

## **BIOALGAL: Algae for Energy - Algal Cultivation and Extraction Research**

**Location:** New Mexico State University, Main Campus

**Project supervisors:** [Shuguang Deng](#) (Chemical Engineering) and [Peter Lammers](#) (Energy Research Laboratory), New Mexico State University



Biofuels extracted and processed from cultivated algae hold promise as a renewable source of hydrocarbons. However, many details regarding the large-scale cultivation of algae and the extraction and characterization of the resulting biomass need further research. Drs. Deng and Lammers are looking for undergraduate students to help with research in those areas this summer.

Students will work with Dr. Lammers' research group to work on algae cultivation at the outdoor cultivation test bed at Fabian Garcia Science Center immediately adjacent to the main campus at NMSU. The cultivation of algae will take place in both laboratory settings and in closed photobioreactors under field conditions. Students will also work with Dr. Deng's group to carry out experiments on hydrothermal processing of algae in a laboratory environment.

### **During this project, students will:**

- Help cultivate algae in a variety of conditions
- Help develop and test a variety of biofuel extraction and characterization techniques

### **Students must have completed the following courses to be eligible to participate in this project:**

- General Chemistry, Physics, and Biology
- Biochemistry and Organic Chemistry (preferred)

### **Students interested in these majors should consider this project:**

- Chemical Engineering and other Engineering majors (B.S.)
- Chemistry, Mathematics, and Biology (A.S., B.A., B.S.)
- Science and Pre-engineering (A.S.)

**Students involved in this project will work at the main campus of New Mexico State University in Las Cruces and at the nearby Fabian Garcia Agricultural Science Station. Housing in the NMSU dorms will be provided.**

## **BIOALGAL: Encapsulating Living Cells for Biofuel and Bioproducts**

**Location:** University of New Mexico, Main Campus

**Project Supervisors:** Linnea Ista ([Center for Biomedical Engineering](#)) and [David Hanson](#) (Department of Biology)

### **Project Description:**

Scientists in the UNM School of Engineering and the Biology Department in the College of Arts and



Sciences are currently pursuing highly interdisciplinary research on novel ways to culture cells and microorganisms in solid matrices (see figure to the left). These matrices are inexpensive and simple to make but have great advantages for controlling both the biological function and the form of a culture. The control over form is essential since form essentially equals function. Aspects relating to form are of great interest to engineers and provide many opportunities for new and creative designs. Little is known about the potential for photosynthetic organisms in these media. However, many are known to form films and grow in compact spaces in order to be competitive in nature, humans just don't know how.

We are interested in expanding this area of research to define the limits and advantages of bioengineered cultures in a range of environments, including in the production of biofuels from algae. We are seeking students who are highly motivated to conduct multidisciplinary research in this area and spending some time working in both Biology and Engineering labs.

### **During this project, students will:**

- Culture algae in liquid and solid media
- Conduct basic to advanced microscopy
- Measure photosynthetic function
- Learn basic biochemistry

### **Students must have completed the following courses to be eligible to participate in this project:**

- Introductory Biology or Biology for Engineers

### **Students interested in these majors should consider this project:**

- Biology (A.S., B.A. or B.S.)
- Science (A.S.)
- Pre-engineering (A.S.)
- Engineering (B.S.)

**Students involved in this project will live and work on the main campus of the University of New Mexico in Albuquerque. Housing in the UNM dorms will be provided.**

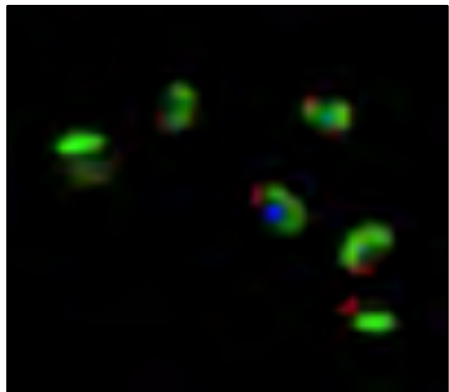
## **BIOALGAL: Visualizing Function in Live Cells for Bioenergy Applications**

