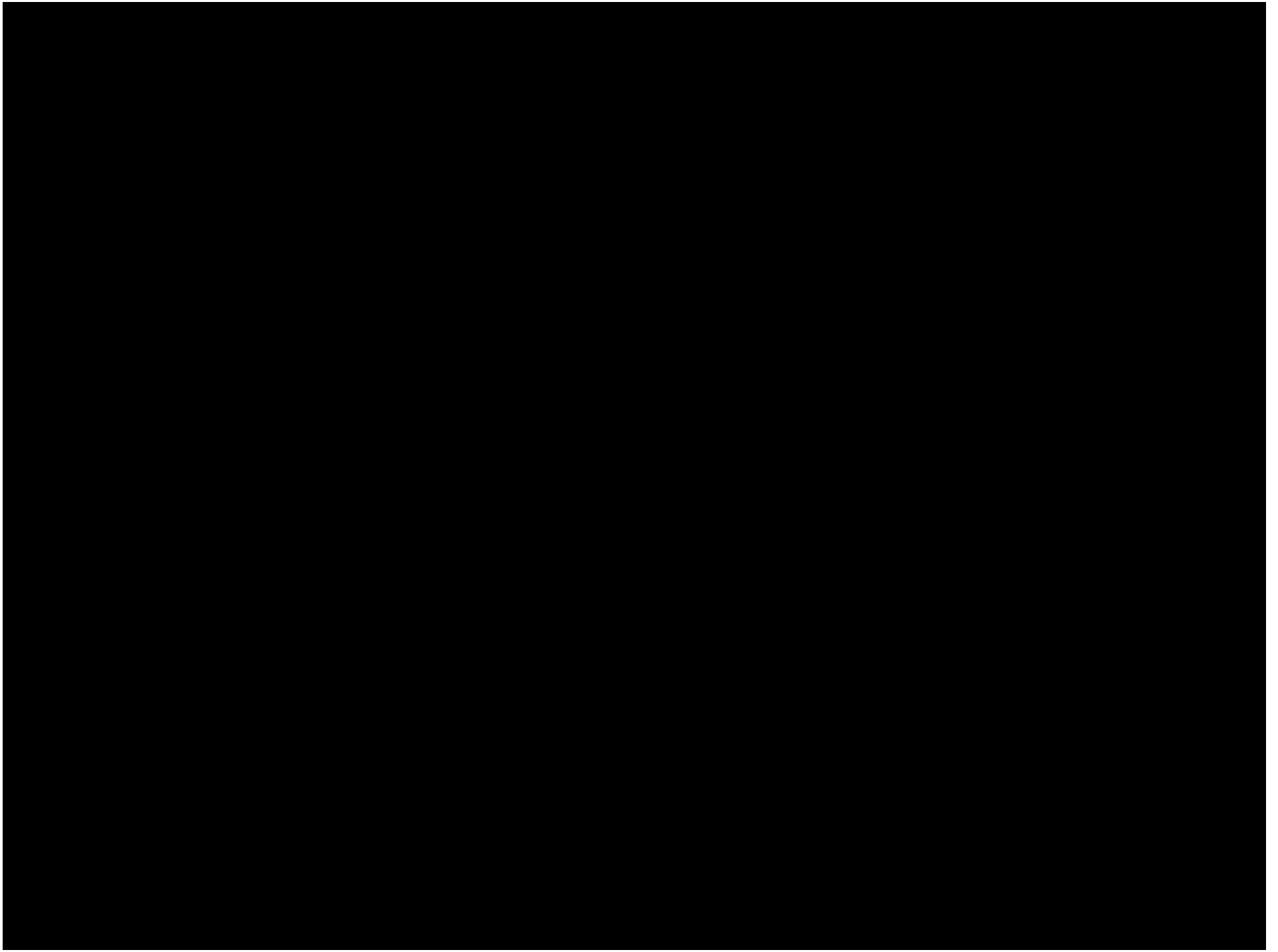


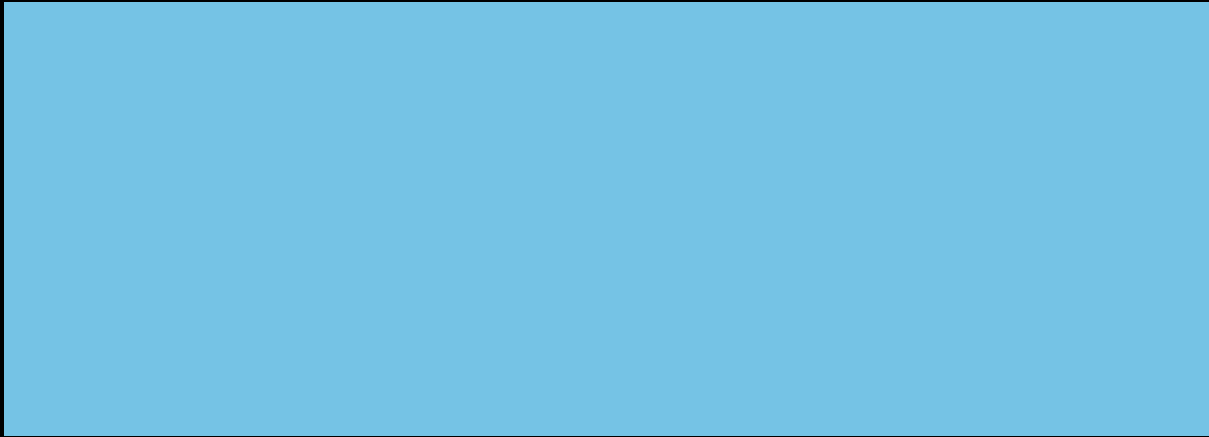


Energy Dumpster Diving

maria a kazandjieva
brandon heller
christos kozyrakis
philip levis

hotpower 09 | october 10 | big sky, mt





45 billion KWh

Datacenters



42 billion KWh

Office & Education
Buildings

Understanding Consumption

How much?

Why?

