

Energy Efficiency in Online Data Intensive Systems

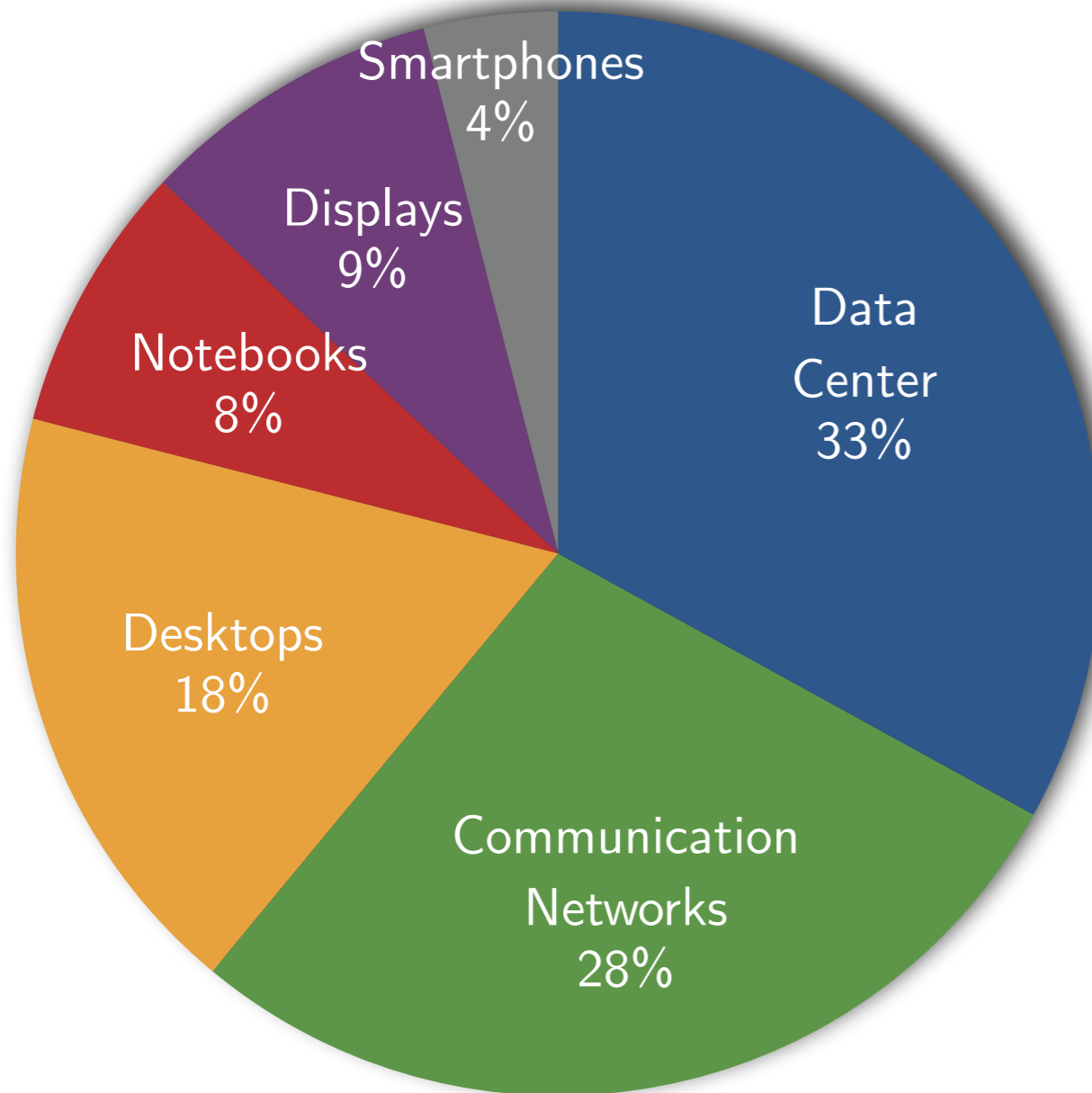
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