Diving Rod

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Possibilities and problems: Experts discuss growing algae for fuel in New Mexico

by Will Keener

Can the sunny skies and mild climate of New Mexico make the state a possible location for production of energy fuels from algae? That question was the focus for a morning of talks at the 56th Annual New Mexico Water Conference, held in Alamogordo, New Mexico, in December. Speakers at the event saw potential in the concept of growing algae and producing fuel from it by using brackish or other saline water sources from the state. They also described many challenges.

Setting a framework for the discussion, Bruce Thomson, Regents Professor of Civil Engineering and Director of the University of New Mexico's Water Resources Program, noted that algal fuel production will require large amounts of water. Traditional energy sources require from 20 to 50 gallons of water for a megawatt hour of fuel, he said, citing a study conducted by Sandia National Laboratories. Fuel production involving biomass may require 100 times that amount, the study indicated.

An algae pond system at the Texas Agrilife Research Center in Pecos, Texas is one study site for the National Alliance for Biofuels and Bioproducts (NAABB). Los Alamos National Laboratory researchers are studying water quality effects on algal biofuel production in partnership with Texas Agrilife.

photo by Jeri Sullivan

Researchers must look at water requirements, water availability, water rights, and salt management in a state "where very nearly every drop of water is spoken for," Thomson said. "Mapping solar resources and comparing those to

Divining Rod

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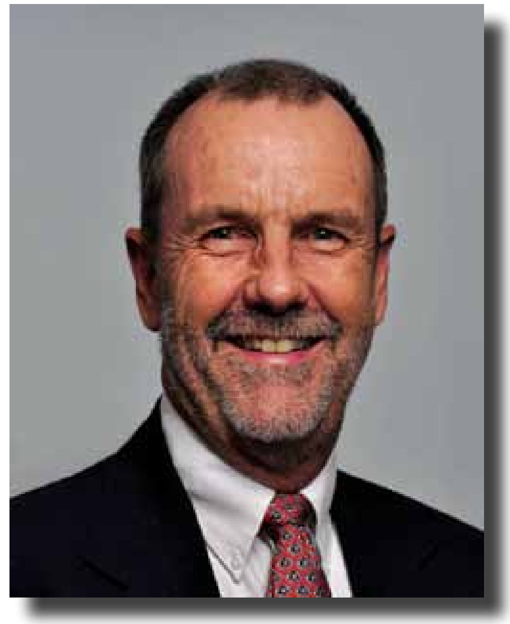
water resources emphasizes the fact that where we want to grow algae is not necessarily the places where there is a lot of water availability."

Alternatives to fresh water include municipal wastewater, deep brackish groundwater, and water from oil and gas production. Municipal supplies have an advantage of being near population centers, while brackish supplies and produced water are more widely distributed, requiring more decentralized production systems.

Thomson outlined a number of attractive features for municipal wastewater supplies, including high nitrogen and phosphorus levels, needed as nutrients for the algae. A typical wastewater system, for a town of 2,600 people, produces enough wastewater with sufficient nitrogen level to grow 660 pounds of algae a day for a seven- or eight-month growing season, he calculated.

But salinity and evaporation rates present challenges, Thomson said. With 100 inches of evaporation per year, the hypothetical municipal system can support about 36 acres of ponds for growing algae. Evaporation increases the salinity of the feed water and if it exceeds about four or five percent, treatment would be required to lower it. Managing the salt also requires water, Thomson noted. If the optimum salinity level for algal growth is two percent, the hypothetical system would produce 2,200 pounds of salt per day during the growing process and produce a waste stream of 13,000 gallons per day requiring disposal.

Deep brackish water supplies offer only limited potential for algal fuels. "These supplies may last for 10 years, 20 years, 60 years, but they are not sustainable,"



University of New Mexico Regents Professor of Civil Engineering and Director of the Water Resources Program addressed participants of the annual water conference on the challenges of algal fuel production.

he said. And while water produced from oil and gas wells is a possible feed source, the high salinity and poor water quality, wide dispersion of the resource, and jurisdiction of the water all need to be addressed.

Thomson called for more research on algal growth in high saline environments, efforts to quantify how much nitrogen and phosphorous are needed and possible sources for these nutrients, and inclusion of salinity management processes and salt disposal in production designs. "Lifecycle estimates must include the costs of water, not just energy," he said.

