

Midterm #2.

1. The grid.

- a) Some economists argue that each user should be charged the marginal cost of electricity plus externalities at the time of use. Define “marginal electricity” *This is the electricity being used that the utility **least** wants to use. The last one that got turned on, or the first one to get turned off... it’s the one that they will turn down when you turn off your lights. So it makes sense that this is the electricity that you should be charged for. Additionally, externalities are part of the cost of my decision. If we don’t pay for them, then we will make decisions that cost us (collectively) more. If we **are** charged for externalities, we will make decisions that best serve society.* and make an argument supporting or contradicting this statement.
- b) People like to attribute the cause of the California Electricity Crisis of 2001 as caused by collusion of bad players, but I want you instead to describe the causes in light of the statement, “in order for the market to work, the decision maker needs to be responsible for the full cost of their decision.” *PG&E had to pay the producers (sometimes) exorbitant prices for electricity, but were not allowed to change the cost to the consumer. Hence the consumer didn’t pay (at the time) for their electricity. However, with the bankruptcy of PG&E, the consumers ultimately **did** pay for this debacle through increased electricity rates.*
- c) In California, we’re wrestling with the pros and cons of the “duck curve” in CAISO’s load profile. Please describe:
- i) What caused the emergence of the Duck Curve? *Rapid inclusion of solar electricity*
 - ii) What time period in the day will California increasingly have a problem? *Evening when load is still high (especially A/C) but the solar electricity is low. In particular, the ramping up of conventional electrical production is difficult for CAISO as they frantically (I’m imagining) bring more production online.*
 - iii) Provide a supply side and a demand side mechanism to mitigate this problem.
Supply side: *Make the supply meet the demand: produce more... build facilities to run in the evening, or build battery storage systems to store electricity during day.*
Demand side... or “demand response”: *make demand meet the supply – price incentives like real time pricing, contracts between provider and consumer to work together... PG&E can turn off my electricity sometimes.*

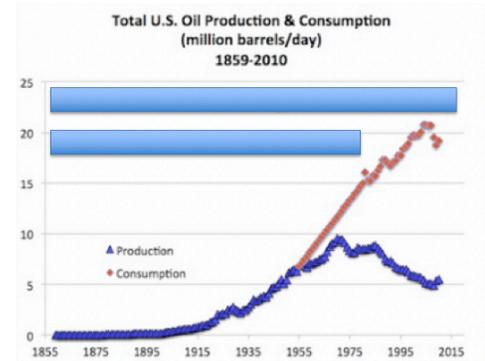
Chris Read outlined SLO's "deep decarbonization" strategy. Please briefly describe the "5 pillars" he outlined. You may have organized these 5 pillars differently than he did, which I will find OK, so don't worry too much about getting them exactly as he had them, but great if you can!

- 1) Carbon-Free Electricity
- 2) Carbon-Free Buildings – mostly through electrification of buildings... like not running NG out to new homes.
- 3) Low carbon transportation options... includes many infrastructure changes including electrification of automobiles.
- 4) Zero-waste... many of you noted that this is a big order... it'll be hard.
- 5) Carbon sequestration, especially natural sequestration, like growing trees.

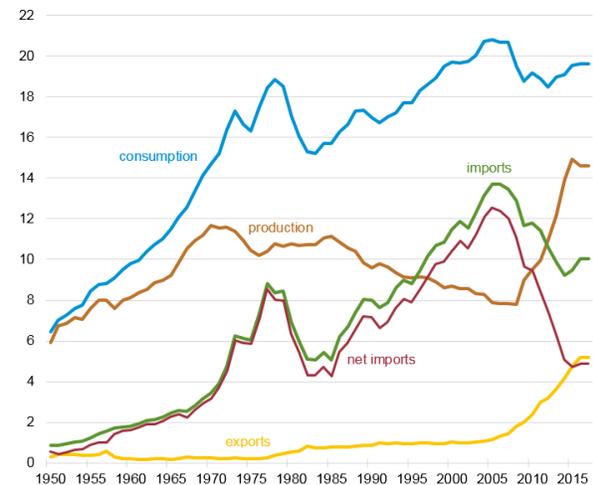
Please look at the graph at right, likely made around 2014 in US oil consumption and oil production.

- a) What is the cause of the abrupt recent change? Why? *I thought this was caused by the preceding high cost of petroleum... it lowered consumption after some time and incentivized more technologies to drill more.*
- b) Please extend the graphs to 2019 as best you can and describe what caused these changes.

This was strange.... Many people speculated what might happen. But, I'm asking you to recount what did happen from 2015 - 2019. Production: Fracking took off and doubled our petroleum production... remember the graphic from the EIA (energy information administration) we visited (at right). The USA is now the world's largest oil producer. Consumption: The conservative administration was against conservation... go figure. It reminds me that I had the president of the Cal Poly Republicans in my energy class long ago. He onetime exasperated to me, "I'm a conservative, we should be CONSERVING resources!" He didn't get it either. Anyway, Trump has not been promoting conservation or efficiency measures, so the consumption began rising again.



U.S. petroleum consumption, production, imports, exports, and net imports (1950–2017)
million barrels per day



Source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 3.1, March 2018, preliminary data for 2017

