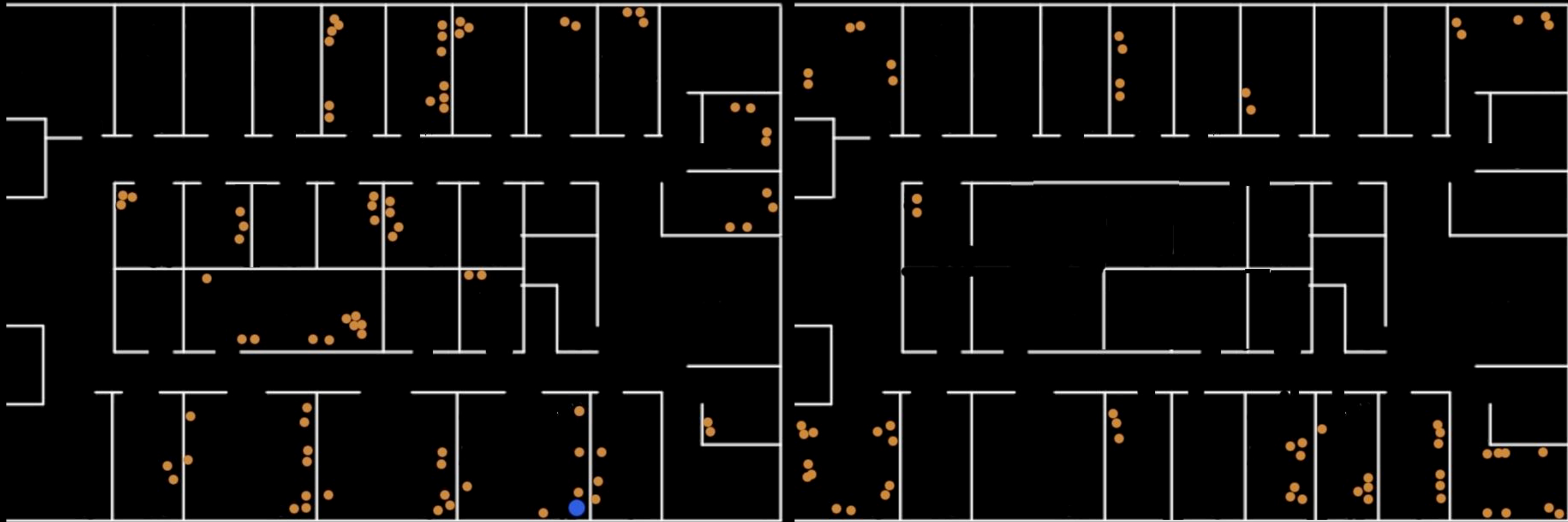
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PowerNet



- Custom-built meters
- Sample once per second
- Wireless collection of data
- Ease of deployment

PowerNet Deployment



- 250+ plug-level sensors
- 2+ years
- PCs, laptops, network equipment, LCDs, servers