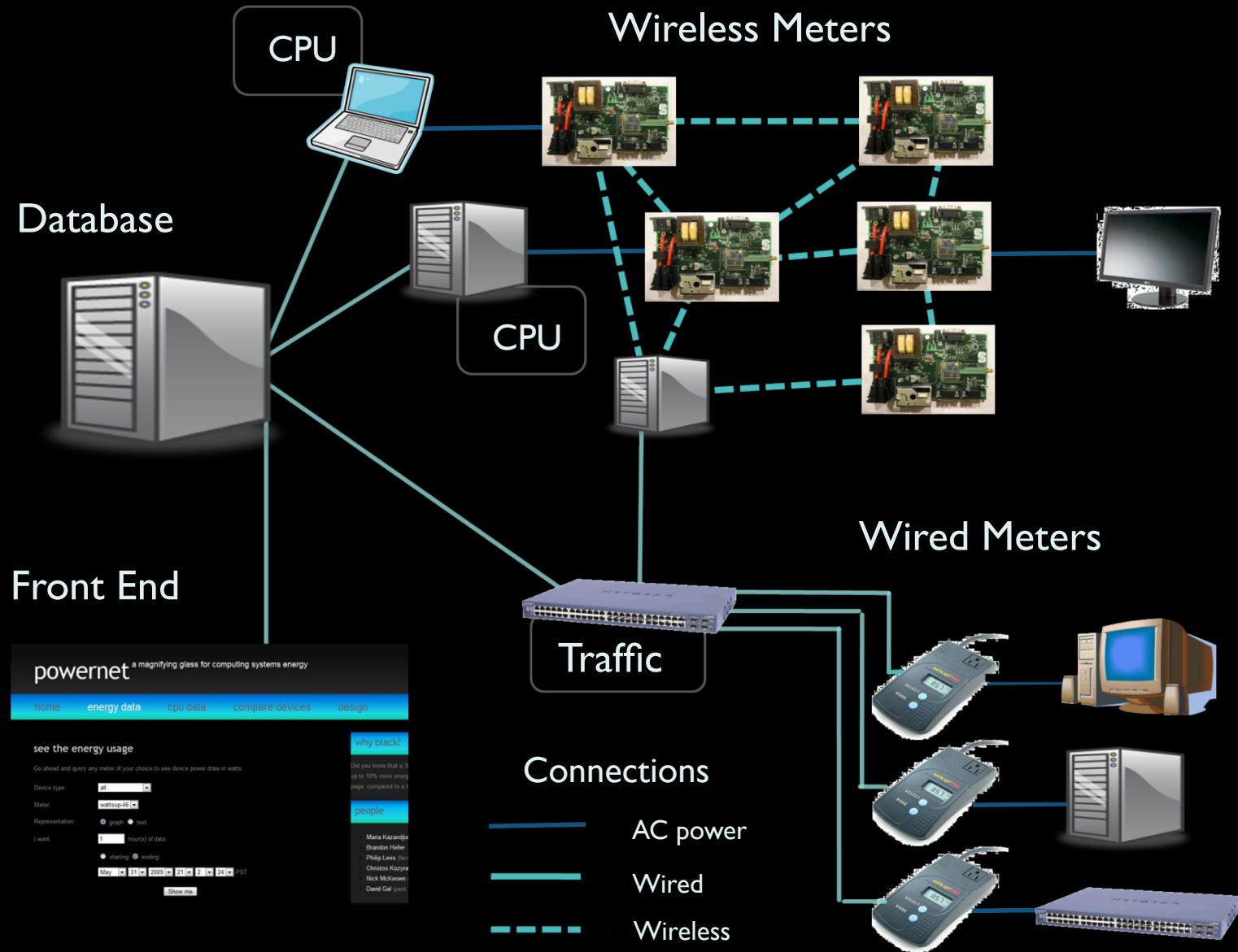
PowerNet

A building-scale power measurement infrastructure

Collect plug-level power data

Correlate power usage with utilization

System Design



Power Meters Comparison

Wired WattsUp .Net

Ethernet-enabled
HTTP for data logging
Sampling rate: 1Hz
Closed software
\$250

Wireless custom-made

802.15.4
Epic core + ADE 7753
TinyOS software
Sampling rate: 14KHz
Relay, dust sensor
\$150