Produced Waters

Water produced from oil and gas wells in New Mexico totals about 28 billion gallons annually, according to state estimates. Jeri Sullivan, a Los Alamos

National Laboratory researcher, estimated that a portion of the 28 billion gallons/year of produced water from New Mexico could be used to grow biofuel algae.

Using funding from the New Mexico Small Business Assistance program and the National Alliance for Advanced Biofuels and Bioproducts, Sullivan is part of a research team that is testing whether those calculated numbers can be practically achieved in the field. The team is working with pond systems owned by Eldorado Biofuels in Jal, New Mexico, and the Texas Agrilife Research Center in Pecos, Texas. The plants move from pond to pond with different nutrients and are finally harvested using a centrifuge process, with careful sampling along the way. The process is using a seawater-tolerant algae species. Testing began last year and will continue this spring.

Sullivan is using the data gathered to create a model of the production process and its variables to improve the ultimate productivity of the systems. Although there is much work to do, some facts have already become clear, Sullivan told the conference audience:

- Growers will have to work closely with oil producers and oilfield service companies with an eye on the produced water. "This is a paradigm shift for oil operators," she said.
- While some produced water may have to be treated for salinity depending on the algal species used, this is not always the case.
- It is important to know what chemicals are being used on the oil production side and to control what may be added to optimize growth conditions for the algae.
- An ideal system will permit mixing of multiple sources of produced water for the best cultivation, and
- Early results of the testing show a 30-day cycle may be best, since evaporation concentrates both salinity and any metals in the water.

Other research

Josh Goldman, a doctoral candidate at UNM, described his work with a two-stage ion exchange process, where concentrate produced in the first stage of reverse osmosis is used to provide additional permeate for a second-stage

The simplest of plant forms, algae packs an energy punch

by Will Keener

On the face of it, fuel from algae is a sweet idea.

- As the prices for oil climb, production peaks, and researchers examine alternatives, biomass is getting a careful look from a number of government agencies and private companies.
- As a solution to the increasing competition between agricultural products for food and for fuel, algal biomass offers the possibilities of using ocean or brackish or wastewater supplies instead of fresh water and producing from lands not suitable for traditional crops.
- Researchers have calculated that algae, one of the simplest plant organisms, can produce 10s or even 100s of times more energy per unit area than any other bio-crop now under investigation.
- An extra bonus for the process is that it uses CO_2 and returns oxygen to the atmosphere.

Currently, about three percent of U.S. fuel production comes from biomass sources. Algal fuels offer further appeal because they require much less water than traditional seed crops now being used, such as corn or soybeans. A U.S. Department of Energy study estimates that if all petroleum used in the U.S. was produced from algae, it would require about 15,000 square miles of land. That's less than 0.5 percent of the U.S. land area and about 14 percent of all the land used to grow corn in the nation in 2000.

However, it's a long reach between calculated production and actual production. New Mexico researchers have joined in the study of algal fuels, but note that a number of key questions must be answered about energy, water requirements, and disposal of salt concentrate before production can go forward.

treatment. The second-stage concentrate stream is captured in a brine reservoir. Following bench tests, Goldman participated in a cooperative effort to build a pilot test plant, operate it, and gather data to optimize the system. He operated the pilot system for five weeks last summer.

Goldman concluded that the system has the potential to improve reverse osmosis recovery rates and produce significant tonnages of gypsum for resale.

Robert Fowlie, principal engineer and senior project manager with the CDM company in Albuquerque, studied the marketability of salts from desalination of brackish water. He found that significant hurdles exist, including lack of demand, competition from natural and synthetic products, and higher costs of recovering the salts. Selective salt recovery may become more viable as processes improve in efficiency, he said.

According to Robert Fowlie, principal engineer with CDM, marketing salts from desalinated brackish water faces challenges such as lack of demand, competition from natural and synthetic products, and the high costs of recovery.

Image from: www.asset-exports-from-us.com/road_salt

Tim Rynders, a Colorado-based environmental process engineer at CDM, reviewed his work on a pilot brine minimization system for concentrate for a water district in southeast Denver, serving about 50,000 customers. In designing a 47-million-gallon per day system using brackish water, planners sought to minimize the number of expensive deep disposal wells needed for concentrate. Rynders tested mineral solubility rates at higher pH to supersaturate the concentrate before re-injection into tight sands formations. Stability is critical he said, “You don’t want a lot of precipitation (during re-injection.)” He concluded that tools do exist to help engineers find the best solutions for treating brackish water.

NMSU engineering graduate student Khaled Abuhasel reported on a ten-day experiment with 18 strains of algae, which showed brackish water not to be an ideal medium for maximizing growth. However, matching species and water salinity can optimize production.

