

Assessment #9

1. Heat pumps and OTEC

- a) What is the difference between a Heat Pump and OTEC (Ocean Thermal Energy Conversion) *in their use?... one moves heat (not air or water), while the other is a heat engine generating work/electricity*
- b) Can a Heat pump put more energy into a room than the electricity it consumes? If so, how? If not, what do we use them for? *We have to obey the 1st law of thermal physics...conserve energy. But a heat pump doesn't MAKE more energy than it consumes, but it delivers more energy to a room than it consumes because it moves the heat from the cold outside with the electrical energy it consumes. Please see the diagrams explaining heat pumps.*
- c) Why is the performance of heat exchangers crucial for Heat Pump and OTEC efficiency? *Many people said that bad heat exchangers will lose heat or lose energy... you can't lose energy. For both processes (heat pump and OTEC), moving heat is crucial. Heat moves from hot to cold naturally, driven by a difference in temperature (even in each heat pump process while being pumped from cold to hot). Improving the heat exchanger will move the heat with a smaller dT (temperature difference.) Then we look at the Carnot Efficiency of the heat pump (where coefficient of performance **DECREASES** with increased dT) and a heat engine (where efficiency **INCREASES** with increased dT). However, because heat moves in opposite directions for these two devices, improving the heat exchanger, lowering the dT required to move heat across the heat exchanger, you will **INCREASE** the dT left for the heat engine, and **DECREASE** the dT that the heat pump has to pump against... thus the purpose of improving the heat exchanger increases the efficiency of both the heat pump and OTEC.*

$$\eta_{\text{Carnot}} = \frac{T_H - T_C}{T_H}$$

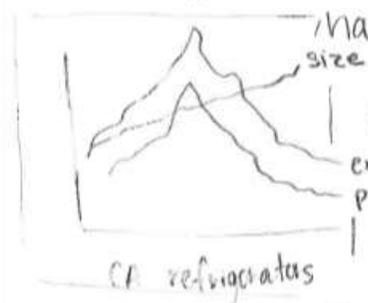
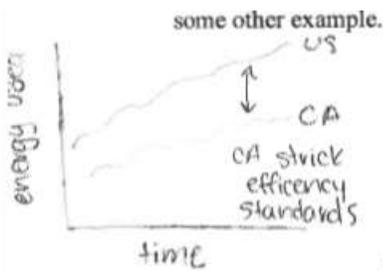
a- OTEC uses the thermal temperature gradient of the ocean to generate electricity as heat pumps put in work on a refrigerant to move heat. ☺

b- Yes, it moves energy from a reservoir (ie ambient air, a pond, etc) by using a refrigerant w/ a low boiling point. It expands and gets cold, letting heat flow into the system. Later, the fluid condenses and can release heat to the targeted area. ☺

c- Heat exchangers are the mechanism by which the ambient energy is pulled from

ambient environment, You want a small ΔT to work most efficiently, that is the temperature difference from your heat exchanger to your reservoir (or your exchanger \Rightarrow room). ☺

- Amory Lovins says that efficiency is like having someone pay you to eat lunch. Please explain how this can be the case with either refrigerators or California HVAC (Heating Ventilation A/C), or some other example. *How many ways did people misinterpret Amory Lovins' statement? Maybe I'm just old and out of touch... so there is this saying, "ain't no such thing as a free lunch" (ANSTAAFL)... Essentially meaning that if something seems as though it's too good to be true, there's going to be some other price to pay down the road... for instance, someone says, "hey use these lights and you will consume less electricity!" ANSTAAFL would dictate that they will cost more, or they will provide crappy light, or they will break, or they are toxic, etc. etc. BUT efficiency is different... not only do you use less electricity and not have to pay a price down the road, but you actually get MORE benefit... so not only is it a "free lunch", it's getting PAID to eat lunch... for instance LED lights: They do cost a little more, but they last forever (so they actually cost you less per hour of use AND you don't have to go out and buy them when they break because they won't break), they are programmable and produce any kind of light you like. They use less electricity, so you save money AND emit less carbon. They emit less heat, so in the summer, you will need less A/C... they clean the toilet (OK, they only go so far). An example for many systems (and I showed you a graph of cost versus increased efficiency), if you increase your efficiency (such as home insulation), not only is the home more comfortable and you save money on heating, BUT you also can down size the heater and A/C or do away with it even lowering the capital cost of building the house in the first place!*



This can be seen with the fridges because over time fridges have become more efficient because of things like command and control. Companies are given energy efficiency standards they have to meet. So in some cases you don't have a choice but to buy energy savers. Also because of market measures like incentives to buy efficiency you are more likely to because of a price break or money back you are given. The low price makes it desirable to buy.

3. We generally think that increased efficiency will decrease emissions and resource use. Please provide at least two well explained reasons why this may not be true. *You can read "Jevon's Paradox", or consider some of our happiness discussions. I'll post some of your solutions later.*

Just because we are increasing our efficiency does not mean we will decrease emissions. In fact we are not really seeing a decrease in our energy use as a result of more efficient technology. For example, lights. LEDs have been developed that are super efficient however, the Earth is brighter at night than its ever been before. We now have issues of light pollution and true darkness is something we really have to search for. Since the lighting is cheaper because of LEDs we just use more. Also refrigerators. Overtime they have gotten bigger, cheaper and more efficient. So first we buy a fridge bigger than the one we probably truly need. Then just because we got a new one doesn't mean we unplugged the old one rather just moved it to the basement so were paying to use that energy and resources the fridge is taking but we might not be using the fridge.