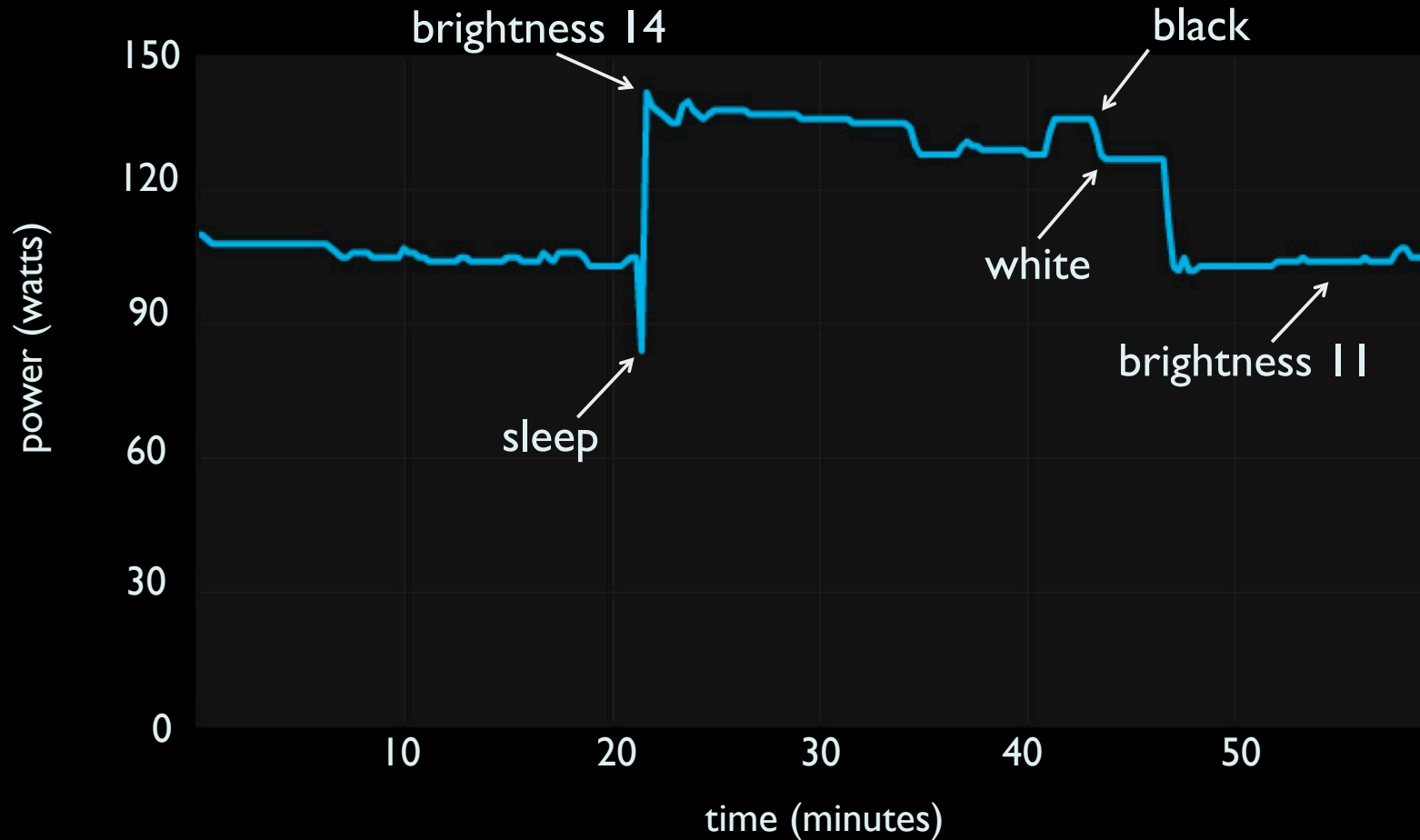
Current Deployment

75 wired and 10 wireless meters
desktops monitors
switches servers

10 CPU monitors
4 network traffic monitors

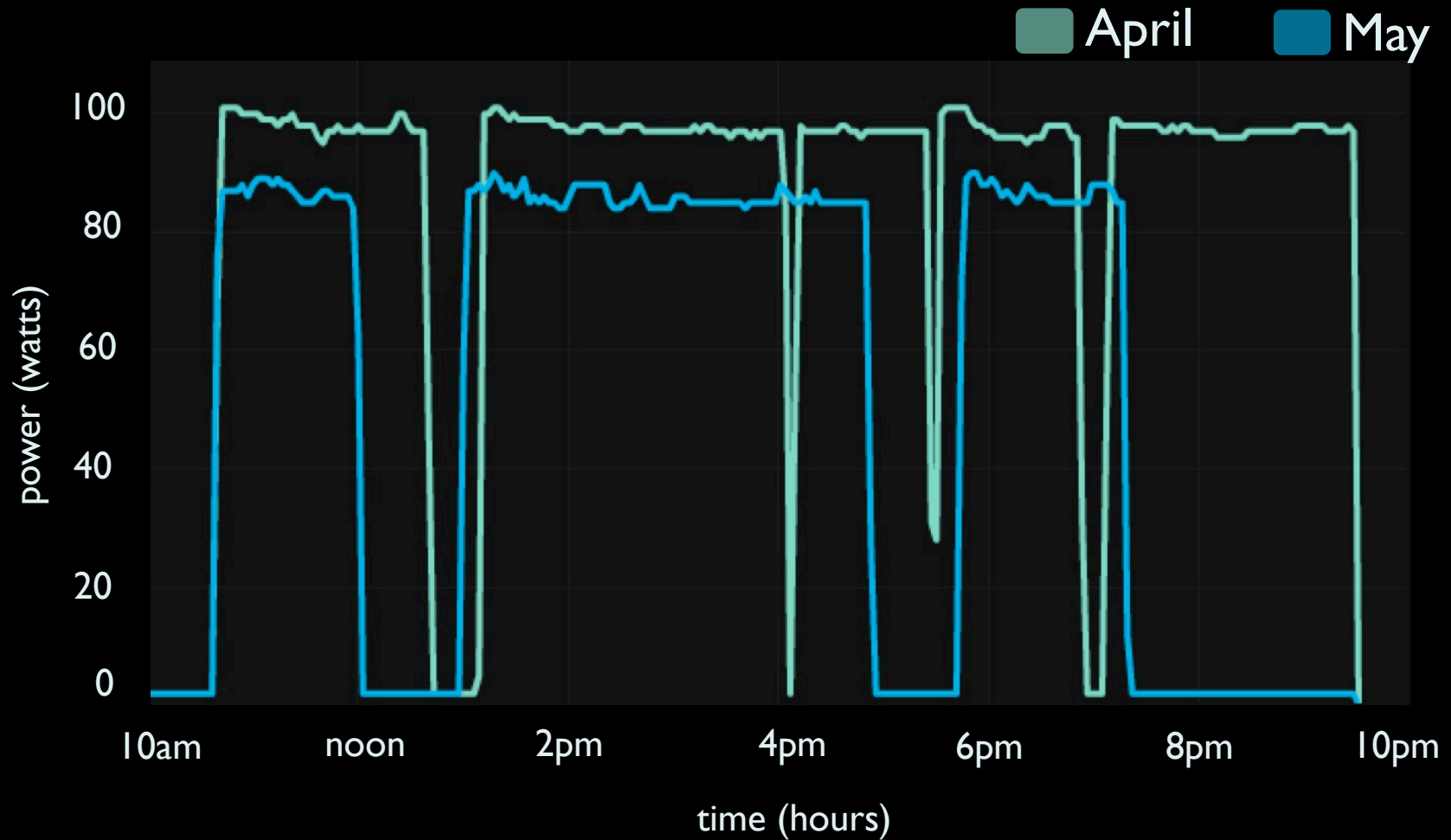
<http://powernet.stanford.edu>

Case Study: Monitors

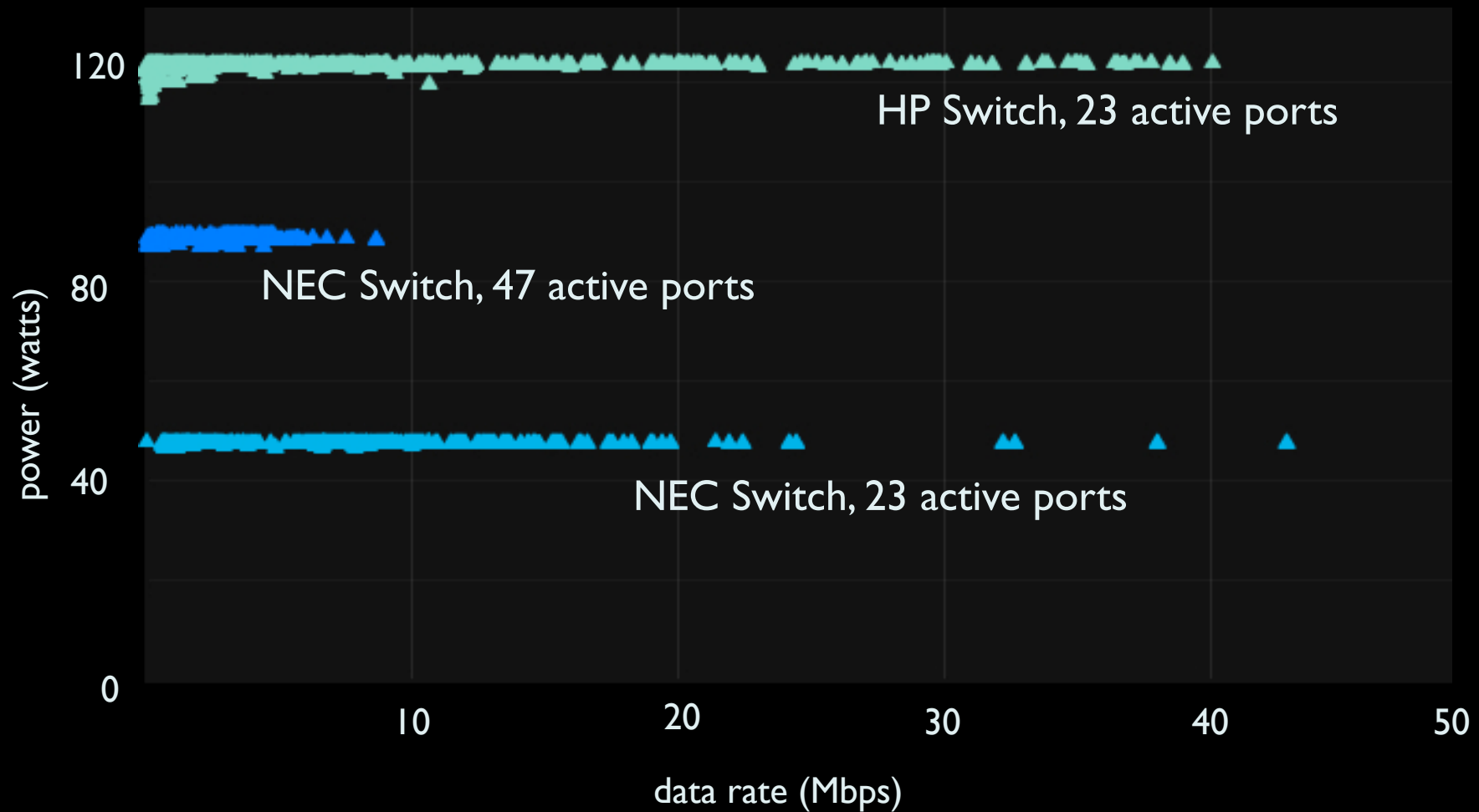


30" Dell Monitor

Case Study: Monitors



Case Study: Network Switches



Other Observations

Desktop data

R^2 correlation between CPU and power usage is >0.9

Very large baseline electricity consumption.

Use data to decide when machines should sleep.

Server Racks

Difference in power consumption of identical machines.

Power data can be an indicator for cooling shortfalls.

Going Forward

100 wireless meters over one floor

Understand user load

Continue to monitor network, CPU, and power

Going Forward

Wired vs Wireless

Powerful PCs vs Thin Clients & server-ran VMs

Thanks.

powernet:

<http://powernet.stanford.edu>

email:

mariakaz@stanford.edu

Datacenters

2005 (source: Lawrence Berkeley National Labs report)

total server electricity consumption	23 billion KWh
including cooling & extra equipment	45 billion KWh

Education & Office Buildings

2003 (source: DOE Annual Energy Review 2008)

total computer electricity consumption	31 billion KWh
including office equipment	42 billion KWh