



ENGINEERING SOLUTIONS FOR RISING OCEANS

by
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Is climate change real? As the global debate continues, the world around us is experiencing the effects of variation, however permanent. Recent reports on the melting glaciers of Greenland confirm what many other studies have suggested: there is an accelerated slide of the glaciers into the sea. Since 1985, scientists say temperatures increased by about 5.4 degrees Fahrenheit (3 degrees Celsius) along the southeast coast of Greenland. This observation has been trumpeted everywhere from the journal *Science* to *Time* magazine and an undeniable consensus has developed along with it: The consequences of a warming climate are closer and more disastrous than previously thought.

But solutions close to home also abound. The University of Georgia biorefinery is linking the problem of global warming to economic development in our state by addressing the causes of the warming with the reversal, to some extent, of its effects thus far.

UGA engineers and scientists are working to establish an industrial base of the future – the biorefinery. A biorefinery is an industrial-scale means to break down biological resources to their constituent parts, revealing new possibilities for supplanting our petroleum-based economy with a biologically-based one. Renewable sources like wood chips, chicken litter, crop residues even trees and grasses, collectively known as biomass, can be used to replace petroleum. In a biorefinery, these materials are used to produce energy (hydrogen, ethanol, biodiesel), make green chemicals (succinic acid, lactic acid) or new industrial additives (lignocellulose) to replace those presently manufactured from non-renewable carbon sources.

The concept of working toward energy and environmental solutions from a biological perspective flows naturally out of a UGA commitment to biological sciences dating back thirty years. This is why the biorefinery has become a hub of UGA expertise.

Carbon sequestration is one very important outcome from biorefining. Traditional methods of CO₂ sequestration involves the capture and pumping of the gas into geological storage – deep down in the earth. Engineers from UGA have come up with an alternate paradigm: why not take the carbon dioxide out of the air by using nature’s ancient carbon cyclers – microorganisms? Not only does this approach address the problem of gaseous CO₂, but the process also can produce value-added products.

One of the most promising new engineering fields at UGA, and one of three new degree programs adopted in the fall of the 2005, is biochemical engineering. Focusing at the metabolic or enzyme level, engineers in this multidisciplinary field use fermentation to break down and manipulate chemical compounds

in pursuit of more useful combinations. Jim Kastner, associate professor of engineering in his eighth year of work on biofiltration, catalytic oxidation and fermentation technology, sees opportunities in the challenges of working with CO₂. “Carbon dioxide is very diffuse in the atmosphere but capturing it in concentrations, as from a smokestack scrubber at a biorefinery or ethanol plant, allows for its use as a substrate or feedstock,” he says. This process, whereby a greenhouse gas that would be released into the atmosphere is utilized as a feedstock for value-added products, is one example of closing the carbon loop in a biorefinery. Kastner teamed up with UGA engineering colleagues Elliott Altman and Mark Eiteman to bring their expertise in biochemical fermentation to this search for new products at the biorefinery.

Eiteman, Kastner and Altman are using CO₂ to produce a suite of useful materials, including succinic acid. This carbohydrate is recognized by the Department of Energy as one of the top ten building block chemicals that can be used for everyday products such as antifreeze, fabrics and plastic containers.

Carbon dioxide is a promising fulcrum for engineers and the biorefinery. Replacements for petrochemicals that play a role in the reduction of greenhouse gases



Mark Eiteman, program leader of the biochemical engineering group at UGA, with colleagues Jim Kastner and Elliott Altman.

leverage two solutions out of a single problem; by this formulation, economic development and environmental remediation not only coexist but can be two sides of the same coin. In the race to reduce carbon dioxide emissions, this connection is crucial and one engineers at UGA are working on everyday. §