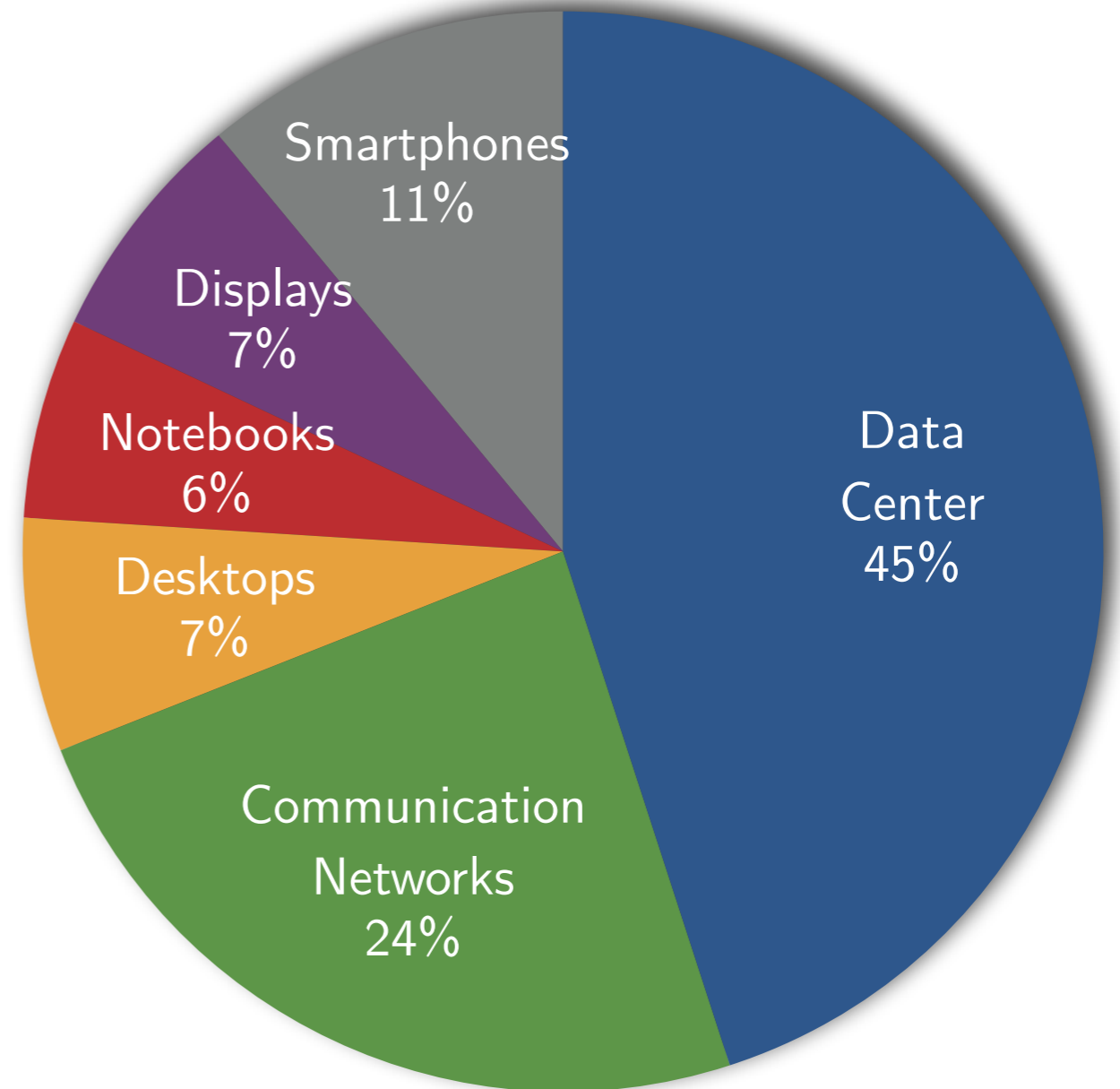
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ICT Global Carbon Footprint

