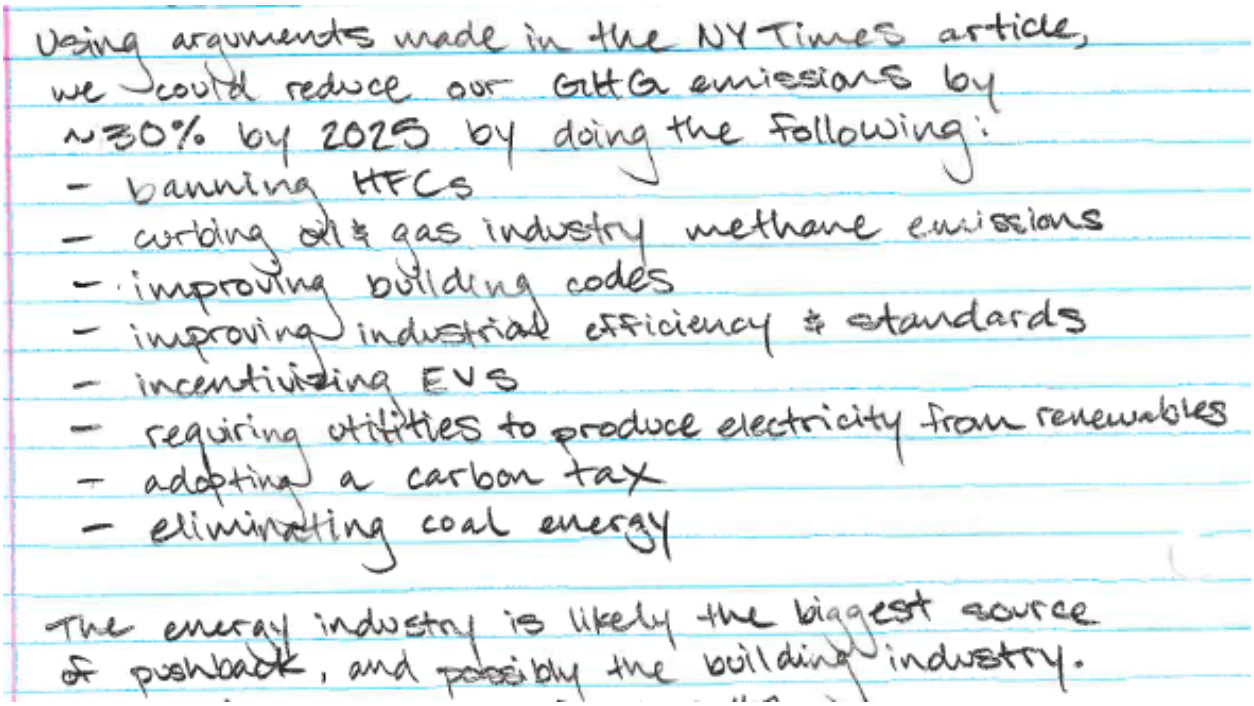
PS#6, Due Tuesday, February 19

1. I've heard that each person is about a 100 W lightbulb… that we put out heat at the rate of about 100 W, on average throughout our lives.
   a) Does it seem to you that this is about right if you think about the heat you give off… does it compare to be about the same as a 100 W lightbulb? You'd have to do your own estimation about this. A 100 Watt bulb is way hotter than a person, but a person has much greater surface area.
   b) Consider if you just lived and didn't exercise too much, how many calories would you consume in a day. Energy in = Energy out. So if you metabolize all the nutrients in your food into heat (a reasonable estimate), calculate the rate at which you dissipate heat into the world. Is this close to 100 W? Remember that a **C**alorie is actually 1000 thermal calories. What if I eat 3000 Calories a day, or 3 million calories (1 cal = ~4.2 J), or about 12 MJ a day. That's ½ MJ/hour, an hour is 3600 seconds, corresponding to 10^6J/7000s, or 140 W.
   c) There was one more question we could ask: Estimate your CO_2 emissions for a day knowing the carbon intensity of your fuel. We know that sugar is like wood (30 g(C)/MJ) and fat is oil (20 g(C)/MJ), so we can estimate the carbon intensity of your food as about 25 g(C)/MJ, multiplying by 44/12 to convert to CO_2 we get about 90 g(CO_2)/MJ). Thus, converting 12 MJ of energy at this rate, we get a little over 1 kg of CO_2 emissions daily.
2. Fission – Fusion what is the difference between these two processes?
   a) How are these two processes different? Please give an example of each process. Fusion joins small nuclei (like in the sun) while fission breaks apart large nuclei.
   b) What is necessary to make each process happen? What do we have to do to make it happen? Fusion, we need to get them to collide, it's all about confinement and heating them up so they collide at high velocity. Fission, you need critical mass so the neutrons collide with a nucleus, so it's about increasing the amount and density of the fuel and controlling the neutrons.
   c) What are the major challenges to making each a wide-spread source of clean energy? Fusion, we can't make it work. It's hard to confine the hot plasma. Fission, we have to control the neutrons, and dissipate the heat or risk a meltdown. In particular with Fukushima, the reactors shut down, but there was no power to keep the water pumps running. The delay neutrons from the radioactive isotopes gave off enough heat to cause a meltdown.

3. Everybody's running on the democratic ticket to be the next US president… how about you too? In your next campaign speech, consider how the USA is going to comply with the Green New Deal and cut carbon emissions 100% in the next 10 years. Make some arguments based on the real numbers of what causes GHG emissions – we have a GHG sources slide in our lectures. Make a strong argument as to what we can cut and not cut and how close we can come to this aspirational state of carbon neutrality in the next 10 years. Who are your supporters, adversaries? What might you do to mitigate blowback? To get an idea of what's working for other countries, please see this NYTimes article: https://nyti.ms/2E7yKLk