Khaled Abuhasel, engineering graduate student at New Mexico State University, reported on his work with colleagues at the Institute for Energy and Environment to determine the role of brackish water as a medium for microalgae production for biofuels. The researchers measured algae growth with different combinations of saline water as a growth medium. An experiment with 18 strains of algae showed brackish water was not an ideal medium for maximizing growth, but careful matching of species and water salinity can optimize production, he said.

Call for Poster Abstracts

The New Mexico Water Resources Research Institute's 57th Annual New Mexico Water Conference

August 28, 2012, Corbett Center, NMSU

Hard Choices: Adapting Policy and Management to Water Scarcity

The 2012 New Mexico water conference includes a Call for Poster Abstracts on any water research and management topic. The meeting will take place on August 28, 2012 at Corbett Center on the NMSU campus. The conference this year is co-hosted by Senator Tom Udall and New Mexico State University President Barbara Couture.

Abstracts for consideration for posters will be accepted through **July 13, 2012**. Poster presentations will be given during an afternoon reception following the conclusion of the one-day conference, at about 5:00 p.m. on August 28. Presenters are invited to attend the entire conference as it provides a special and unique opportunity to learn more about New Mexico's water scarcity issues and possible solutions. Students especially will benefit from interaction with state and national water experts on this critical topic. We anticipate over 250 attendees at this year's conference.

Abstract Guidelines

Poster abstracts related to any and all water research and management topics will be considered at this year's conference. Abstracts must not exceed 250 words and must be submitted online via the New Mexico Water Resources Research Institute's conference website at http://2012.wrri.nmsu.edu/abstracts. All accepted abstracts will be posted on the conference website.

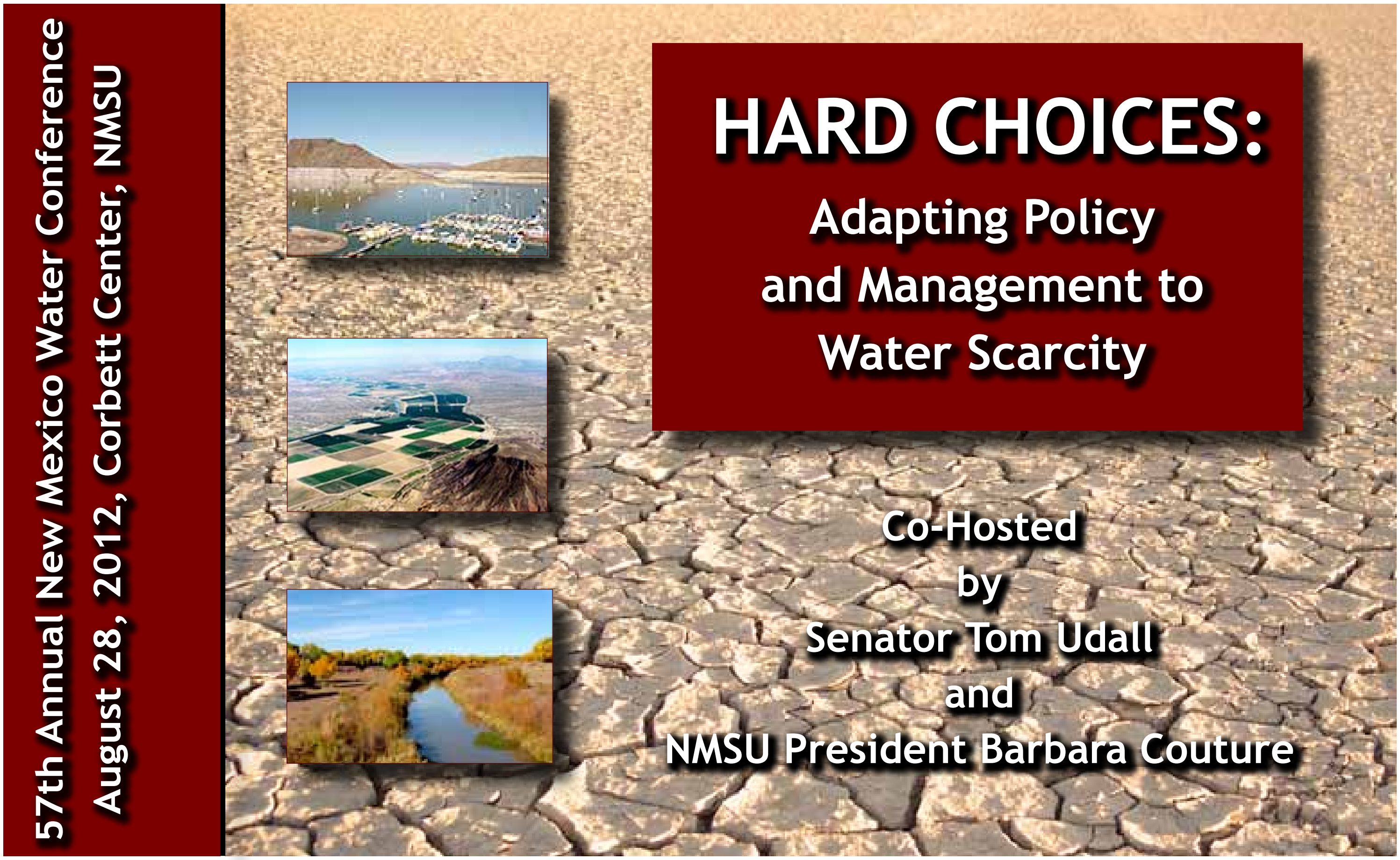
Presenters whose abstracts are accepted should set up their posters by noon on August 28 and should be at their poster during the reception when conference participants will be viewing posters.