Relative contribution – 2010



Relative contribution – 2020

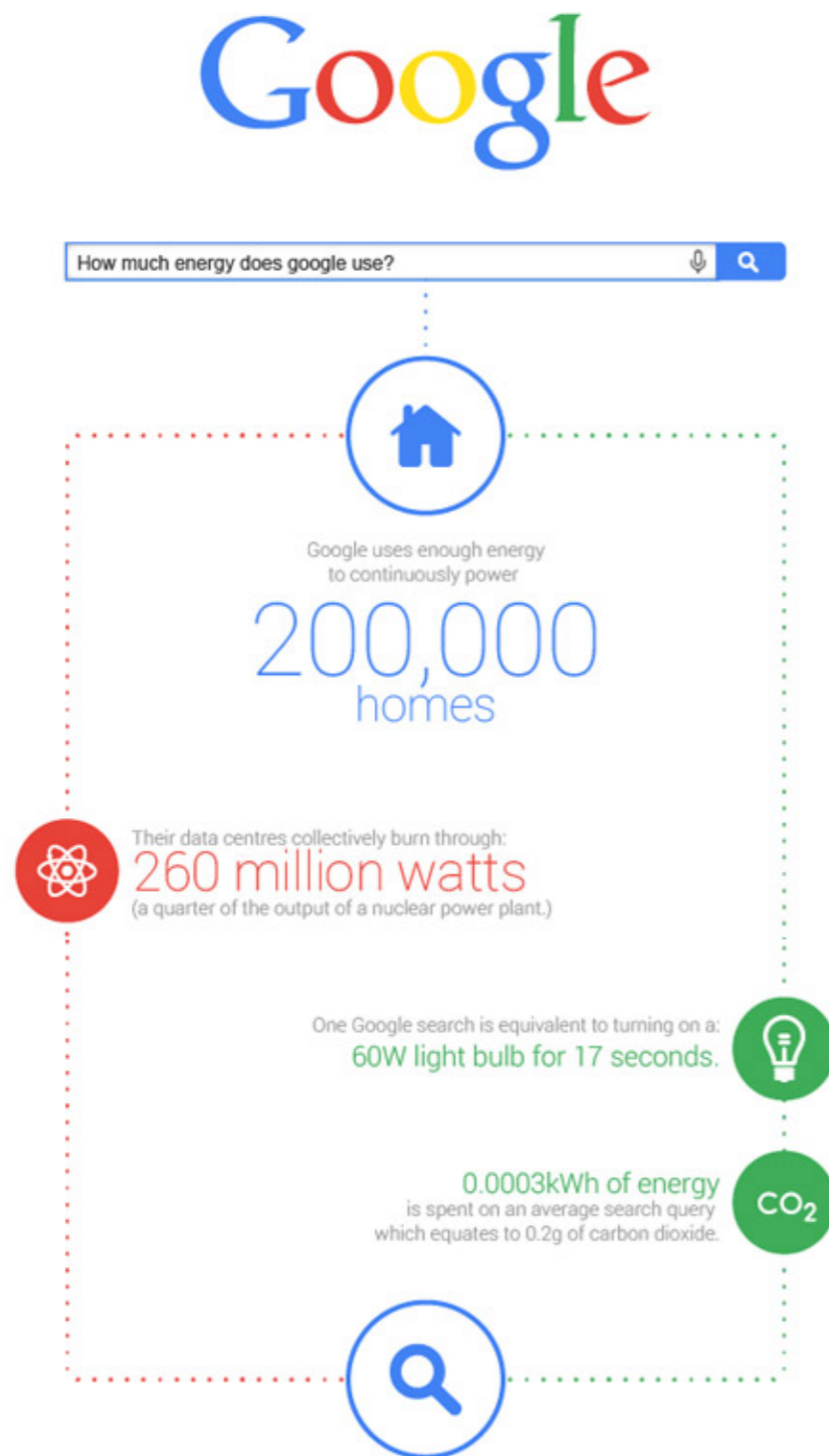


QUINCY DATA CENTERS