**Locations:** Sandia National Laboratories and the University of New Mexico, Main Campus

**Project Supervisors:** [Jerilyn Timlin](#) (Biosciences, SNL) and [David Hanson](#) (UNM Biology)

### **Project Description:**

Scientists at Sandia National Laboratories (SNL) and the UNM Biology Department are collaborating to



develop and use new methods for measuring physiological function of algae and plants *in vivo* using advanced microscopy. Much of our work is designed to have rapid measures of the spatial arrangement of physiological processes in order to better understand how individual cells, populations of cells, and organisms function. Work to date has included using hyperspectral imaging (collecting the spectrum of light at each pixel instead of a single intensity) to identify lipid droplets within algal cells (see red areas in the figure to the left). In this study, we also grew the algal cells under two environmental conditions (high and low CO<sub>2</sub>) and measured the carbon capture efficiency with respect to the amount of lipid production. We found that

low CO<sub>2</sub> grown cells are 2.5 times more efficient at capturing CO<sub>2</sub> because they can concentrate CO<sub>2</sub> inside their cells. Surprisingly, these data do not exist for any other algae currently being used or consider for production of biofuels or bioproducts.

We are interested in expanding these kinds of analyses to other growth environments and with other species of algae and even some plants. We are seeking students who are highly motivated to conduct multidisciplinary research in this area and spending some time both at UNM and SNL.

### **During this project, students will:**

- Culture algae or grow plants
- Conduct basic to advanced microscopy
- Measure photosynthetic function
- Use stable isotopes to assess physiological function
- Learn basic biochemistry

### **Students must have completed the following courses to be eligible to participate in this project:**

- Introductory Biology or Biology for Engineers

### **Students interested in these majors should consider this project:**

- Biology (A.S., B.A. or B.S.)
- Science (A.S.)
- Pre-engineering (A.S.)
- Engineering (B.S.)

**Students involved in this project will work both at Sandia National Laboratory and on the main campus of the University of New Mexico in Albuquerque. Housing in the UNM dorms will be provided.**

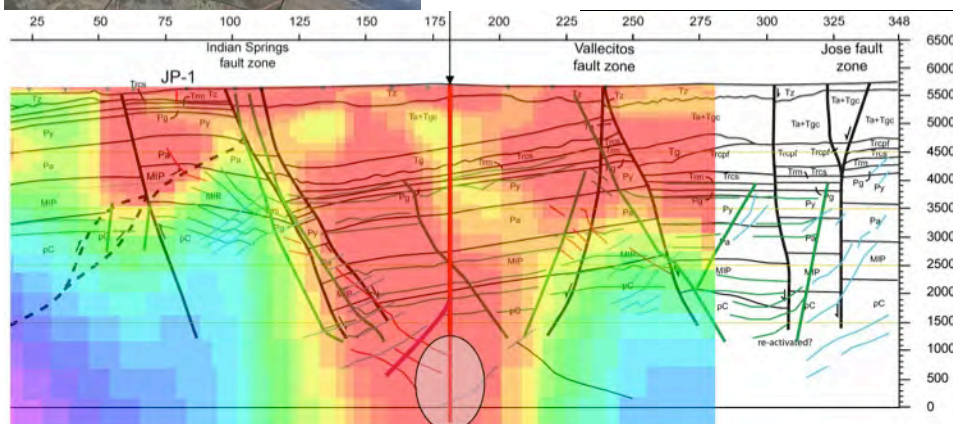
## GEOTHERMAL: Imaging Geothermal Systems using Magnetotelluric Methods

Location: New Mexico Tech

Project Supervisors: Mark Person

### Project Description:

The goal of this project is to understand the plumbing of New Mexico's geothermal systems using a variety of surface geophysical techniques and mathematical modeling. Students will learn about the basics of surface electrical resistivity methods including direct current resistivity methods, magnetotellurics (MT), audio magnetotelluric (AMT), and time domain electromagnetic methods (TEM). Students will be supervised by graduate students and faculty in the use of the geophysical equipment and on construction of numerical models.



Geophysical field equipment, deploying MT devices, and resistivity image of the Jemez geothermal system in northern New Mexico.