4. Thinking about MT#2 next Friday Feb. 22? Maybe you could take last year's MT#2 being this problem set is so light. Keep in mind that this year we covered solar energy before MT#2, so solar energy will also be covered.
5. Petroleum:

   A) Please explain how increased demand for petroleum is *increasing* the amount of (available) petroleum reserves in the ground. Explain the ensuing risk to humans and the environment that result from increasing accessible petroleum.

   B) Please see this short US EIA report (https://www.eia.gov/energyexplained/index.php?page=oil_imports) to note recent changes since I made the petroleum video. Comment on recent changes that are interesting? What changes does this have with life in the USA (about driving and the kind of cars we drive.)

   C) A petroleum expert began a talk I attended in Berkeley with, "We used to be worried that we're running out of oil. Now we're worried we're *not* running out of oil." What did he mean by that? Why might some experts feel we *need* to run out of oil?

- America is now the leading country in oil production. Global oil reserves are increasing as supply has outpaced the consumer demand. We are at the point where if we used the entirety of the oil reserves we currently have, not including any future production, we would increase the temperature of the earth to make it unlivable! We need to run out of oil, at least halt oil production because we literally cannot use the reserves we currently have stored.

↑ price means ↑ supply

5. a) As demand for petroleum increases, supply decreases. This causes an increase in price of petroleum, which encourages producers to take bigger risks (like environmental degradation or endangering human lives) and/or improve technology in order to access more petroleum reserves.

b) I find it interesting that we're "unable" to track from where and to whom petroleum is imported in the U.S. due to the way refineries & import terminals are run. I also didn't know that we import fuel ethanol as petroleum.
My guess is that we've reduced our dependence on imported petroleum because of electric car popularity, (and maybe because of the Dakota Access Pipeline?).

Yes, very suspicious to me too

c) Our main problem now isn't running out of fuel, it's running out of time (to save the environment from the impacts of fossil fuels). From an economic standpoint, and some people's political standpoints, we'll likely need to run out of oil before people stop using it.

great answer

6. Remember to send me an Email with your empathy self-intervention epiphany.