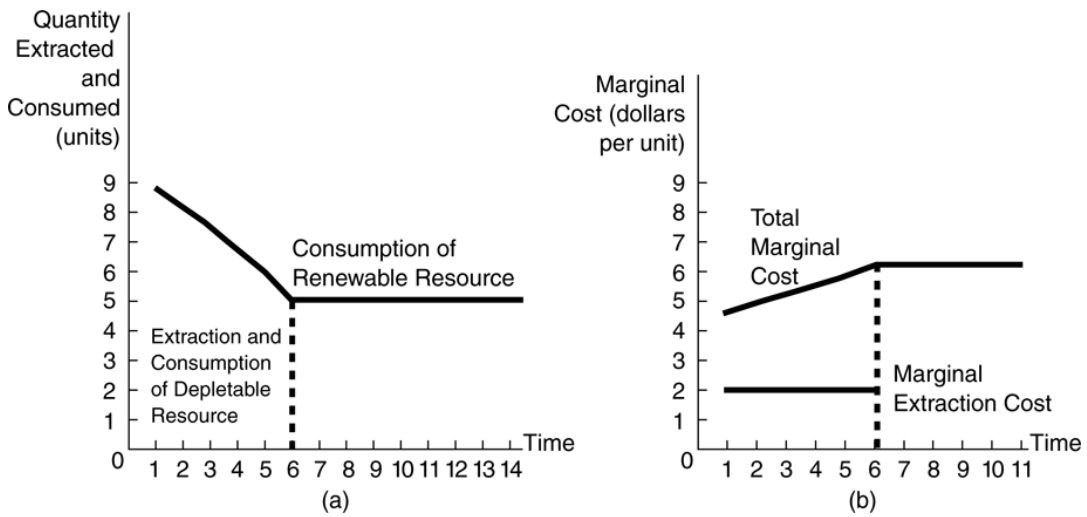
Econ 342: Environmental Economics
Chapter 6
In-Class Assignment

1. Consider a constant marginal-cost depletable resource with a renewable substitute resource, given by these equations:

$$P = 8 - 0.4q$$
$$MC\ of\ extraction = \$2$$
$$R = 10\%$$
$$Q = 40$$
$$MC\ of\ renewable = \$6$$



a. Describe, in general terms, the dynamically efficient time path for **(i) marginal extraction cost (ii) marginal user cost; and (ii) quantity extracted** based on the graph above. ***[10 points]***

Marginal Extraction Cost: The MEC is constant at $2 throughout the life of the resource.

Marginal User Cost: The MUC increases with the time period since the depletable resource becomes more valuable to future generation as the scarcity rises. The total MC is the sum of MEC and MUC, which keeps on increasing because of the rising MUC. The total MC increases until it reaches $6, and after that the total MC is constant at $6. Since the MC of the renewable resource is $6, it becomes cheaper to use the renewable resource once the total MC of the non-renewable resource also reaches $6. Thus, at $6 we substitute from depletable resource to a renewable resource substitute.

Quantity Extracted: The dynamically efficient amount of quantity extraction for the depletable resource declines with time period until it reaches a quantity of 5 at time period 6. At that point, we switch to a renewable resource and the optimal quantity is constant at $5 forever from that point on.

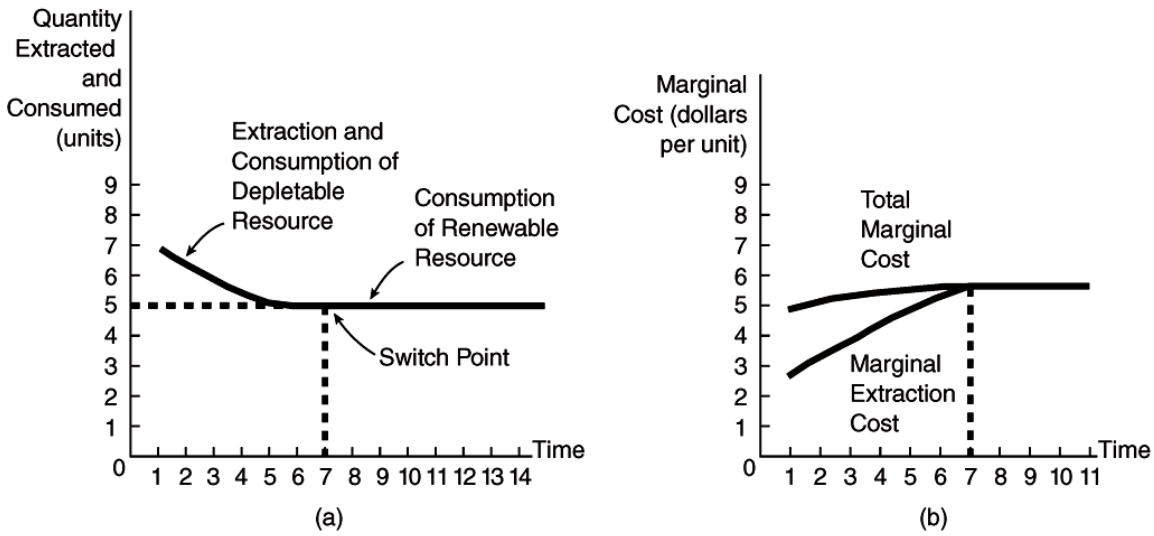
b. What does switching point mean? When does the switching occur in the graph above? ***[2 points]***

The switching point is the time when we substitute from a depletable resource to a renewable resource. In the above example, the switching point occurs at the time period of 6.

c. What happens to the switching point if the Marginal Cost of the renewable resource is $9 instead of $6? Why? ***[3 points]***

If the total MC of the renewable resource is $9, then the switching point would not occur. It becomes cheaper for the society to simply keep on using the depletable resource until it becomes exhausted. This is because the maximum WTP for the depletable resource is $8 [P = 8 – 0.4q], at which point the total resources are exhausted. Thus, we would rather exhaust the depletable resource by paying up to $8 rather than use the renewable resource by paying $9.

2. For the increasing marginal-extraction-cost model of the allocation of a depletable resource with a renewable substitute given below, describe what happens if:



a. A per-unit tax imposed by the government for each unit of the depletable resource used. What would be the **new** effect on **(i) marginal extraction cost and marginal user cost; (ii) quantity extracted; and (iii) switching point** ***[7.5 points]***

Marginal Extraction Cost: The MEC would rise because of the tax. That would shift the MEC slightly higher.

Total Marginal Cost: The total MC would rise a little higher because of the increase in MEC.

Quantity extracted: The optimal quantity extracted would decline somewhat since the consumers also have to bear the cost of higher taxes.

Switching point: The switching point to renewable resource would be faster because of the higher total MC of the depletable resource. Producers would not extract the cumulative amount of depletable resource because of high cost. It would be cheaper to simply substitute to a renewable resource substitute.

b. A per-unit tax imposed by the government for each unit of the renewable substitute resource used? What would be the effect on **(i) <u>the switching point</u>** ***[7.5 points]***

The switching point would be a little later than at the time period of 7 as show in the graph above. This is because it is now costly to use the renewable resource because of higher taxes. Thus, the society would use the depletable resource a little longer until the total MC of the depletable resource equals the after tax total MC of the renewable resource.