### During this project, students will:

- Receive training on MT/ATM/TEM equipment
- Install MT equipment in the field. This includes running copper cables, digging shallow trenches, and carrying 12-volt deep marine batteries

- Downloading data
- Using inversion software to view subsurface formation
- Development of cross sectional geothermal models

**Students must have completed the following courses to be eligible to participate in this project:**

- Science classes moving toward Physics I & II is desirable
- Math classes moving toward Calculus I & II is desirable
- Some exposure to programming (e.g. matlab) is desirable

**Students interested in these majors should consider this project:**

- Geology (A.S., B.A. or B.S.)
- Pre-engineering (A.S.)
- Engineering (B.S.)

**Initially, students involved in this project will live and work on the main campus of the NM Tech in Socorro. Housing at NMT will be provided. Significant portions of time will involve fieldwork where students will be in hotels and move through the backcountry. A valid drivers license and the willingness to drive 4-wheel drive field vehicles is required.**

## **GEOHERMAL: Using Geochemical Tracers in Geothermal Systems**

**Location:** University of New Mexico, Main Campus

**Project Supervisors:** Laura Crossey ([Earth & Planetary Sciences](#))

### **Project Description:**

The UNM Geothermal research team is currently pursuing highly interdisciplinary research on the viability and sustainability of NM's geothermal systems: from examining the geologic setting with novel geophysical methods and hydrologic monitoring to sampling and analyzing geothermal fluids and gases. Locating 'blind' (or hidden) geothermal resources is a major challenge and goal, as is understanding the effects of geothermal fluids on regional surface and groundwater resources. Spatial variations in the measured parameters will be analyzed using geographic information systems (GIS). Practical tools in determining water quality, sampling of streams, wells and engineered water systems, and fieldwork will be applied. A particular focus will be using new laboratory techniques to quantitatively determine concentrations of key trace constituents such as arsenic and uranium in highly saline geothermal fluids.



### **During this project, students will:**

- Sample geothermal waters in the field
- Participate in field geophysical surveys
- Learn basic water chemistry
- Measure metal concentrations in geothermal fluids
- Apply basic GIS tools

### **Students must have completed the following courses to be eligible to participate in this project:**

- Introductory Chemistry and Math

### **Students interested in these majors should consider this project:**

- Science (A.S.)
- Science and Pre-engineering (A.S.)
- Geoscience (B.S.)
- Environmental Science (B.S.)
- Chemistry (B.S.)

**Students involved in this project will live and work on the main campus of the University of New Mexico in Albuquerque. Housing in the UNM dorms will be provided.**

## **Osmotic Power Development: Acquiring Energy from Waste Water**

**Locations:** New Mexico Institute of Mining and Technology (New Mexico Tech)

**Project supervisors:** Frank Huang (NMT Environmental Engineering), Qiang Wei (NMHU Chemistry, Trevi Systems Inc.), Yongming Tian (NMT Environmental Engineering)

### **Project description:**

In 2007, New Mexico generated 28 billion gallons of produced water from oil and gas production with a significant portion (~44%) being disposed of as a waste via underground injection. Although osmotic pressure has been observed for centuries, it was never used to harness energy using produced water as the sources. One of the critical areas of developing osmotic power using highly saline produced water is membrane fabrication and characterization. The selected students will participate in the dry-jet wet spinning of hollow fiber membranes (HFMs), the characterization of the HFMs, including DMA, DSC, SEM, salt rejection, water flux, S factor, and bursting pressure, the construction of HFM modules, and the testing of the modules in the pressure-retarded osmosis (PRO) system to determine the sustainable energy densities.

### **During this project, students will:**

1. Fabricate and analyze polymeric membrane materials via wet-chemistry method
2. Learn and apply advanced characterization techniques to correlate structure and properties relationship of advanced membrane materials for osmotic power development
3. Practice real-time problem-solving skills through several cutting edge projects including module design and construction, fiber spinning extrusion, PRO testing

### **Students should have completed the following courses to be eligible to participate in this project:**

Science classes moving toward Organic Chemistry

Fundamentals of Mechanical Engineering

### **Students interested in these majors should consider this project:**

Chemical Engineering, Mechanical Engineering, Environmental Engineering, Chemistry, Materials Engineering (A.S., B.A., B.S.)

