Matt Krueger HW #1

1. In order to "feed" the internet, massive data centers continue to be built to host the servers. These data centers are physically large facilities that consume huge amounts of energy. Considering what you as a consumer feel is important when you visit a website, answer the following.
   a) Enumerate four elements that should be considered when selecting a new location of creating a data center and briefly explain why they are important.
   b) What do you think would be the implications for a community hosting a large data center? Enumerate at least three and assess them as positive or negative impacts for the community.

a) Geographical Location: choose a 'safe' location that is free of natural disasters or humans with potential to damage data center
Existing Infrastructure: energy & surrounding infrastructure to use; costs should be minimized and existing infrastructure should be up-to-date with newest tech.
Population/Proximity: should be close to service many customers/clients
Scalability: enable expansion of data center. This is timely as AI datacenters are needing to be larger than ever. ex: Stargate

b) + accessibility/speed: clients are able to quickly access data
− environmental: data centers are detrimental to the environment; increased CO_2 usage → pollution
+ jobs: workers are required to ensure that the center functions properly

2. In 2022, all datacenters combined around the world consumed around 300 TWh of energy. which translates to US $50 Billion for energy usage. A barrel of oil produces 1700 kilo-watt hours releasing 1.3 tons of CO2 emissions. Datacenters accounted for 137.6M tons emission of CO2 that year. For comparison purposes 200M tons of CO2 = amount of CO2 is the amount produced by 40 million cars. Using this data, evaluate the impact of reducing the power consumption of all data centers combined by 10% in terms of:
   a) Economic cost
   b) Environmental impact

$300 : 50 \text{ b} \rightarrow 6 \text{ TWH} = 1 \text{ b}$
$270 : x \rightarrow \frac{270}{6} = 45 \text{ b}$

a) cost: −10% → 270 TWh
reducing power consumption by 10% would decrease spending on energy by 5 billion

b) 1 barrel: 1700 kilowatt hours, 1.3 tons CO_2
data centers: 137.6 m tons
# of barrels: $\frac{137.6e^6}{1.3} = 105,846,153.8$ barrels
reduce 10% → 95,261,538.46 barrels ~ Saving 10,584,615.38 barrels and reducing CO_2 by 13760000 tons

3. A typical desktop computer uses about 50 to 250 watts (https://www.kompulsa.com/much-power-computers-consume/). Assuming the cost of 1 kWh of energy is 12 cents and the computer is never turned off, answer the following.
   a) How much have you paid after running the computer after a year? Assume 150 Watts av.
   b) What factors are making this cost an over estimation?
   c) Consider a data center that is running 24/7. The Datacenter consumes and average of 150MW. What is total electric cost incurred by the data center in a year?

a) Hours in year: $\frac{24 \text{ hrs}}{1 \text{ days}} \cdot \frac{365 \text{ days}}{1} = 8760 \text{ hrs}$ $\frac{150 \text{ watts}}{1} \cdot \frac{8760 \text{ hrs}}{1} \cdot \frac{\$0.12}{1000 \text{ watts hrs}} = \$157.68$

b) the computer being always-on makes this an overestimation

c) $\$157.68 \cdot 10^6$

4. There are several measures that can be adopted to reduce the amount of power required by a datacenter. Google has implemented a number of these improvements (http://www.google.com/about/datacenters/ top of page efficiency).
   a) Enumerate three of these measures.
   b) Can you think of something else that data center owners could do to reduce the power consumption in their datacenters? Explain your answer.

a) temperature & cooling modules: reduce energy consumption by 70-90%
- 0.13 W cooling per watt of direct power

cloud servers with high utilization: reduce direct energy for servers by 70-90%
- reduced amount of servers
- higher usage on servers

limited carbon emissions: cleaner energy sources
- windmills
- solar energy

b) task management / optimized computer algorithms: limit "always-on"
I'm sure something of the same idea is implemented, but have a main always-on computer/computers allocating energy resources to other computers in the cloud to increase efficiency by idling computers.