iFAST: The International Forum on Advanced Environmental Sciences and Technology

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6 a.m. PDT; 8 a.m. CDT; 9 a.m. EDT; 1 p.m. GMT; 9 p.m. Beijing

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C. Criddle is a professor of civil and environmental engineering at Stanford University and senior fellow in the Woods Institute for the Environment at Stanford. Criddle's specialty is microbial biotechnology for recovery of clean water, renewable energy and renewable materials. He received his doctoral degree from Stanford and began his academic career in 1989 at Michigan State University. After returning to Stanford in 1998, he has led research teams focused on groundwater bioremediation, biological wastewater treatment, and reuse and bioplastics from organic waste feedstocks. He has many refereed publications and patents and is a co-author with award-winning San Francisco cartoonist Larry Gonick of the Cartoon Guide to Chemistry, a widely used supplement for high school and first-year college chemistry classes. At present, Criddle directs the Codiga Resource Recovery Center at Stanford. The center's goals are to accelerate development and adoption of promising resource recovery technologies and to train and inspire a new generation of students for continued innovation.

Geochemical cycles out of control: how microbial biotechnology can help

Human economic systems are driving exponential increases in greenhouse gas emissions (CO_2, CH_4, N_2O); discharge of recalcitrant and harmful organics; and accumulation of reactive nitrogen. These increases are largely unchecked by any commensurate increase in removal rates. At the base of the major biogeochemical cycles that control the composition of Earth's atmosphere and major water bodies are microorganisms that can respond rapidly with enzyme catalysts enabling short timescales for natural selection and/or bioengineering. Market forces can conceivably be harnessed to accelerate such interventions. Distributed resource recovery centers managing local waste and wastewater streams could thus provide controlled environments for the growth and maintenance of complex, self-assembled microbial communities that perform ecologically critical functions, and for targeted use of genetically modified organisms that produce high-value products. By the end of the 20th century, over 15,000 wastewater treatment bioreactors were operating in the United States alone. These systems were designed and constructed at a time when markets were linear, energy costs were low and global climate change was not on the radar. In linear markets, waste products resulting from the consumption of water, food, fertilizers and materials are ideally collected, transported to centralized bioreactors, treated to remove organics, nutrients and toxic substances, and the treated water and residuals (both gas and solid) are discharged to the environment. These traditional systems can change as circular markets are created that mirror ecological cycles, i.e., where waste or degradation products of waste serve as feedstock for new products. In this vision, bioreactors and landfills contribute to food/energy/water microgrids, enabling low-cost production of renewable energy, and of local resource recovery centers for clean water that offsets demand for imported water, nutrients that offset demand for imported fertilizer and new materials, such as biodegradable bioplastics and fire retardants, that offset demands for materials made from non-renewable feedstocks. Brines generated by water purification and "waste" heat could be harnessed for growth and processing of extremophile microorganisms capable of producing high value products without the need for aseptic cultivation. Distributed, local resource recovery systems will enable more resilient local markets by facilitating more efficient conversion of waste to products, decreasing transport costs, and contributing to local supply of clean water, energy, nutrients and materials. The tools needed to design and operate such systems are at hand due to advances in systems biology, membrane and materials science and smart grid automation. Because waste and wastewater are where people are, the adoption of such strategies could enable bottom-up growth of local economies with low transport and production costs, low or negative greenhouse gas emissions and more resilient supplies of materials and energy.

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