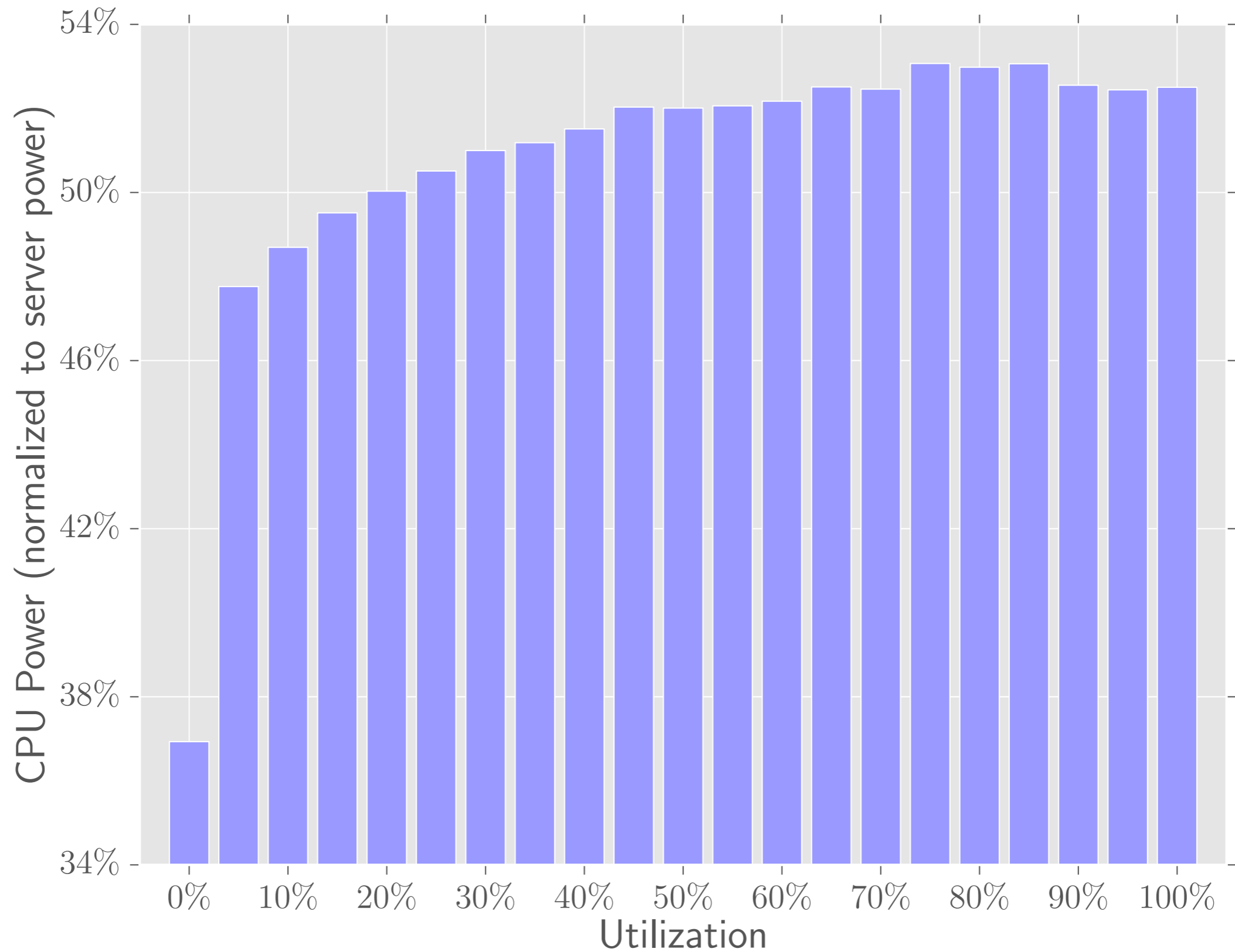


Source: <http://www.coloandcloud.com/editorial/quincy-wa-big-data-centers-leverage-abundant-inexpensive-renewable-energy/>