Registration

Regular registration for the one-day conference is $25 and free for full-time students with an ID. The conference includes lunch. All posters presenters must register for the conference by August 24. All registration is online at http://2012.wrri.nmsu.edu/register and everyone is required to register whether they pay a registration fee or not.

Timeline

Abstract Deadline	July 13, 2012
Notification of Acceptance	July 31, 2012
Online Registration Deadline	August 24, 2012
Poster Setup	by noon August 28, 2012
Poster Reception and Viewing	5:00 PM August 28, 2012



Senator Tom Udall and NMSU President Barbara Couture will co-host this year's NM WRRI annual water conference. This one-day conference will address the impact of water scarcity in the West, particularly in New Mexico.

The conference will include four panels modeled after a Senate hearing, where panelists will provide a very short statement and then respond to moderator and audience inquiries. This open forum will allow academics, farmers, ranchers, and the general public to talk about water use and its impact on New Mexico's unique heritage. The conference will also benefit city planners, economic development entities, environmentalists, local, state and federal agency staff, national laboratories, water attorneys, and private water firms.

The conference will also host a reception with poster presentations at the end of the day. Registration is only $25 with no charge for full-time students with an ID, and includes lunch. The conference website is located at: http://2012.wrri.nmsu.edu.

Sponsors

WRRI

Tom Udall
Senator for New Mexico

Rio Grande Basin Initiative

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Sandia National Laboratories

Los Alamos National Laboratory
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Preliminary Program

7:30 am	Registration
8:30	Welcome New Mexico Water Resources Research Institute Interim Director *Alexander "Sam" Fernald* New Mexico State University President *Barbara Couture* U.S. Senator *Tom Udall*
Session 1:	**Setting the Stage: Where is the Water and How Much Do We Have?** *Moderated by Phil King, New Mexico State University*
9:30	Panelist Introductions
9:34	New Mexico's Water Budget, *Sam Fernald*, New Mexico WRRI
9:40	Climate Change, *speaker to be determined*
9:46	Deteriorating Water Infrastructure and Impact on Supply, *speaker to be determined*
9:52	The Transboundary Aquifer Assessment Project, *Mike Darr, U.S. Geological Survey*
9:58	Status Quo of Water Rights in Times of Shortage: Legal and Environmental Constraints, *Steve Vandiver*, Rio Grande Water Conservation District, Alamosa, CO
10:04	Facilitated discussion
Session 2:	**Water Users Perspectives: American Indian, Agriculture, Municipal, Energy, and Environmental** - *Moderated by Jeff Witte, Department of Agriculture* (invited)
11:00	Panel Introductions
11:04	Navajo Water Rights Settlement, *Stanley Pollack*, Navajo Nation
11:10	Scarcity Impact on Acequias, *Paula Garcia*, New Mexico Acequia Association (invited)
11:16	Municipal Water Reuse, *Larry Webb*, Rio Rancho
11:22	Energy and Water, Richard Sayer, *Los Alamos National Laboratory*
11:28	Environmental Perspective, *Denise Fort,* Utton Transboundary Resources Center
11:34	Discussion with audience on other best practices and policy ideas
12:15 pm	**Luncheon**
12:45	Keynote speaker: Secretary *Ken Salazar*, Department of the Interior (invited)
1:15	Update by New Mexico State Engineer Scott Verhines
1:30	Break
1:45	Past New Mexico State Engineers Round Table *Eluid Martinez*, *Tom Turney*, *John D'Antonio* (invited)
Session 3:	**Building a Plan: Best Practices in Water Markets** *Moderated by Commissioner Mike Connor, Bureau of Reclamation* (invited)
2:30	Panel Introductions
2:34	Best Practices, *David Yardas*, National Fish and Wildlife Foundation
2:40	Water Leasing Market Experiments, *David Brookshire*, University of New Mexico
2:46	Rio Grande Basin Opportunities, *Lee Peters*, Elephant Butte Irrigation District
2:52	Questions and answers
Session 4:	**Can We Grow the Pie? Conservation and Supply Opportunities** *Moderated by Bruce Thomson, University of New Mexico*
3:30	Panel Introductions
3:34	Collaborative Modeling for Decision Support, *Howard Passell*, Sandia National Laboratories
3:40	Desalination Update, *Kevin Price*, Bureau of Reclamation
3:46	Watershed Restoration, *Jack Chatfield*, Canadian River Riparian Restoration Project
3:52	Floodwater Capture, *Paul Tashjian*, U.S. Fish and Wildlife Service
3:58	Salinity Control, *Fred Phillips*, New Mexico Tech
4:04	NSF Water Infrastructure Engineering Research Center, Nirmala Khandan, NMSU
4:10	Discussion with audience on other best practices and policy ideas
4:45	Final Thoughts
5:00	Poster Presentations and Reception