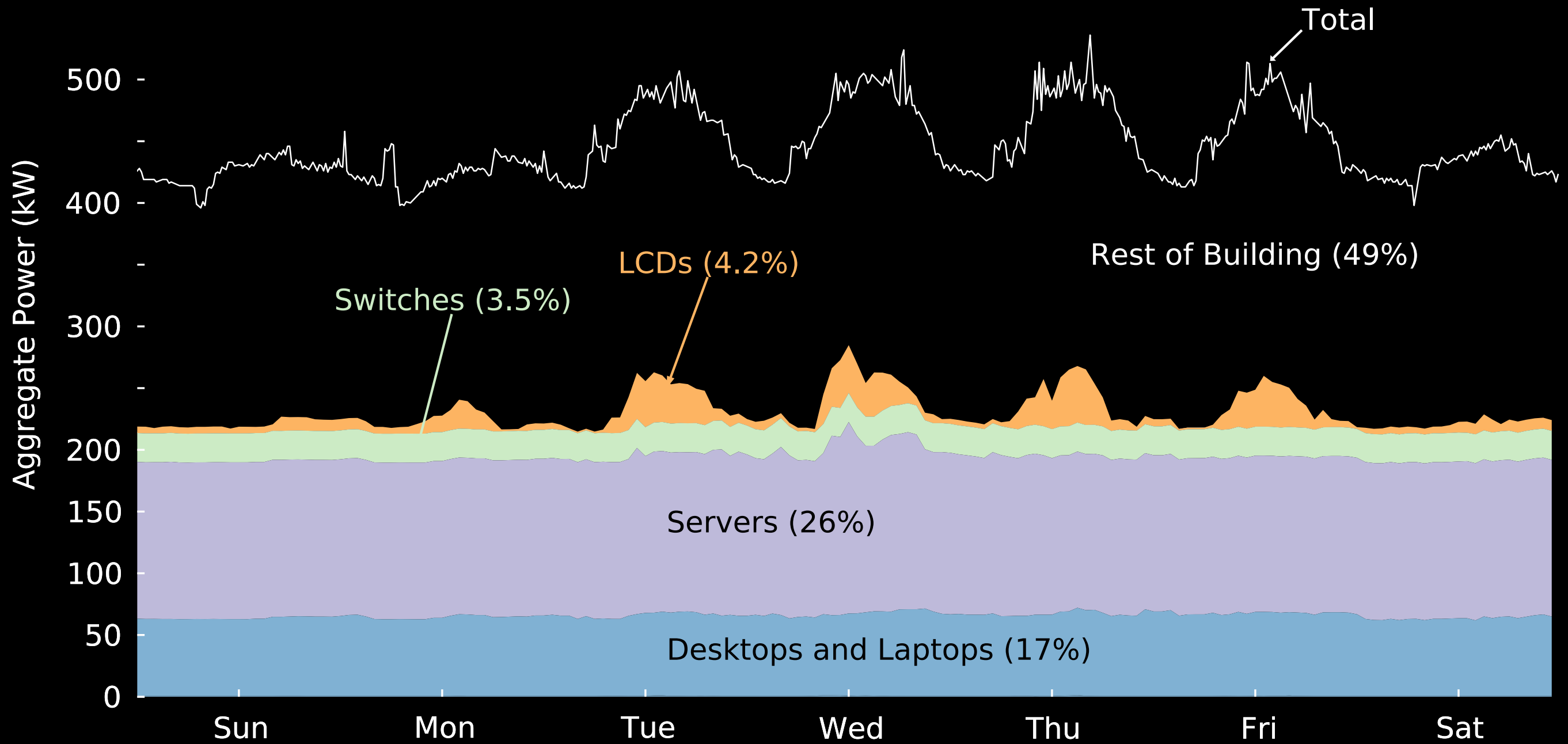
PowerNet Data

- Augment power data with utilization
 - CPU
 - active processes
 - network traffic
- Data available at powernet.stanford.edu/data.html
- Board schematics, at powernet.stanford.edu/about.php

