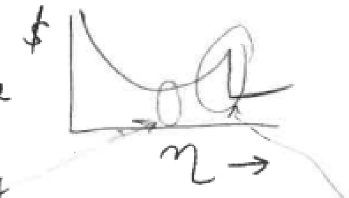
Assessment #5.

1) I'll draw a graph on the board relating increased efficiency measures (such as having wider, shorter pipes, or increased insulation) and total cost to the user or factory.
   a) Please explain why it might have that shape… or at least how Amory Lovins might explain it.
   b) Please explain what this might have to do with a "NegaWatt"? The NegaWatt is the power producing capacity you don't need because of efficiency measures. However, in this situation, it is the power *consuming* capacity (like the heater or heat pump) that you don't need to install.

b) Please explain what this might have to do with a "NegaWatt"?



a) As you start to invest money, efficiency goes up so that the savings you make relative to the initial investement starts to lower as η ↑. However, after a certain point, pumping more money in will only benefit in so many efficiency savings & that Δ starts to go up. This straight part is when your efficiency is so good you don't even need things like AC anymore.

b) A "nega watt" is like power not ~~used~~ needed. So when efficiency goes up, you use less power than you would have before. When "nega watts" are greater than actual power, you saved more than now has to be produced.

2) I manage a massive parking garage in LA… Crap! The lights are on all night long and hardly anyone is there. The *annual* energy usage is about 200,000 kWh. I first decide to install all LED lights at a cost of about \$100,000 to have them installed. This cuts my electricity bill in half. Make a simple estimate for me assuming that we only care about a 5 year time period and there is no interest rate:
   a) What is the cost of conserved energy? Saving 100,000 kWh/year for 5 years is 500,000 kWh divided by the \$100,000 capital cost yields a cost of \$0.20/kWh… a little more than you'd pay to *not* conserve the energy.
   b) Estimate the amount of abated carbon? 1/3 kg CO_2/kWh yields ~170 tons CO_2 reduction over the 5 years.
   c) What is the cost of abated carbon? The cost to you is the \$100,000 *minus the savings* from saved electricity bills… 500,000 kWh at \$0.15/kWh yields \$25,000. \$25,000/170 T ~ \$200/Ton.
   d) Are there any other benefits? You can fire ("let go") one maintenance person responsible for replacing lights because LEDs last so long. Additionally, there is less of a threat of lawsuit of someone falling or getting mugged because it's dark because the lights need replacing.
   e) Would you do it? Of course… but you might not unless a \$200/Ton increased the price of electricity to over \$0.20/kWh which would make the investment alone cost effective.

a) What is the cost of conserved energy?
b) Estimate the amount of abated carbon?
c) What is the cost of abated carbon?
d) Are there any other benefits?
e) Would you do it?

install = \$100,000 → P = 0

each year → $\frac{\$100,000}{5}$ = \$20k

a) $COCE = \frac{\$}{kWh} = \frac{\$20,000}{100,000\,kWh} = \frac{\$.2}{kWh}$

kWh ↳ not consumed

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electricity bill cut in half → 100,000 kWh not used annually

b) $100,000\,kWh \times \frac{185\,g\,CO_2}{MJe} \times \frac{3600 \times 10^3\,J}{1\,kWh}$

1 kWh × $\frac{60\,min}{1\,h}$ $\frac{60\,s}{1\,min}$ × $\frac{1\,J}{W \cdot S}$ =

$\frac{100,000\,kWh \times}{1\,kWh}$

NG → 1/3 kg per kWh

$100,000\,kWh \times \frac{1/3\,kg\,CO_2}{1\,kWh} = 33,000\,kg\,CO_2$ → before was double, so Δ = 33,000 kg CO_2

1 kWh = 3600 kJ

savings ←

c. $CAC = \frac{\$}{CO_2} = \frac{\$20,000 - \$15000}{33000\,kg\,CO_2} = \frac{\$5000}{33,000\,kg\,CO_2}$ ≈ $\frac{1}{6}$ \$/kg

\$170/Ton

savings → $\frac{\$.15}{kWh}$ × 100,000 kWh = \$15,000

d) less CO_2 = helping environment, LED will last way longer & is more efficient

e) Yes, LED is a better option in the long run

3) Nuclear Energy:

a) Very few of us are concerned about safety (nuclear waste or nuclear disaster). Why are most of us not concerned about safety? Even if you *are* concerned about safety, please state why most of us are not.
b) Explain the role of delay neutrons in controlling nuclear fission.
c) Why did DH prevent the US from going down a road of nuclear fuel reprocessing – be specific with direct reference to important substances. Plutonium chemically distinct, easily purified, weapons grade

c) Why did DH prevent the US from going down a road of nuclear fuel reprocessing – be specific with direct reference to important substances.

Per kWh

a) Nuclear accounts for the least amount of deaths from any energy source in the U.S. There is concern about discarding nuclear waste (if the rods got in the wrong hands) but we don't re-use rods in the U.S. The imminent deaths from coal right now outweigh potential catastrophies from nuclear down the line.

b) Delay neutrons help keep the reactions controlled. When a reaction is stopped, there are still fissions that create daughter nuclei/delay neutrons, so the reaction can be started again.

c) when the control rods are used, they can be dangerous in the wrong hands b/c plutonium can be chemically separated. Reprocessing nuclear waste could be very dangerous. because (?) Fissile!

4) Lighting. Please distinguish the following technologies wrt *how it works, *the relative efficiency, *how robust the device is…
   a) LED lights
   b) Incandescent Lights Black Body radiation. Filament gets hot and glows. Most of the light comes in the IR, so is not visible, but the bulb gets hotter than hell. Best used as a heater.
   c) Fluorescent Lights

I spoke about "efficiency" in the video, and how lights don't really have an efficiency because you see different wavelengths at different efficiencies. Different wavelengths have different *efficacies,* measured in lumens. We see best at green 555 nm at 683 lm/W… but would we want to have just green light? So different lights have different efficacies, and can be thought of as different efficiencies if we think of 555 nm as 100% efficiency. Please compare at https://en.wikipedia.org/wiki/Luminous_efficacy

a) LED → P/N junction diodes, last the longest, great variety of colors, best efficiency, least amount of power for same brightness (best option)

b) Incandescent → shortest lifespan, most expensive in the long run, worst for environment, most power for same lumosity, cheapest upfront cost.

c) CFL → medium lifespan, gas, medium power for same lumosity, can get pretty hot, medium expensive upfront cost.

⇒ Electrons Ionize gas ⇒ UV light
UV ⇒ excites Fluorophore ⇒ Visible light.