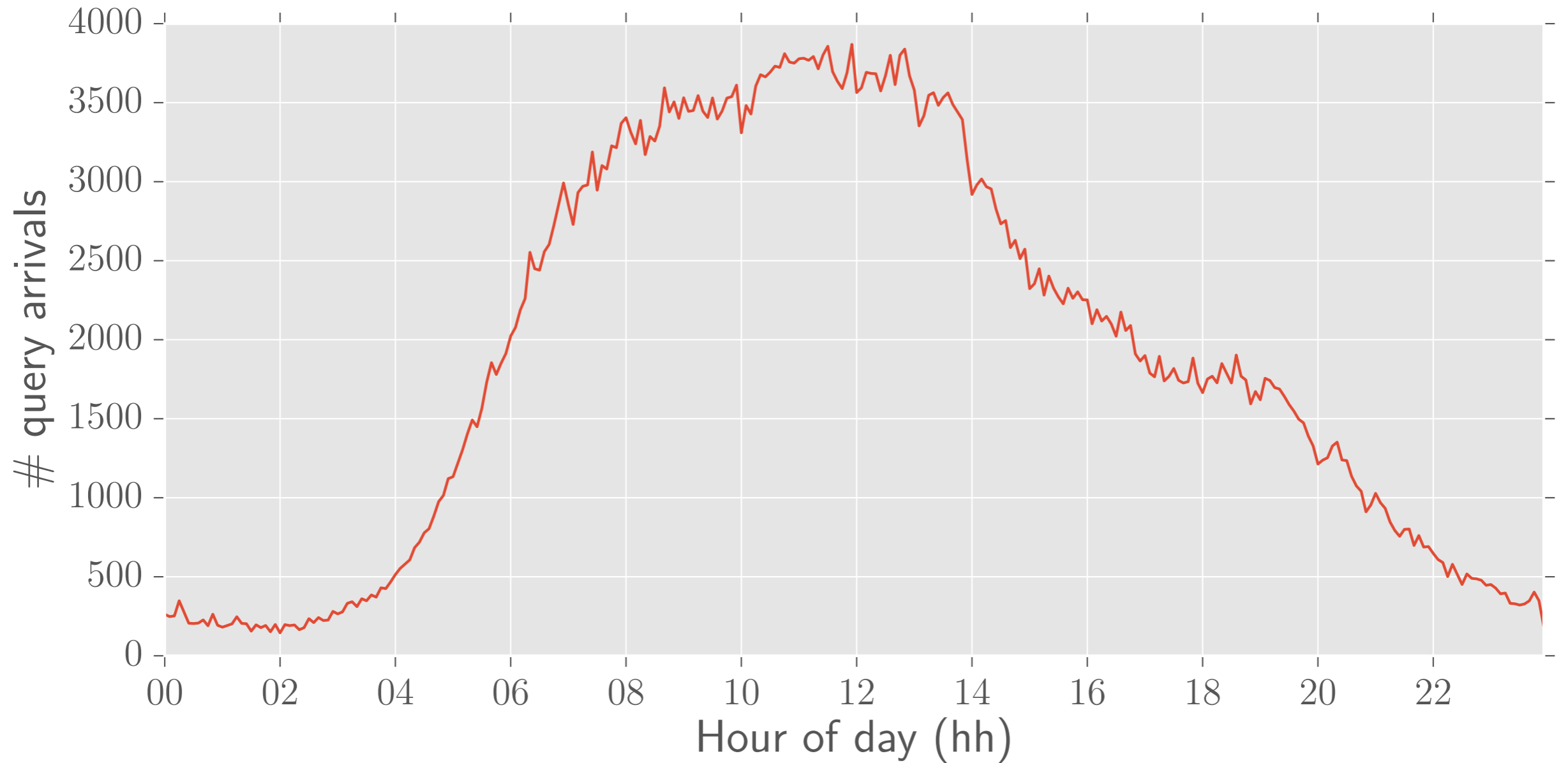
How much energy does a search engine use?



CPU Energy Consumption (II)