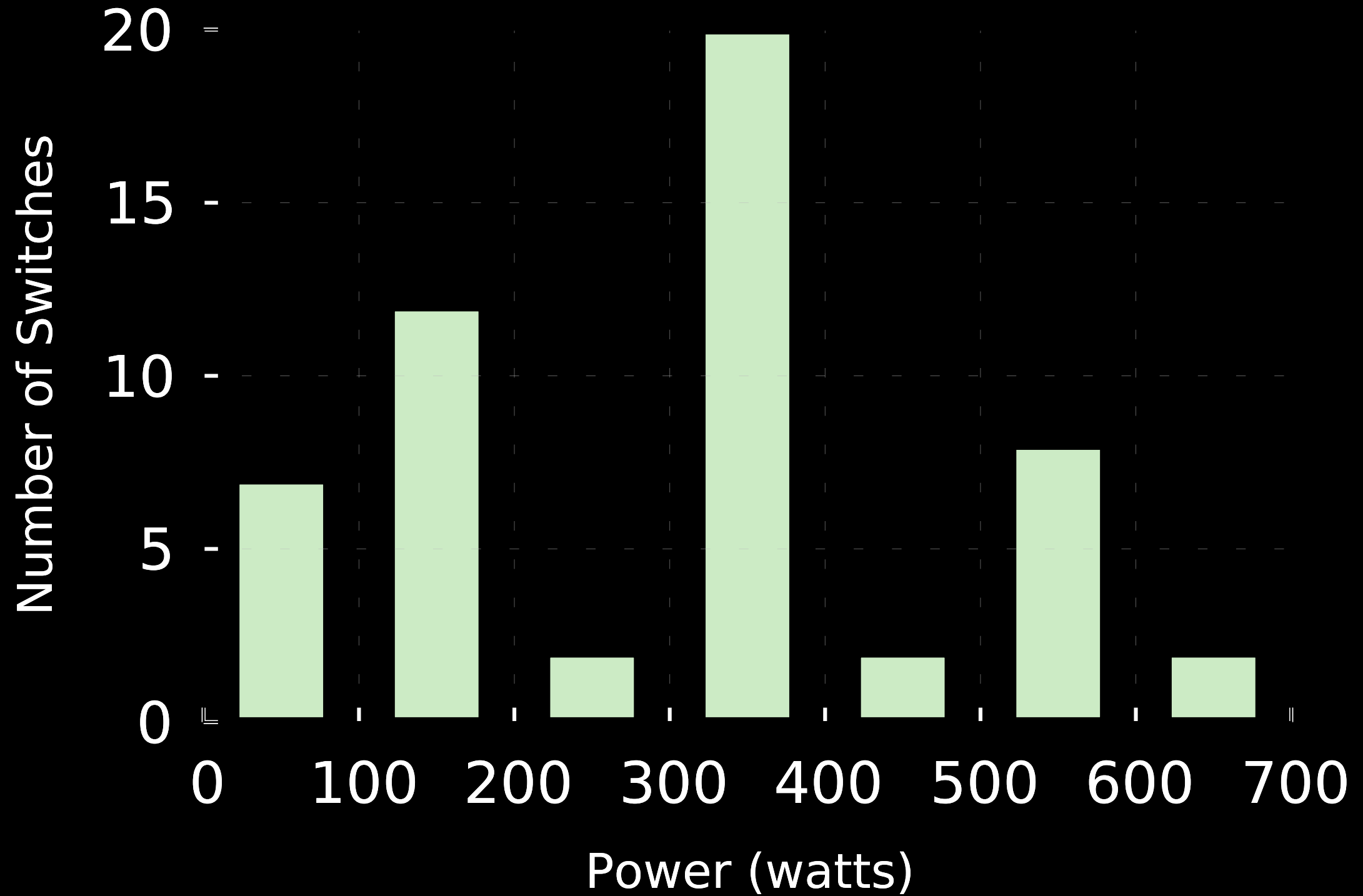
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Power Over Time



