



MEC 3040 Take-Home Quiz for Module 1: Introduction to bioenergy

Please note that you are welcome to type your answers into this document, save and submit it.

1.1: What is bioenergy?

1. What assumptions are made in calling bioenergy a form of truly renewable and sustainable energy?
Sustainability would require that no more biomass is harvested than can be regrown within a reasonable amount of time; time in which more is used or need. And that growing, processing and using biomass cause no harm to the environment or to resources needed by succeeding generations.
2. Give an example of each of these bioenergy conversion technologies:
 - (a) Thermal
 - (b) Chemical
 - (c) Biochemical*(a) Combustion of lignocellulose (with or without densification)*
(b) Conversion of oil (triacylglycerols) to biodiesel
(c) Conversion of organic materials to biogas by anaerobic digestion

1.2: Current & projected energy use

3. How does US use of bioenergy compare to global use of bioenergy?
*In 2009, the US got only 8% of energy from renewable resources and biomass made up half, 4%. In 2007 – 2008, the use of biomass energy was 10% of fossil fuel use: 50ish EJ for biomass vs. 500ish EJ for fossil fuels. Of that, traditional biomass was 9%, and more modern biomass was less than 5%.
[2019: US is now up to 21% RE for electric production; but 12.2% RE for all primary energy use. Half of the 12.2% is bioenergy.]*

1.3: Forms of bioenergy

4. Give one example each of agriculturally derived first-, second- and third-generation biofuels and justify (explain) why your examples should be classified as first-, second-, or third generation.
First: Ethanol from corn is a first-generation biofuel because it is made from a crop that serves as human and animal food.
Second: Biodiesel made from waste oil is a second-generation fuel because it is made from a waste product. Though the oil was made via agriculture, creation of biodiesel doesn't compete with feeding people.
Third: Biodiesel and other liquid fuels made from algae oils are third generation because their feedstock (algae) can be grown at large scale using waste nutrients. The growth is agricultural. Technically, algae can be used as a food source. But, if it's grown on waste people would probably not want to eat it.



1.4: Bioenergy feedstock materials

5. Why is transportation a critical factor in growth, harvesting, processing and transportation of bioenergy? Why is it less critical for fossil or nuclear fuels?
Transportation is a bigger issue for biomass/bioenergy because biomass feedstock materials, and even processed biofuels, are generally less energy dense than fossil fuels. And, the US has a very efficient infrastructure for storing and transporting fossil fuels – particularly liquids. That transportation infrastructure does not work well for most biofuels. Liquid biodiesel and bioethanol may be exceptions.

1.5: Bioenergy co-products

6. Many people use the terms co-product and byproduct interchangeably but they are not the same.
- (a) Give definitions of each that clearly explain the difference.
(b) How can a byproduct become a co-product? Give a real or hypothetical example.
*(a) Co-products have significant economic value while byproducts do not.
(b) A byproduct can become a co-product if a good use can be found for it. In the best scenario, the use is a genuine one with real economic value. Assigning some sort of regulatory credit to the byproduct also adds value to the technology that creates it; methane credits are an example. California pays farmers for methane they burn rather than release into the atmosphere.*

1.6: Drivers of bioenergy development

7. Why is (governmental) policy a critical driver of bioenergy development & implementation? Use a specific example(s) to illustrate your answer.
Bioenergy infrastructure is still being developed and that development is complex and can be capital intensive. Farmers need to be convinced to grow bioenergy feedstock, processors may need to invest large amounts of capital in plants and will succeed only if the right feedstock is available. Energy distributors have to be convinced that the bioenergy supply is steady and that a market exists. Consumers must invest in new cars, heating systems or appliances. These steps – the investment in hard and virtual bioenergy infrastructure - require coordination, skill, capital and some degree of certainty. Government policy can support the development of bioenergy by tax incentives, grants and loans, fuel standards, carbon caps, etc. And government subsidies can persuade developers that they have a partner in development as well as fiscal support.

1.7: Bioenergy debate

8. What four phases of bioenergy are considered in life-cycle analysis?
- 1. Feedstock growth or production*
 - 2. Conversion or processing*
 - 3. Distribution of bioenergy or biofuel*
 - 4. Use (or conversion to energy)*



1.8: Is bioenergy sustainable?

9. In your opinion, what are the biggest barriers to the sustainability of bioenergy? Why?
I believe that the greatest barrier to bioenergy sustainability is the potential of Ensuring that bioenergy feedstock production by agriculture or forestry (silviculture or “wild harvest”) to significantly decrease habitats and biodiversity and / or degrade the environmental quality of the lands and waters.

1.9: Bioenergy vs. food debate

10. There is wide agreement that first-generation biofuels or bioenergy have impacted the availability of food. In your opinion, will second or third generation biofuels pose more of a threat to world food supplies? Why?
Since first-generation biofuels are produced from food crops, it’s likely that second- & third-generation bioenergy, from waste food, perennial grasses & woody material vs. algae respectively, will pose less of a threat to world food supplies because these feedstock materials are not now used for food. However, growing the biomass used for second-generation bioenergy might compete with food production for land area. Since it is hoped that third-generation algae will be grown on abundant wastewater and produce cleaner water this generation of biofuels should have the least impact on food production.