

1. How many people live in the USA?: _____
2. How many people live in California? _____
3. Compared to the annual energy use of an average earthling, a US American uses:
the same 2x as much 4x as much 8x as much 16x as much 32 times as much
4. Climate Change is *primarily* the result of (check *all* correct).
 Emissions of greenhouse gasses like CO₂ and methane.
 Refrigerants destroying the ozone, allowing greater penetration of UV radiation.
 Sunlight is growing more intense
 The heat given off when we burn fossil fuels.
 The earth's atmosphere insulating the earth by absorbing infrared radiation.
5. The portion of *California's* Electricity supplied by *solar and wind combined* is about:
1% 5% 10% 25% 50% 75%
6. Global Solar deployment (total amount of solar power) doubles every
Month year 2-3 years 5-7 years 8-12 years 20 years never happens
7. What is the *per capita* electrical power consumption in the USA?
1 W 10W 100 W 1000 W 10,000 W 100,000 W MegaWatt, GigaWatt, 100 GigaWatt,
8. The USA average *per capita* CO₂ emission is closest to:
50 mg, 10 kg, 1 Ton, 15 Tons, 25 kiloTon, 85 kiloTon, 1 MegaTon, 10 MegaTon, 30 MegaTon, 3 GigaTon,
9. The power output of an average coal, NG, or nuclear facility is closest to a:
Watt, milliWatt, kiloWatt, MegaWatt, GigaWatt, 100 GigaWatt, Tera Watt, 17 TeraWatt
10. Check *all* the correct statements
 China emits more *total* CO₂ per year than the US.
 China emits more *per capita* CO₂ per year than the US.
 China's CO₂ emissions have grown significantly over the past 10 years while US emissions have dropped slightly
 China's CO₂ emissions continue to rise, with no end in sight.
 China is responsible for more total CO₂ presently in the atmosphere than the US.
 China emits more criteria pollutants (like mercury, SO_x and NO_x) than the US.
 Most of China's electricity comes from nuclear, so China's electricity is relatively carbon-free.
 About 25% of China's emissions result from production of exports, so these emissions could be assigned to other countries.
*****short answers*****
 - 1) At a party, you hear, "I'm going to buy ethanol to fuel my car, then I won't have to worry about CO₂ emissions!"
 - a) Why is it possible to say that in burning ethanol, the tailpipe emissions add no CO₂ to the atmosphere?
Folks did pretty bad on this... the CO₂ coming out of the tail pipe is the same that the plant absorbed over its lifetime.
 - b) LCA (life cycle analysis) emissions *actually* free of CO₂ emissions, almost free, or does ethanol fuel emit a lot of CO₂? Please explain your answer.
Fertilizer is a big part of this... producing fertilizer from natural gas is very carbon intensive, although we could capture the carbon, we don't... but there's many other parts of the process that are carbon intensive.
 - c) Please describe one environmental impact of the biofuel industry not related to CO₂.

- 2) Please explain the three kind of lighting technologies: how they work, what causes the light!
- Incandescent.
 - Fluorescent
 - LED
 - Now that you've identified them, please indicate which I should buy and why.
- 3) Electricity is generated using natural gas in California. My Nissan Leaf has a 20 kWh battery, meaning it can hold 20 kWh of electrical energy.
- If I charge the battery from a 6 kW charger, how long will it take to charge the battery? Show your work
 - How much will it cost to charge the battery? Show your work
 - How much CO₂ will be emitted into the air to generate the electricity to charge the battery of my car? Show your work
- 4) I want to put 2000 W of solar panels on my house.
- About what will the surface area of the panels be? Show your work
Sunlight is 1000W/m², with 20% efficiency yields 200 W/m².
 - About how much will I have to pay for the panels when I buy them? Show your work
 - About how much will the entire installation cost? And what other costs are there? Show your work
Most folks WAY underestimated this. When you put panels on your house, the panels constitute less than 20% of the cost. The rest is near equal parts of installation, balance of system (the electronic processing stuff), permitting, and maintenance.

5) Heat pumps

a) What does a heat pump do?

Folks did pretty bad on this one... a heat pump is just an AC or refrigerator making heat (not water or air) flow “backwards”, from cold to hot.

b) Briefly describe the mechanism by which a heat pump operates. Include a simple drawing.

c) Let’s say I want to heat my home in the winter. What are the pros and cons of doing it with a heat pump versus burning natural gas?

d) Several of our speakers talked about using heat pumps instead of natural gas as part of the greening of California. Please explain why heat pumps would be more environmentally sound *especially in the future*.

The key thing about the future is that likely the grid electricity will be near carbon free.

e) Let’s say I decide to put in a heat pump to warm my house in the winter and cool it in the summer. Describe what I can do to maximize the efficiency and why such a strategy works.

6) Nuclear.