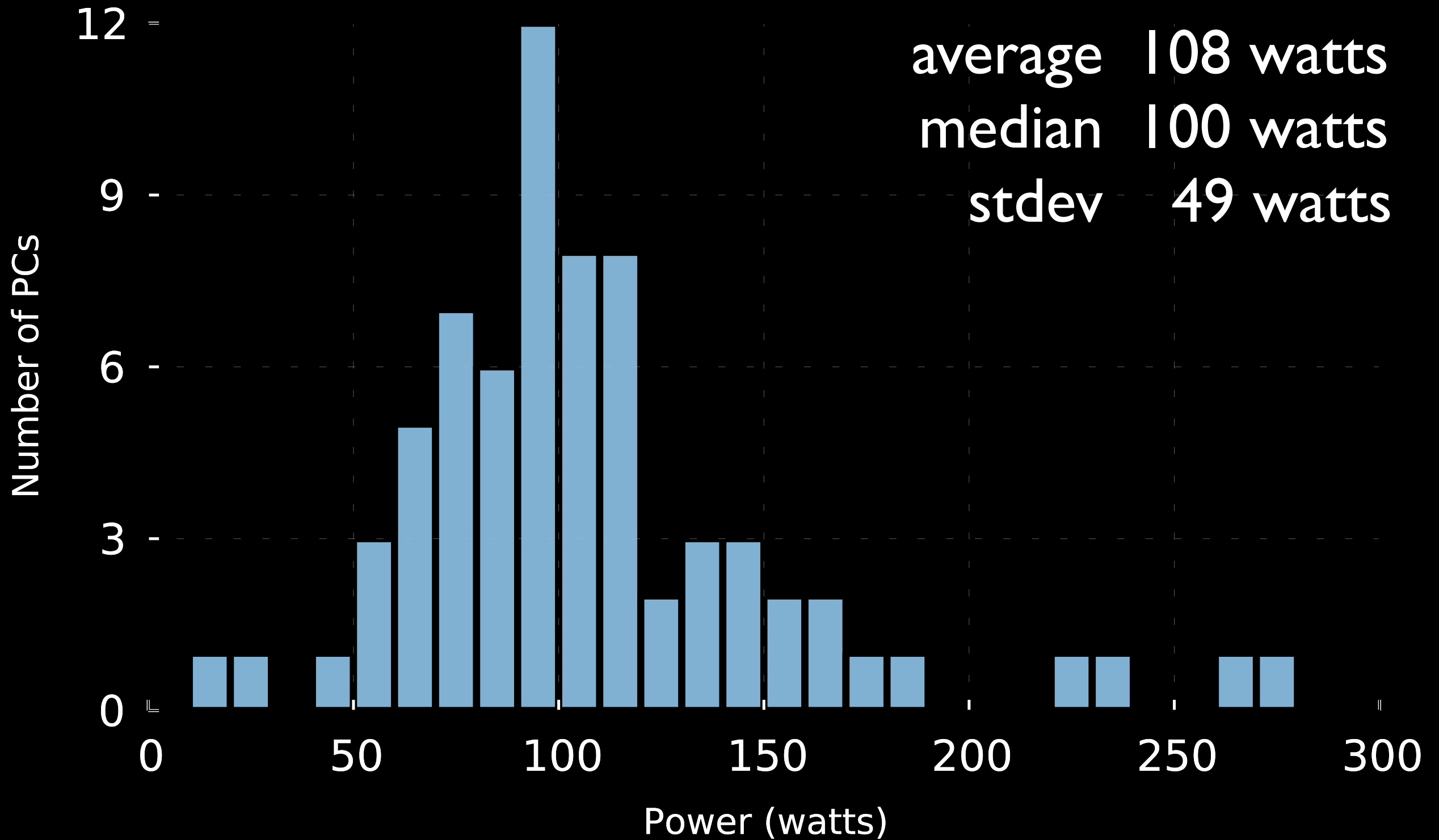
Switches



LCDs

Screen Size	Count	Power
< 20"	42	30 W
20" to 22"	40	45 W
23" to 25"	84	63 W
26" to 27"	15	80 W
29" to 32"	44	120 W

Desktops



Key Observation

Device classes differ

1. Desktops
large variation in power draw
2. LCDs
power-hungry but duty cycled
3. Switches
low variation within time and space

