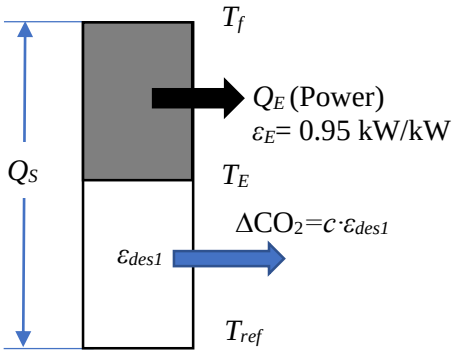
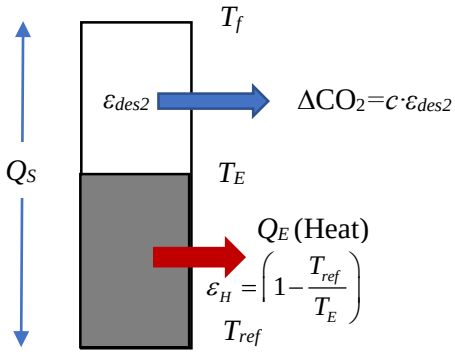
IS EXERGY DESTRUCTION MINIMIZATION IS THE SAME THING WITH ENERGY EFFICIENCY MAXIMIZATION? ***The Answer Is Definitely No.***

Assume that *energy* supply with an identical amount of Q_{sup} is utilized in two different applications at the same location with the same reference temperature, T_{ref}:

(1) either in generating electrical power Q_E. After power generation, heat is rejected at a temperature of T_E. Exergy is lost by a unit amount of ε_{des1}, or

(2) an identical amount but in the form of heat, starting at T_E this time. A different amount of exergy is lost by a unit amount of ε_{des2}. T_f is the energy source temperature (or Carnot Cycle-equivalent)





Case 1 Electrical Energy Generation, c=0.27 Case 2 Thermal Energy Generation, c=0.63

Everything looks the same in terms of energy quantities. The energy efficiency, η_I is simply equal to:

$$\eta_I = \frac{Q_E}{Q_S} \quad , \qquad (1)$$

For both cases, their energy efficiencies are exactly equal according to the first law of thermodynamics. In other words, it does not matter whether you generate power, steam, heat, or cold, all of which have different qualities and forms of energy. In this respect, do not forget that in one case (1) you get power and in the other case (2) you get heat. Only the quantities are the same but their qualities are quite different. Electricity has a unit exergy of 0.95 kW/kW, which means that 95% of electricity may be utilized in value-adding useful work. Thermal energy has generally lower unit exergy:

$$\varepsilon_H = \left(1 - \frac{T_{ref}}{T_E}\right) << 0.5 \text{ kW/kW} \qquad (2)$$

Both cases, namely 1 and 2 have different exergy destructions, namely E_{X1} and E_{X2} even the energy quantities are the same, Q_E. Equation 3 now establishes the point where the First Law stops forever:

$$\underbrace{Q_E\left(1 - \frac{T_{ref}}{T_E}\right)}_{E_{X1}} \neq \underbrace{Q_E\left(1 - \frac{T_E}{T_f}\right)}_{E_{X2}} \qquad (3)$$

Furthermore, exergy destructions cause nearly-avoidable CO_2 emissions, ΔCO_2.

Now, are you insisting that your answer should be YES? I do not think so. Otherwise, you will violate the Second Law of Thermodynamics. According to Equation 3, any pair of optimum solutions and their derivatives for minimum exergy destructions and energy efficiency maximizations will be different.