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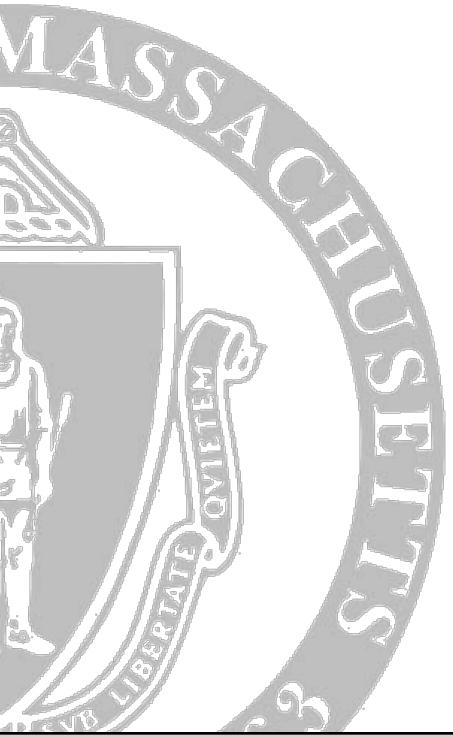
Energy-agility: A New Grid-centric Metric for Evaluating System Performance



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Rethinking Energy-efficiency (1/4)

Energy-efficiency = Work done per joule of energy used

Better energy-efficiency —> systems run longer

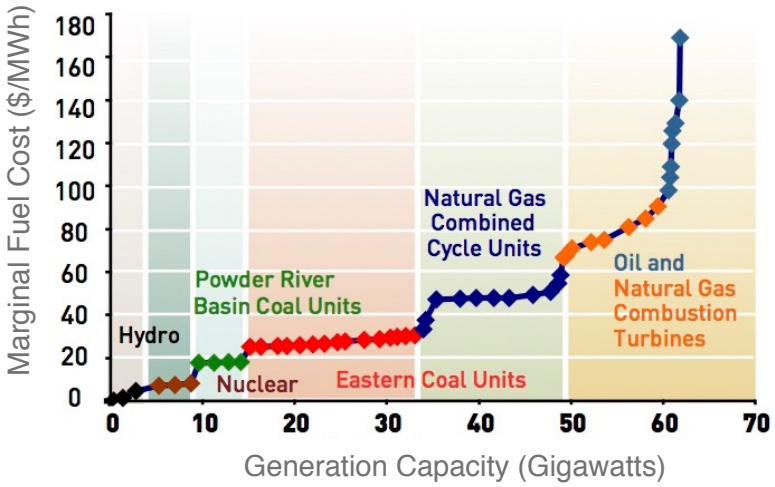
Better energy-efficiency —> lower energy bills, lower carbon footprint

Rethinking Energy-efficiency (2/4)

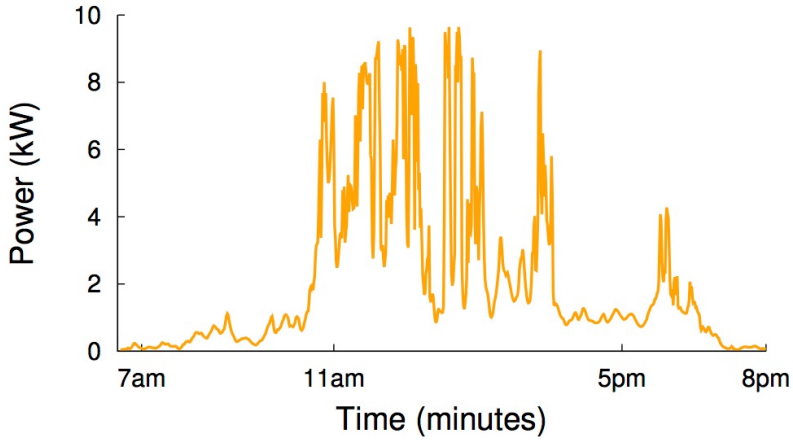
What is wrong with the datacenter scenario?

Misplaced Assumptions!

