Introduction to Renewable Energy – Biomass

Captured solar energy from biological systems currently plays a large role in human society through agriculture and small-scale domestic use. Expanding the use of biomass for large-scale energy services could help reduce the greenhouse gas intensity of the energy system. Because photosynthesis captures CO_2 from the air, the resulting carbon-based feedstock can be processed and utilized in a similar manner to fossil fuels with lower net emissions of CO_2.

Biomass energy conversion could take advantage of many existing waste streams, but would also likely involve the cultivation and conversion of dedicated energy crops. The naturally low efficiency conversion of solar energy to biomass leads to large requirements of land, water and nutrients. Lifecycle cost, energy, and greenhouse gas emission considerations such as fertilizer production, harvesting, and feedstock transportation are barriers to the widespread use of energy crops. Increases in the yield of energy crops for given energy, water, and nutrient inputs would decrease the associated lifecycle costs. Research utilizing modern biotechnology could increase efficiency with respect to each of these inputs.

Research enabling more efficient and lower cost conversion methods could also benefit biomass energy. Thermochemical conversion systems designed for fossil fuels could be adapted to accommodate biomass feedstock, or new systems designed to take advantage of the unique properties of biomass could be explored. Biological conversion systems have the potential for higher efficiency and lower cost as our understanding and control of these organisms increase.

GCEP supports three projects in the area of biomass energy.

Professor Gavin Sherlock from Stanford and Professor Frank Rosenzweig from the University of Montana are developing hybrid yeast strains for enhanced ethanol production from biomass. The yeast species will be heat and ethanol tolerant and able to utilize the cellulosic and hemicellulosic portions of biomass feedstocks.

Professor Chaitan Khosla is developing microbial processes for biodiesel synthesis using Escherichia coli. His program optimizes fermentation conditions for biodiesel production, evaluates the ability of a variety of microbial enzymes to directly produce fatty acid methyl esters in E. coli, and introduces new enzymatic systems into the bacterium.

Professors Chris Field and Rosamond Naylor are carrying out a thorough assessment of the climate consequences of converting landscapes from their previous uses to biofuels crops. The goal is to provide a set of tools for quantifying the integrated impacts on climate of expanding the area utilized for biomass energy production.