Assessment #8.

1. Your friend wants to go all solar: buy a Tesla and get solar panels on her roof. She commutes from Paso Robles (30 miles *each way*) and already has a $150/month electricity bill without the Tesla. Please calculate (estimate):
   a) her average energy use per month and average power draw after she adds the Tesla. Oops, I made a factor of 2 mistake in the final division. It should be an average draw of 2 kW, and thus I need a 10 kW system, 50 square meters, and $5,000, and a total cost of about $35,000. Yikes! But it would probably save me $4000 per year, so it would pay for itself in 12 years. 8 or 9 years.
   b) the power necessary for the solar panels
   c) The surface area of the solar panels
   d) The cost of the solar panels
   e) The cost to install a working solar electric system
   f) She wants to heat house and water with an electric heat pump. She presently uses 10,000 ft^3 of natural gas per month (~100 therms, or ten million BTUs). How would this consideration change the above calculations?

a) cost = 0.15/kwh · kWh, E = $150 / $.15/kwh = 1000 kwh/month

60 miles/day ⇒ 300 miles/wk ≈ 1500 miles/month   Tesla ⇒ 4mi/kwh

E = 1500 miles/month ÷ 4 miles/kwhr ≈ 400 kwh/month

P = E/t = 1400 kwh / (24 hrs · 30 days/month) ≈ 1 kW

b) assuming a capacity factor of ~25%, we get a 4 kW system ... Ok, a 5 kW system to play it safe

c) Sunlight is 1000 W/m² ⁄ solar panel ≈ 20%, so we get 1/5 kW/m²

so, we need ~25 m², or ~250 ft²

d) We can probably source solar panels at ~50¢/watt, so $2500 for the panels.

e) the Balance of System (BOS: inverter etc.) + permitting + ~~cost of~~ installation ~~[illegible]~~ is likely another $3.00/w or $15,000. So total cost = 17,500

f) 10^{10} Joules ÷ $3.6 \cdot 10^6$ J/kwh ≈ 3000 kwh$_{th}$ ÷ COP≈4 ≈ 750 kwh$_E$

This would increase the system size by ~50%

2. Ok, so what are we going to do? Governor Newsom hears that SLO has the country's most ambitious goal of carbon neutrality by 2035 and that you're in the energy class. He immediately invites you to telecom (because flying you out would be shameful). Set out a plan for him using facts and ideas from this class. If this question is too broad, you can pick one part of the solution to describe more fully.

   This question was worded ambiguously. It should have been worded: In California's quest to be carbon neutral by 2035, please provide the *policies* that you would recommend and back them up using information from our class. For example, "make everyone use renewable energy!" is not adequate. Please state policies and explain why they are good policies.

There are so many things we could discuss here. Some of the basic ones are increased efficiency, increased solar generation, electrifying electricity use, conversion of diet (good luck with that one), and management of the grid.

I'd start with leaning on PG&E to provide better incentives for people who want to go beyond net metering – so that each house could become a producer for the homes and businesses around them. Then roof tops would be completely covered with solar panels rather than 1/3 covered. Then we need to electrify energy use: Statewide incentives to convert to heat pumps, electric ranges, and electric cars. More below on how to make that happen.

Next, we need to manage the electricity so that supply = demand… or in my argument to ***manage demand*** to equal supply. We need to put real time pricing in full force. Each electricity consumer will have a display of the present cost of electricity. In a short time people will adjust to the variable supply. The electrification of the transportation sector will be a large part of this. The electricity provider can make a deal with each BEV owner so that the utility can charge and discharge the cars in a pre-agreed on pattern. In particular, when people come home for the evening, they should expect that their batteries will be somewhat drained in the evening to be charged again with wind power at night. There will need to be charging facilities at work so that cars charge in the day with ***FREE*** solar electricity and people come home with their cars relatively well charged.

In general, we need to internalize external costs. California should implement at \$100/ton CO_2 tax (corresponding to about \$1/gallon of gas and \$0.30 per kWh of NGCC electricity) and use this money to support efficiency, renewable energy, education, and carbon offsets such as reforestation and afforestation. These taxes will cover upstream emissions for foods, as food is a large part of our carbon footprint. We can let people eat beef and cheese if they are paying to offset the carbon, chemical, and water costs.

The longer-term goals are in city and regional planning. How do we find ways for people to live and work in the same place? Can we improve public transportation? Yes, we will electrify the transportation sector, but it would be even better to shrink it as well.

These are just some ideas that will start us on the right path. In particular, we need to have a state-wide discussion about energy use all the time. Financial consequences for our decisions is a great way to get this discussion going.