- a) Pete finds nuclear so unimportant that he forgot to put it on MT#2. Why might Pete not think nuclear is worth talking about too much? You can also state if you disagree with me and why. *My perspective is that 40 years is too long to be married to a technology, necessary to pay off the mortgage for the massive capitol cost of building a plant... things are changing too fast. We don't even know for sure we'll stay with central station / grid infrastructure... but that's just me. Maybe others have a different perspective... lots of people claimed irrational public fear is the only think holding back nuclear. I don't agree, but I could be wrong.*
- b) If we did expand nuclear, we could reprocess fuel rods to extract plutonium and unused uranium. Pete's friend, DH convinced the government to not allow reprocessing out of concerns about proliferation. Please explain why reprocessing fuel rods could be a proliferation risk. *"chemically distinct" makes things easy to purify.*

ESSAY:

AOC calls you to guide national policy on the Green New Deal because she heard about all the great changes happening in California. You will be graded on how you support your answers with course content, not by the political agreement of your answers with mine. If you don't want to work with AOC, please pick the politician of your choice.

In your discussion, I will expect you to identify all of the following in your plan: *market* and *command and control* mechanisms; *supply side*, and *demand side* management; *internalizing externalities*, *smart grid strategies*; *CCE* or *CCA* (community choice energy or aggregate); *environmental justice* issues. Upstream emissions. Even if you don't endorse some measures, I want you to identify them in your discussion – even if to say, “don't do this because...”

Ground Transportation: About what portion of California's GHG emissions are from motor vehicles? 1%, 5%, 10%, 20%, 40%, 60%, 80%, 90%, 95%
What changes do you foresee in the next 10 years in automobile and truck technology and how society travels? And what changes will we make in order to decrease emissions during this time?

I didn't manage this essay part well, in my opinion. Using the terms above isn't sufficient if you don't describe them in a way that makes it clear you know what they are.

Many folks used the words incorrectly:

Environmental Justice, should really be called “environmental injustice”

*Supply side and demand side refer only to markets that you're trying to balance such as energy markets where you have to make sure that the demand is met... it doesn't really refer to buying cars because if there's too many or too few cars, the market takes care of itself. So it really isn't appropriate to say “we'll stop selling ICE cars as a supply side” mechanism to move the country to low carbon. Such a move would be a bold command and control mechanism true. However, supply side is when you make sure that the consumer always has enough electricity, water, sewer capacity, natural gas. So installing battery storage would be a supply side mechanism to balance the load, where real time pricing or other smart grid market mechanisms would be demand side control or *demand response*.*

Upstream emissions generally only refers to energy... for instance for gasoline, you have tail pipe emissions as well as the upstream emissions of the mining and processing of the gasoline. However, electric cars are zero emissions... except for when you consider the upstream emissions of the electricity. Many people used the term for “embodied emissions” for say beef. This is the first time I asked this kind of question, so I'm grading gently on this.

Smart Grid: just writing this is insufficient. What is the smart grid? How are we making this communication work? How will we improve this two way communication?

The California Grid: How do we make it greener, and what (if anything) should we do about the grid falling apart? What challenges do we face as we go 100% renewable and what should we do about it? Support your answers.

Our homes and neighborhoods? What changes do you recommend in our building codes? Support your answers.

Them (as opposed to us)

1) Should California build strong ties with poor countries? They are poor... what advantages would collaboration with them bring us with respect to energy, society, and the environment?

This question was great... I never expected such a diversity of answers... except everyone said that we *should* engage:

- Environmental justice indicates that we have an obligation to help them... especially because our wealth is the cause of their CC problems.
- By helping them develop carbon free, we make the world better for us.... We have the know-how because of our technology!
- We can learn from them how to be happy with less.
- They have small activation barrier to change, so we can implement things there faster than here... and learn quicker about our own future
- We'll look like super great leaders by helping out poorer countries
- We'll have access to their natural resources by forging good ties with them
- We can earn money through the international carbon market if we can help them develop carbon-free!

- They are massive emerging markets! Let's exploit this opportunity and make a financial killing before China does! What's cool is that all political ideologies want to do the same thing, so you can provide each person with a good reason to do what you may want to do for a different reason!

2) What actions are being done toward electricity in poor countries? How is it different from the way the US became electrified?

3) Distinct from really poor countries, tell me about what's happening in China – what is changing there with respect to energy, economy, emissions?

Food – Health of the person and health of the planet. Do we have to compromise one for the other? California wishes to be a world leader in healthy people, as well as environmental management. – *Please provide facts learned in the class.*

1) Are there significant environmental effects from food production? If so, please name a few.

Again, Fertilizer is a big part of this... producing fertilizer from natural gas is very carbon intensive, although we could capture the carbon, we don't... but there's many other parts of the process that are carbon intensive. Then dumping the extra fertilizer into the water system poisons the water for drinking and makes algae blooms in oceans.

2) Do we have to compromise healthy foods to be environmentally responsible?

Most food that is good for you is also gentle on the planet... it isn't rule, but by and large this is the case for most foods.

3) Schools and supermarkets should have foods less damaging to the environment – please outline foods to avoid and foods to promote and why.

Red meats and milk products, then things that take lots of energy like frozen, processed, exotic imports, etc... many fish species are destroying the fishing ecosystems.