Implications for Methodology

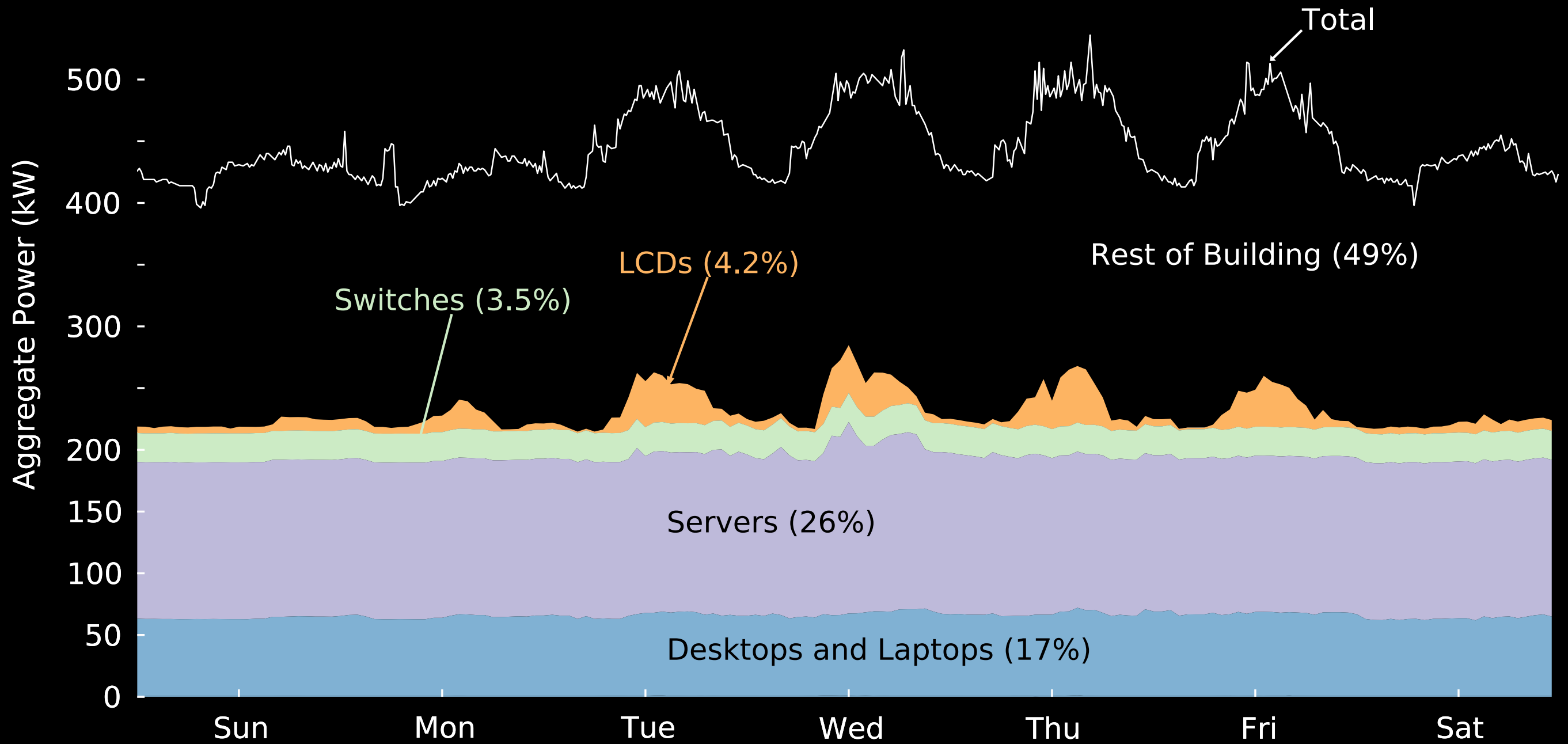
Power draw does not follow a simple distribution

- Uniform sampling will not cover important outliers
- Must be smarter about sampling if we can't cover all