✗ All energy is created equal



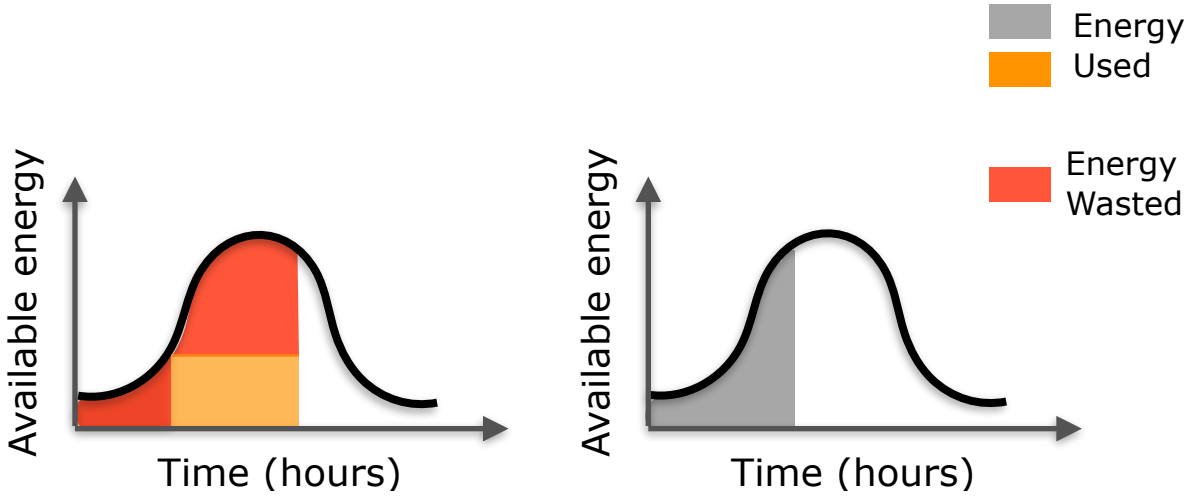
✗ Energy is available at any time



Rethinking Energy-efficiency (3/4)

Why energy-efficiency is not sufficient?

Renewable-powered datacenter



Energy Consumed	Less	More
Finish Time	Later	Earlier

Rethinking Energy-efficiency (4/4)

How do we evaluate green compute systems?

Energy-efficiency	✗ Solely driven by workload ✗ Opaque to energy characteristics
Energy-proportionality	
Energy price	✗ Non-standard metric

Energy-agility (1/3)

Energy-efficiency = Work done per joule of energy ***consumed*** by the system

Energy-agility = Work done per joule of energy ***available*** to the system

Formally,

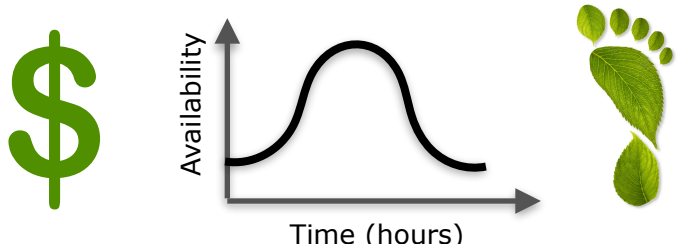
Energy-agility = Work done given a power signal P(t) that dictates an energy cap over each interval (t - T, t]

Energy-agility (2/3)

Salient Characteristics

1. Accounts for energy **used** and **wasted**

2. Captures energy characteristics



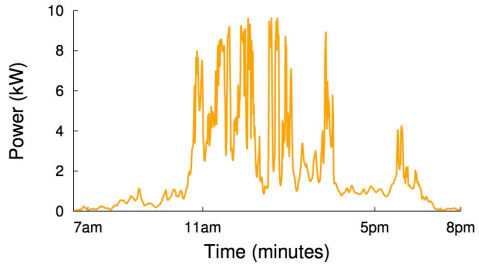
3. Quantifies dynamics between a ***platform***, its ***workload*** and its ***energy***

- ☑ Enables a rigorous and Price-independent system evaluation

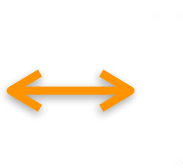
Energy-agility (3/3)

Design Considerations

System



Input power signal

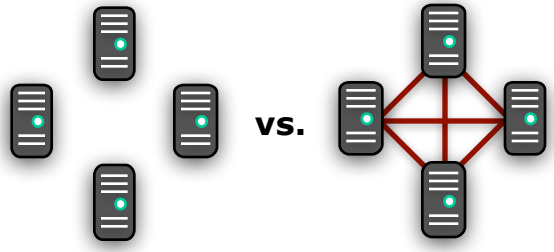


Energy Storage

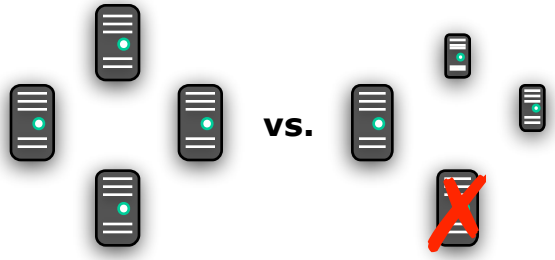
DVFS / ACPI S-states

Platform power states

Application



Inter-node coordination



Intermittent power changes

Conclusion

Energy-efficient systems are not necessarily “green”

- ☑ Quality/characteristics of energy matter as much as the quantity
- ☑ Current metrics are ineffective for green energy

We propose a new metric, ***energy-agility***

- ☑ Enables a rigorous performance evaluation of a green compute system

Questions

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Sustainable Computing Lab (http://sustainablecomputinglab.org/)

Thank you!