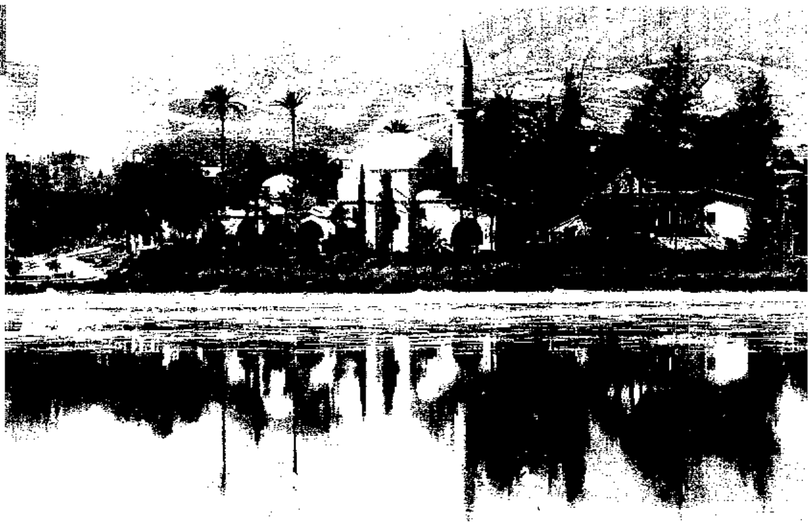
Each year, major wastewater treatment systems spend trillions of joules of energy converting the motor oil, gas, and other hydrocarbons contained in municipal wastewater to carbon dioxide and water. The process not only destroys the energy contained in wastewater, but also uses about twice as much energy as it destroys. Ten years ago, major treatment centers in the United States spent 650 trillion joules of energy destroying 354 joules of "waste" energy.

To change this, Professor Mark Shannon and Associate Professor Wen-Tso Liu are teaming up with researchers at Yale University (Meny Elimelech), Massachusetts Institute of Technology (Anne Mayes), and Clean Membranes, Inc. (Trent Yang). Their goal: to develop a single-stage anaerobic membrane bioreactor that recovers the energy from the wastewater while reducing the overall energy input needed to do so.

They were told it could not be done. Yet, in 2007, Shannon's collaborators published a paper in the *Journal of Membrane Science* that described such a system. Their "dream" system not only reduces environmental pollution by oxidizing organic matter aerobically, but also produces energy through the direct anaerobic degradation of biomass. Meanwhile, a nonfouling nanofiltration membrane reduces energy inputs while filtering the wastewater. A typical wastewater system would require a large area of membrane, according to Shannon, but would deliver a significant amount of clean energy and water every day.



Solar Desalination Yields Two for [Almost] the Price of One

Rising temperatures are rapidly evaporating fresh water supplies in arid regions of the world. In 2008, a record drought on the island of Cyprus triggered emergency rationing and forced the government to import more than 8 million cubic meters of water from neighboring Greece.

Removing salt from seawater could provide access to an immense untapped resource. After all, about 96 percent of the water on earth is salt water. The downside is that current desalination methods are extremely expensive and consume vast amounts of energy that, in turn, take massive amounts of water to produce.

To avoid a vicious cycle that would consume more water than it generates, John Georgiadis, Mark Shannon, and graduate student Andrea Vozar have teamed up with the Cyprus Institute, researchers at the Massachusetts Institute of Technology, and the Electricity Authority of Cyprus to develop a thermal desalination method that uses the sun's energy to produce power at the same time as drinkable water from the sea.

Once the solar energy is collected and stored, a boiler generates hot steam fed into a turbine for power production. After turning the turbine, the still-warm steam drives the desalination process. The desalination device consists of a series of evaporators and condensers that separate salt from water. This makes the overall process very efficient, because it replaces the cold reservoir required for a traditional power plant and makes use of all the waste heat.

The researchers plan to build a demonstration unit of just a few kilowatts in Cyprus. Once a pilot plant of similar size is created, it will be the first demonstration of such a dual-purpose thermal-solar plant. The project is funded by the government of Cyprus and the National Science Foundation.