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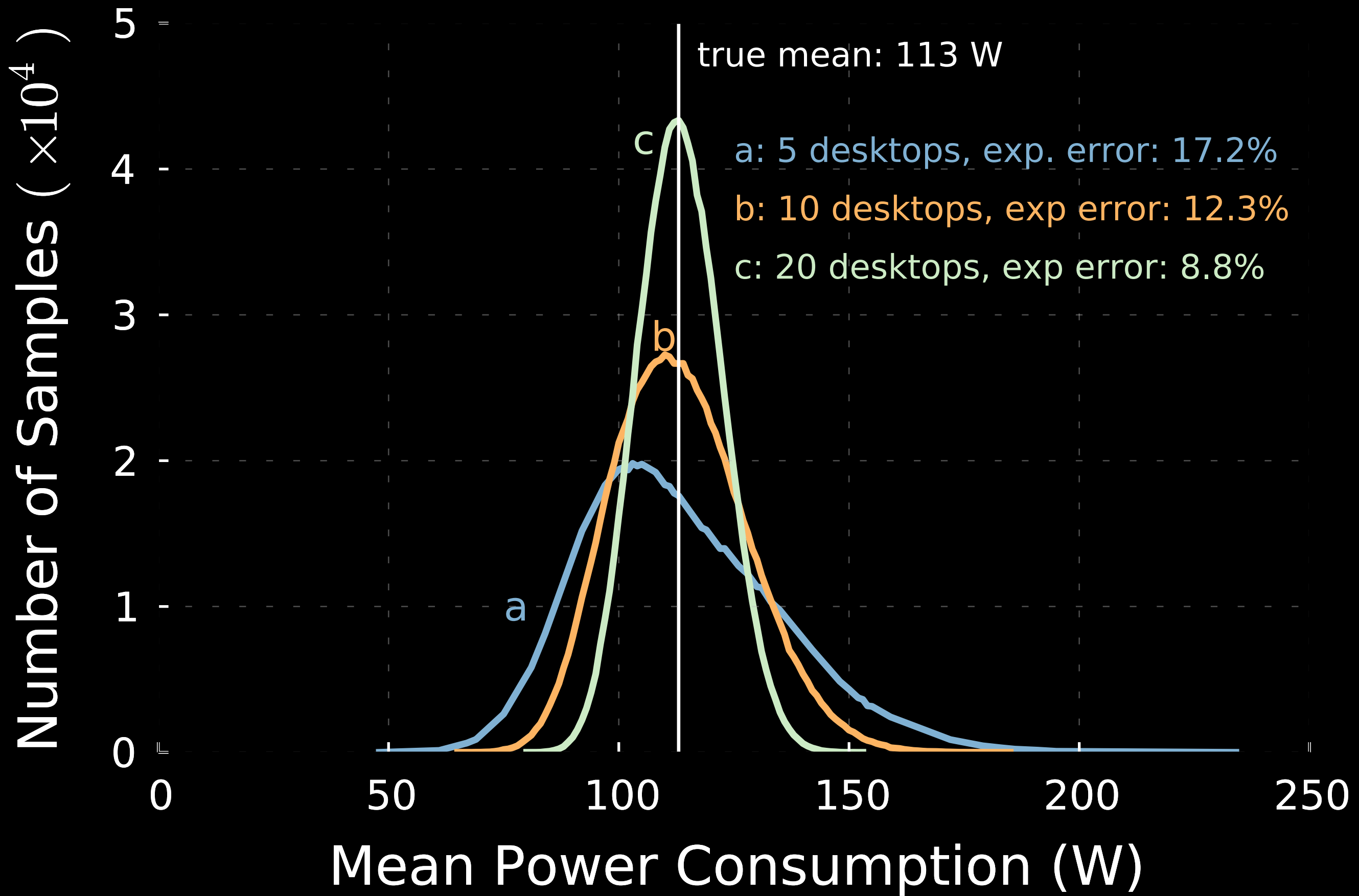


Extrapolation Steps

1. Measure a wide variety of PCs, ~ 100
2. Get total number of PCs (~ 750)
via active IPs on the network
3. Divide PCs in 3 categories
 - laptops, low-end, and high-end desktops
4. Scale from measured to all, in each category

How Many PCs?

