CS305: Computer Architecture

Empirical Evaluation-III

https://www.cse.iitb.ac.in/~biswa/courses/CS305/main.html

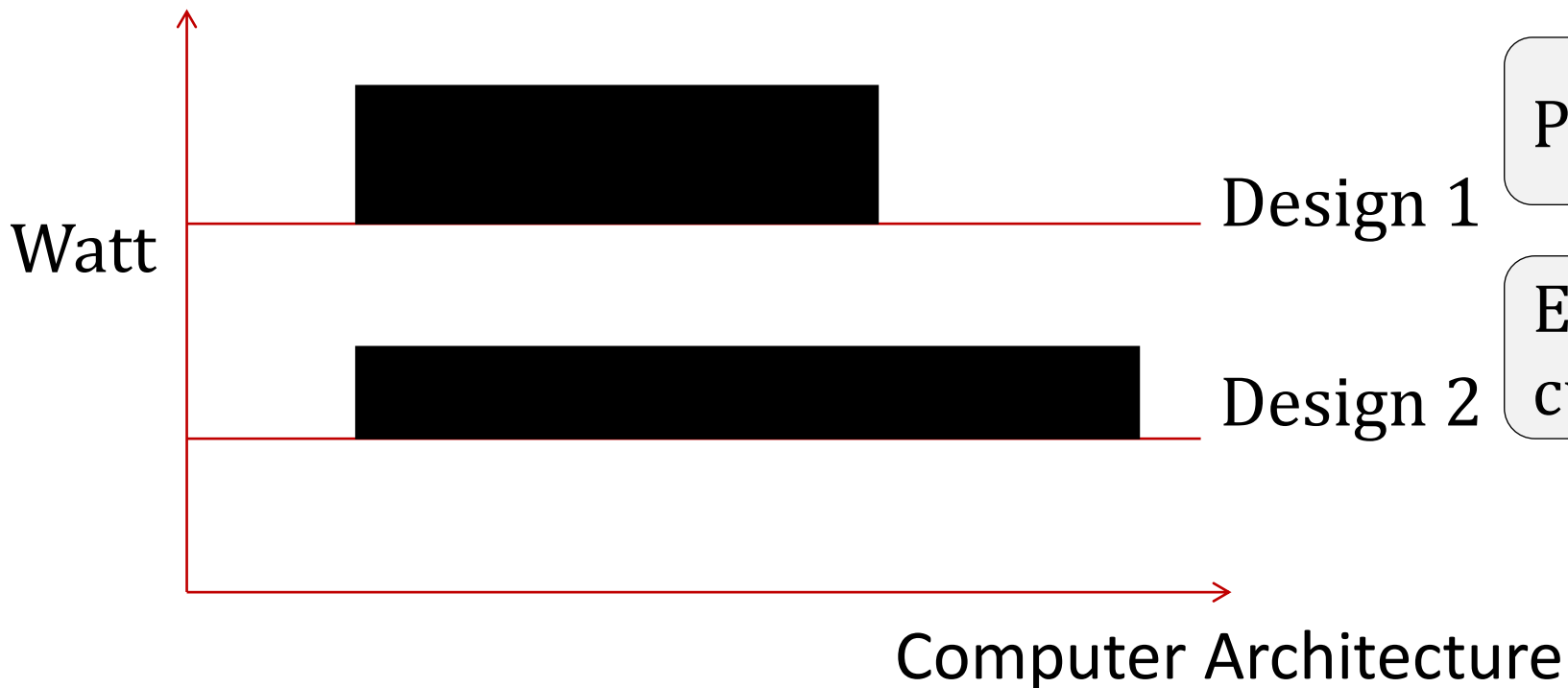*https://www.cse.iitb.ac.in/~biswa/*

Energy and Power

Energy: Measure of using power for some time

Power: Instantaneous rate of energy transfer

Power: Height of the curve

Energy: Area under the curve

Watt

Design 1

Design 2

Computer Architecture

Power Efficiency

Power efficiency = Performance/watt

Energy efficiency = Performance/Joule

Why Power/Energy?

Mobile battery life ☺

Electricity bill ☺

Power – heat, more cooling systems, more electricity
Co2 emissions ? ☹ Sustainability?

Power

- Dynamic one: Power consumption when a unit performs some operation (transistors switch between 0 and 1) : $C\,V^2\,f$

- Static or leakage one: leakage current flows even when the transistor is off

Just an Example

Intel 80386 ~ 2W

Intel Core i7 ~ 130W ☹

Techniques like clock gating, power gating, DVFS, later in the course.