Search Engine Daily Query Traffic

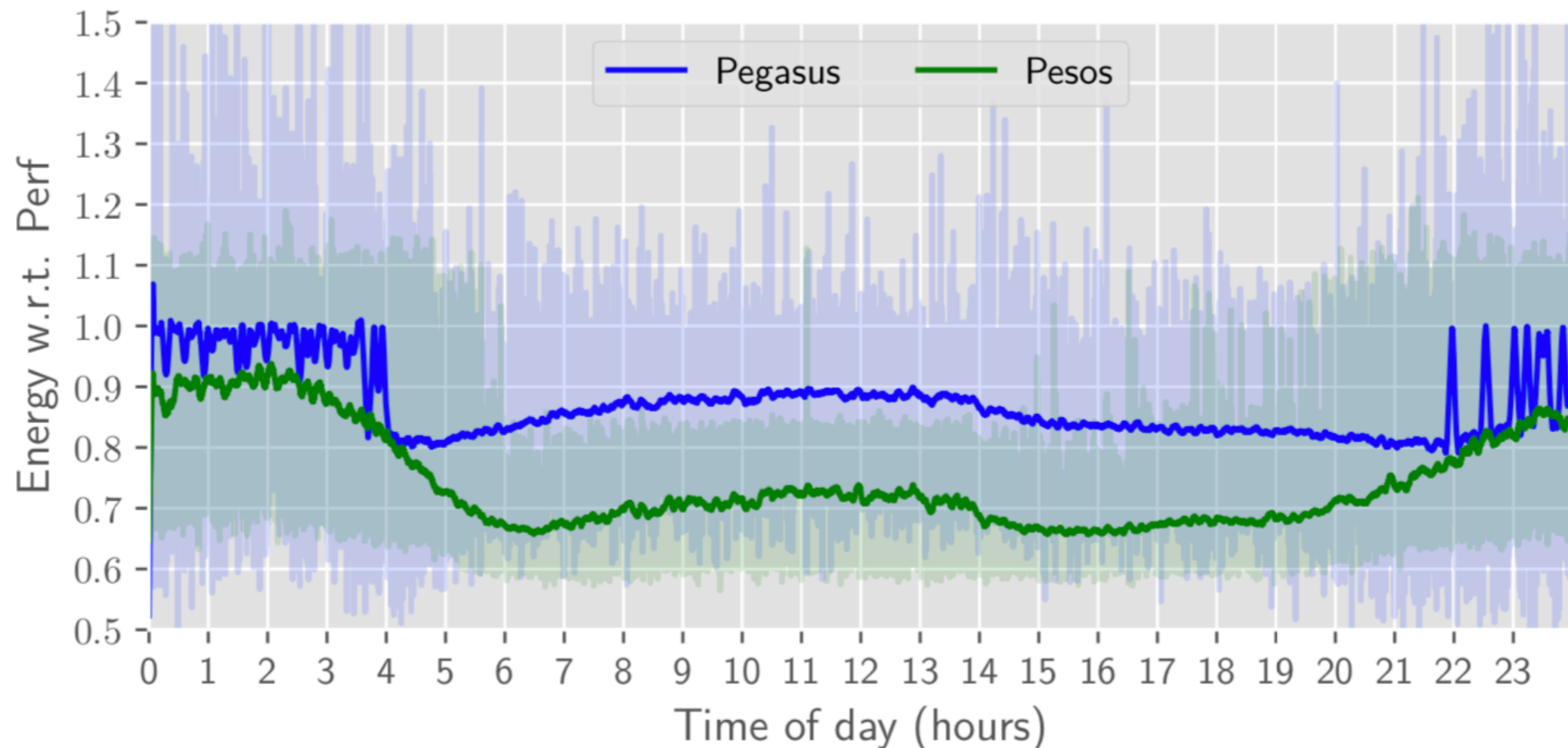


Idea

- We must take into account **processing times** constraints
- We could **minimize a combination** of energy consumption and processing times
- But **users can't distinguish** response times smaller than a given latency (e.g., few hundreds of milliseconds)*
- Try to **reduce CPU energy** consumption while fulfilling a given **latency constraint**.
 - E.g., each data must be processed in less than 500 ms.

* I. Arapakis, X. Bai, B. B. Cambazoglu. *"Impact of response latency on user behavior in web search"*. SIGIR 2014

Experiments



- PEGASUS does not exhibit significant energy savings when traffic is low
- PEGASUS energy savings up to ~20% w.r.t. PERF when traffic is high
- PESOS energy savings up to ~10% w.r.t. PERF when traffic is low
- PESOS energy savings up to ~30% w.r.t. PERF when traffic is high

Overall Energy Consumption

	PERF	PEGASUS	PESOS
Energy (MWh)	254	218 (-18%)	179 (-29%)

What is next?

- How to incorporate heterogeneous data/processing requirements?
- How to leverage renewable energy sources, e.g., air, solar, geothermal?
- How to incorporate personal energy sources, e.g., solar panels?
- How to leverage autarkic energy markets?
- Can we Leverage blockchain technologies to implement energy market ledgers?

References

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