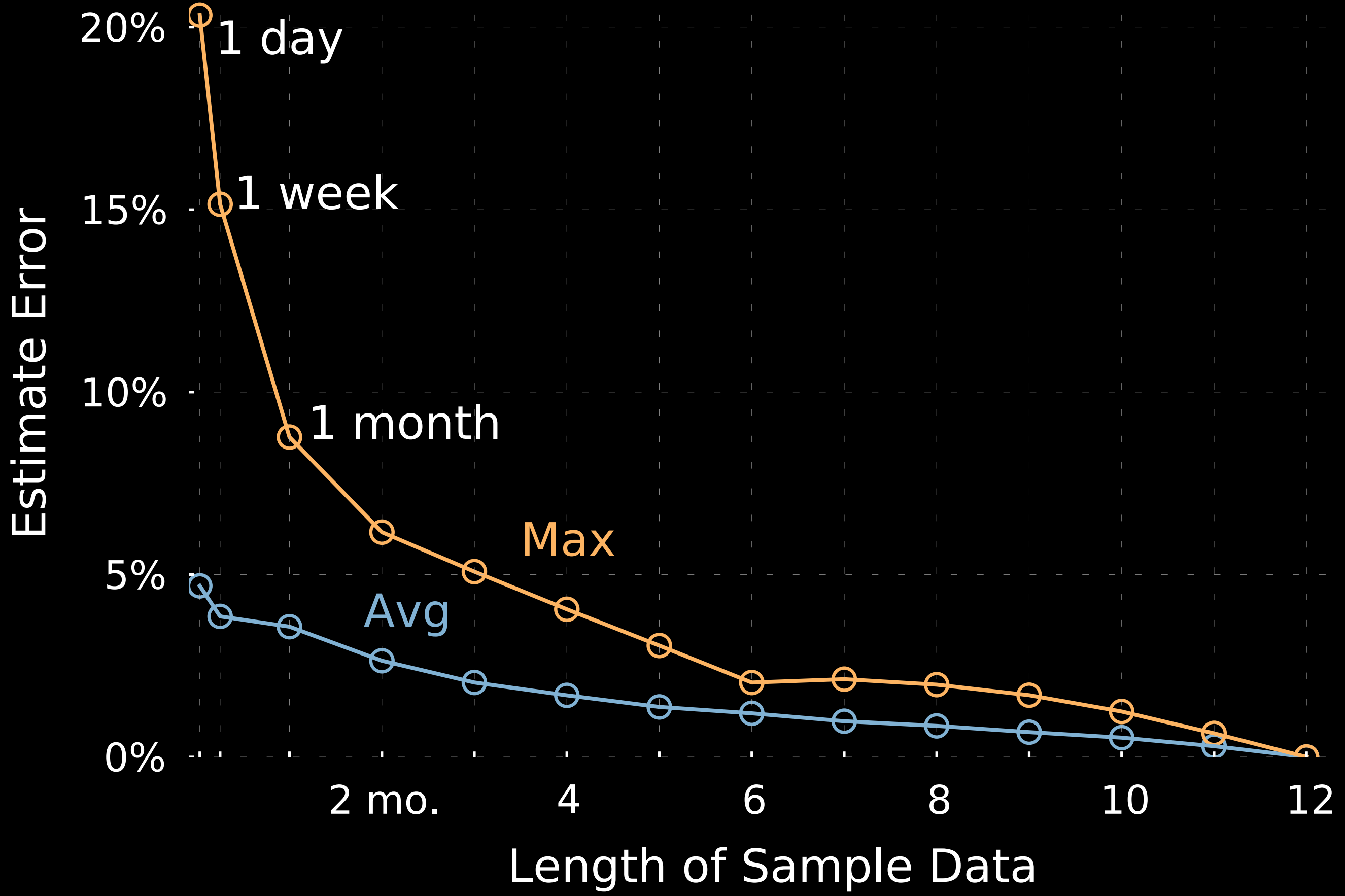
- Calculate average power draw over 69 desktops
- Pick random sets of 5, 10, or 20 PCs
 - calculate averages
- Compare expected error



Duration of Measurements

- PowerNet: 2+ years
- But how long is long enough?

What if we wanted to know
the cost of all PCs for 1 year?



Final Tips

1. Don't sample uniformly:
denser instrumentation for high-variation classes
2. Focus on breadth of measurements:
more devices for a shorter period of time
3. Collect more than just power data:
get the best metadata you can
understand utilization



4. Share
moar datas, please!

Thank you

- data: powernet.stanford.edu/data.html
- info: powernet.stanford.edu/about.php
- contact Maria: mariakaz@stanford.edu