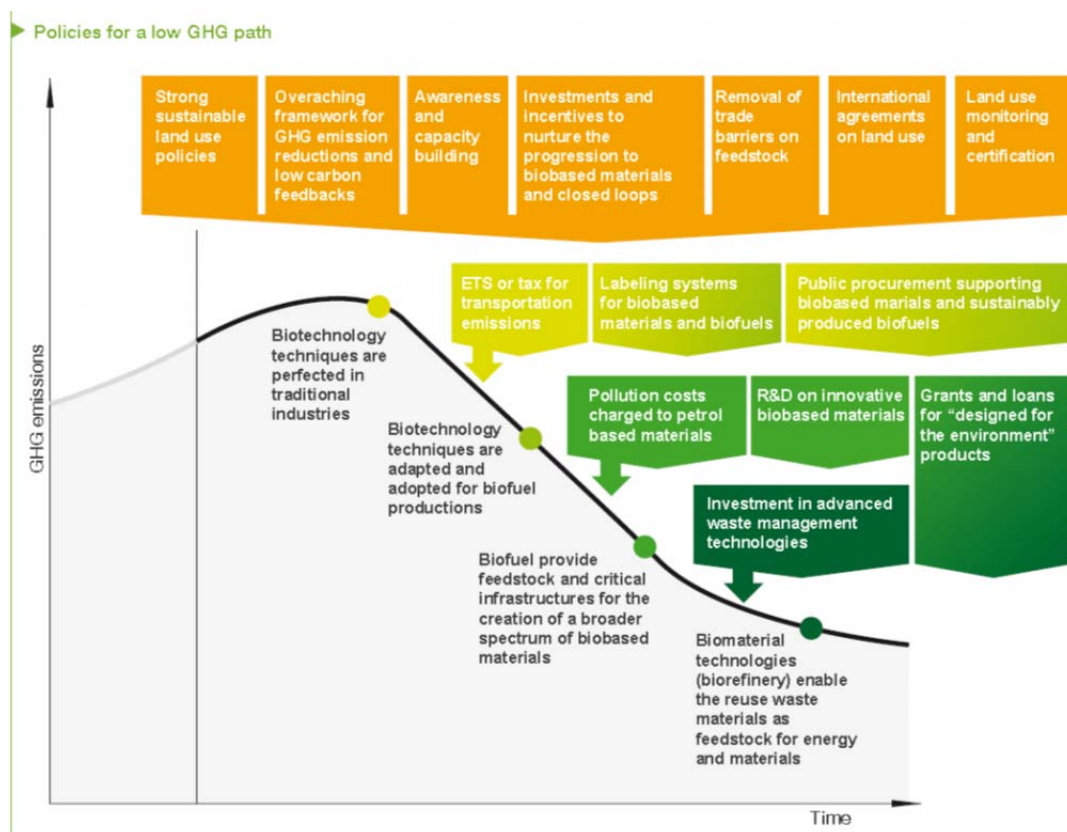


COURSE “Introduction to Green and Sustainable Chemistry”

Written exam – 23 July 2015 (Part II)

- 1) As Hendershot (1995) has pointed out, most process options will be inherently safer with respect to one type of hazard, but may be less safe from a different viewpoint. Which methods need to be used in inherently safer design and evaluation of inherent safety? What must include an accident-prevention program? Give examples taken from chemical and mechanical industry.
- 2) Governmental intervention can play a significant role in the effort to advance the industrial biotechnology sector down a low-GHG curve. Based on the following graph, discuss the general policies on land use and trade barriers removal as well as more specific policies, related to the different dimensions, that are needed to “push” the sector in the right direction.



- 3) Discuss briefly the importance of multi-product approaches and supply chain management in a biorefinery industry.
- 4) **Enzymes and proteins are essential components of living systems. Which are the peculiarity of their structures responsible for their typical function of biocatalysts, storage materials and reproduction controlling agents?
- 5) It is argued that ethanol produced from cellulose could be considered renewable compared to other fuels such as petroleum. Hemicellulose can also be used in the production of bioethanol? Discuss briefly the advantages and disadvantages of using biofuels such as bioethanol as energy sources.
- 6) Explain the role of levulinic acid and xylose as C-5 building block in biorefinery.
- 7) **What are the three major classes of plant secondary metabolites? Within each major class, identify two distinct groups of secondary metabolites and their possible use.
- 8) Which are the main differences between biocatalysis/biotechnology and traditional chemical catalysis? Provide examples illustrating the advantages and limits typical of the specific area.

- 9) "Giving each molecule the same processing experience presents one of the generic principles of Process Intensification (PI)." Provide 2 examples of PI-technologies that, at least partially, address that principle. Motivate (briefly) your choices.
- 10) Which of the following is not a green engineering principle? Exemplify the correct one.
a) Output pulled rather than input pushed; b) Renewable rather than depleting; c) Maximize efficiency
d) Follow the triple bottom line.
- 11) Comment the sentence: "Chemical processes have always intrinsic risks. Green engineering requires special attention to reduce the environmental impacts, to enhance process performances and to manage safely resources" How Process Analytical Technology (PAT) and Quality by Design (QbD) can help in reduce risks.
- 12) Which strategies can be adopted to reduce environmental impact of the VOC solvent methylene chloride (CH_2Cl_2 , b.p. $42\text{ }^\circ\text{C}$) when used in cleaning of dead animal skin? Suggest possible substitutes in case the impact will result above the EU ADI limit of exposure.
- 13) **Conversion of fructose into mannitol is catalyzed by the enzyme Mannitol Dehydrogenase which requires NADH as cofactor? Which is the meaning of various terms in the previous sentence and there are in normal chemical catalysis functional analogs of cofactors? Make some examples.

** Responses due by Eng. Environ. students.