New Mexico Senator Tom Udall co-sponsors reauthorization of the Water Resources Act

Senator Tom Udall recently co-sponsored the bipartisan Water Resources Research Act. Introduced by Senator Benjamin Cardin, S.2104, the Act reauthorizes money for grants to Water Resources Research Institutes, like the one located at New Mexico State University. These grants can be used to fund research that fosters improvements in water supply reliability, exploration of new ideas to address water problems, expand understanding of water phenomena, entry of new scientists, engineers and technicians into water resources field, and the dissemination of research to water managers and the public. It also authorizes national competitive grant programs to address regional water issues. This reauthorization would also add green infrastructure research and development as a focus of the program. The current authorization expired in Fiscal Year 2011. The other cosponsors are Senator Boozman (R-AR), Senator Boxer (D-CA), Senator Inhofe (R-OK), and Senator Sessions (R-AL).

NM WRRI publishes report on using brackish water for turfgrass irrigation

February 2012

UTILIZATION OF SALINE AND OTHER IMPAIRED WATERS FOR TURFGRASS IRRIGATION

WRRI Technical Completion Report No. 358

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NMSU extension specialist Bernd Leinauer and students Elena Sevostianova and Casey Johnson are authors of a three-year study funded by the NM WRRI that looked at using the vast amount of brackish water in New Mexico for turf irrigation. New and improved salt tolerant warm season grasses have made the prospect of using these grasses in conjunction with saline irrigation water quite promising. These grasses were tested for their combined cold hardiness and salt tolerance under harsh high altitude climate conditions.

The report is available in full text at http://wrri.nmsu.edu/publish/techrpt/abstracts/abs358.html

USGS leads research to reconstruct Pliocene ocean temperatures

"The litmus test of whether a climate model has any predictive power to tell us what future conditions might be on planet Earth in response to both natural and human climate drivers is the ability of that model to accurately predict past climate conditions as preserved in the geologic record," explained U.S. Geological Survey director Marcia McNutt. "Finally we have a paleoclimate dataset against which to test models with accuracy comparable to the accuracy that we need in the models for future planning and decision making."

The USGS is leading research to reconstruct Pliocene ocean temperatures primarily using fossils contained in sediments from that time period.

"Confidence in data, as discussed in this paper, refers to the overall quality of our Pliocene temperature estimates," said USGS scientist Marci Robinson. "For each temperature estimate, we looked at factors such as the abundance of fossils, the number of samples analyzed, fossil preservation, and the techniques used for analysis."

Scientists from around the world are using the Pliocene reconstructions to compare climate model simulations from fourteen general circulation models. This is an international effort with models developed by the United States, Japan, France, United Kingdom, China, Germany, and Norway.

For more information on this effort, go to: http://www.usgs.gov/newsroom/article.asp?ID=3147.