Data Centers [Courtesy MICRO 20 Keynote]

205TWh of electricity/year used[†]

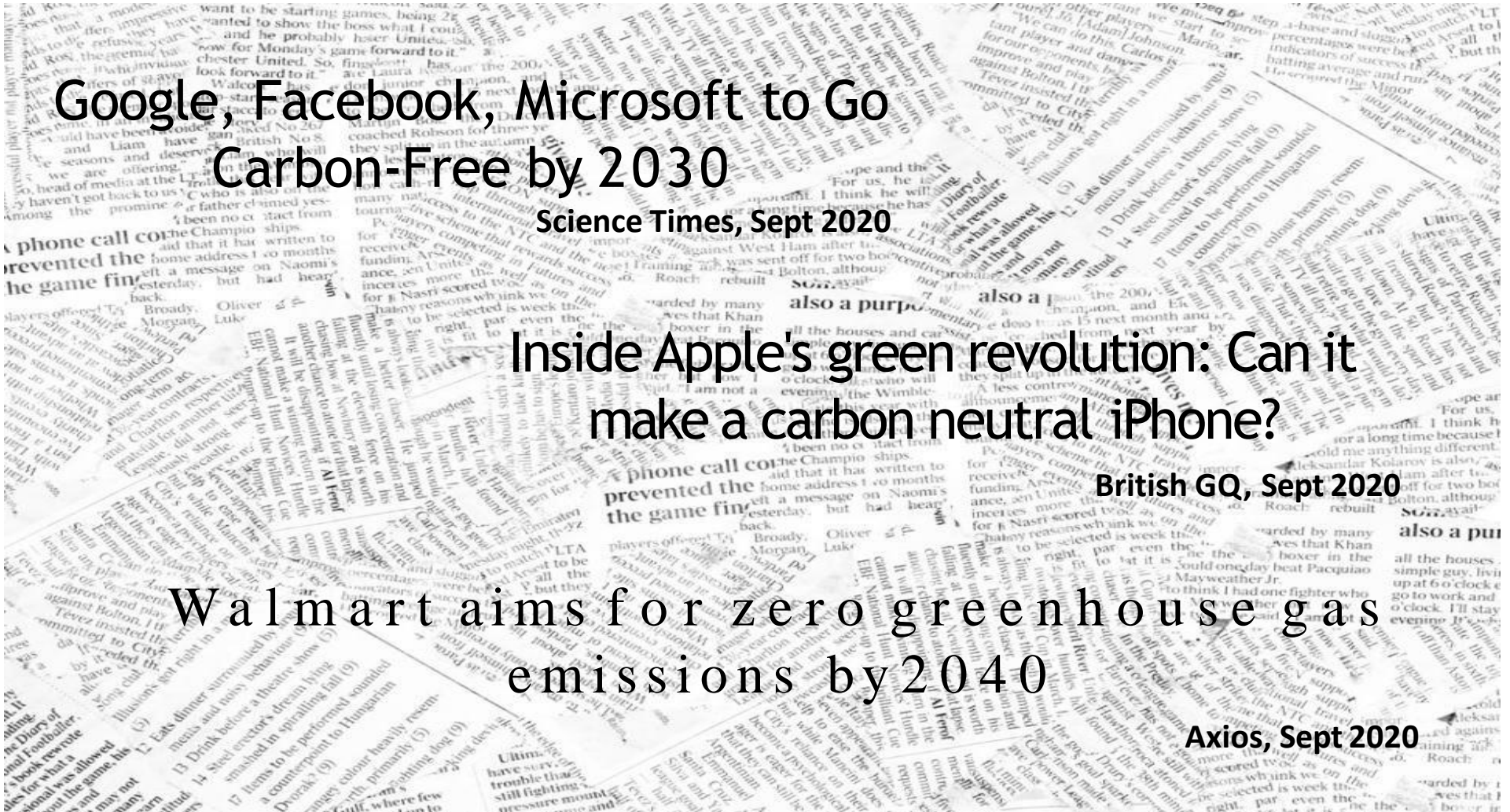Equivalent to 1 year of: *

31.3M cars

31,292 wind turbines

189.3M acres of forestland
(Texas is ~172M acres)

145M metric tons CO_2

https://www.iea.org/reports/data-centres-and-data-transmission-networks

Computer Architecture

The Big Guys are ....

Google, Facebook, Microsoft to Go
Carbon-Free by 2030
Science Times, Sept 2020

Inside Apple's green revolution: Can it
make a carbon neutral iPhone?
British GQ, Sept 2020

Walmart aims for zero greenhouse gas
emissions by 2040
Axios, Sept 2020

The future

"A cloud for everyone, on every device."
Satya Nadella

Current World Population

7,810,981,656

As of September 10, 2020

World Internet Users

4.57 Billion

As of July, 2020

Examples

	Monthly Active User	# Monthly Active Users	Carbon/year (Metric Tons)
Facebook (2019)*	~0.1 kg CO2e	2.38 Billion	252,000[†]

0.25 miles   54,443 cars

	Cost per hour (KWh)	Average Daily Hours	Tons CO2e/day	Carbon/year (Metric Tons)
Netflix-2019[+] (Including Devices)	0.12 – 0.24	165,000,000	14,141-28,282	5,200,000 to 10,400,000

0.2 – 0.4 miles   1.1M – 2.2 M cars

* https://sustainability.fb.com/report-pages/climate/
[†]86% renewable energy mix
[+]George Kamiya, "Factcheck: What is the carbon footprint of streaming video on Netflix?",
https://www.carbonbrief.org/factcheck-what-is-the-carbon-footprint-of-streaming-video-on-Netflix

Gracias