**Students involved in this project will work at New Mexico Tech in Socorro. Housing in the NMT dorms will be provided.**

## **SOCIAL/SCIENCE NEXUS: New Mexico's Energy/Water Future - Attitudes and Preferences Towards Energy Production**

**Location:** University of New Mexico, Main Campus

**Project Supervisors:** Janie M. Chermak and Jennifer Thacher (Department of Economics)

### **Project Description:**

Energy and water scarcity are often linked problems and expanding human activity that is increasing



demand for both is a challenge to managing these resources.

Choices between energy and water are often considered from the physical science perspective. However, resource management policies must consider social acceptance of those policies in order to gain support. Given the diverse energy resources available in the state, the importance of the fossil fuel industry to the state, and our scarce water resources, the attitudes and preferences of New Mexicans is critically important. This work focuses on gathering and analyzing preferences and attitudes towards energy

production and water use.

Students participating in the Social Natural Science Nexus will take part in the administration of a statewide energy/water survey. They will gain experience in data gathering, management, analysis, and data reporting. In addition, they will participate in developing effective tools to disseminate the data to a diverse audience. From this they will gain knowledge in the potential impact improved information and societal attitudes can play in resource use.

### **During this project, students will:**

- Gain experience in data management from data entry to cleaning
- Conduct literature reviews
- Conduct data analysis and interpretation
- Complete a poster project from their work for presentation

### **It is preferable that students have completed the following:**

- Introductory statistics or econometrics
- Introductory microeconomics

### **Students interested in these majors should consider this project:**

- Economics (A.S., B.A., B.S.)
- Statistics (A.S., B.A., B.S.)
- Political Science (A.S., B.A., B.S.)
- Environmental Studies (A.S., B.A., B.S.)

Students with strong writing skills, experience with Excel, and familiarity with a statistics package (SAS, STATA, NLOGIT) are preferred.



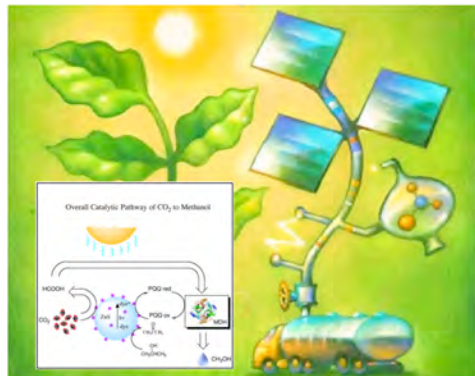
## SOLAR: Photons to Fuels and Feedstocks: Solar Energy in New Mexico

**Locations:** New Mexico Tech, University of New Mexico, Main Campus and New Mexico State University

**Project supervisors:** [Michael Heagy](#) (NMT Chemistry) and [Martin Kirk, Yang Qing](#), and [John Grey](#) (UNM Chemistry) Hongmei Luo (NMSU Chemical Engineering)

### Project description:

Solar energy is an important type of renewable energy. However, the initial cost of silicon-based solar panels is either prohibitive or not well suited for a variety of applications. This primary goal of this



project is to synthesize and test new, non-silicon molecules and materials for the collection of energy from sunlight. For example, zinc sulfide crystals coated with light absorbing organic dyes might be able to convert CO<sub>2</sub> to methanol (see the figure to the left).

Students participating in the solar energy team will take part in several cutting edge projects involving spectroscopy, photochemistry, and synthesis in organometallic, inorganic, and polymer chemistry. In all cases, our team will utilize a multidisciplinary approach to accomplish our goals, and

students associated with the project will make new materials be involved in determining key photo, magnetic and electrical features of these new systems. Weekly or biweekly meetings with project group members will enhance student learning by tackling research problems, giving oral presentations, and learning the theoretical basis of the research being performed in solar team laboratories. Social events within each team are also anticipated to promote team spirit and these will promote informal discussions between students and the PIs.

### During this project, students will:

- Synthesize and characterize new molecules and materials
- Learn and apply advanced spectroscopy techniques
- Learn and apply advanced magnetic techniques

### Students must have completed the following courses to be eligible to participate in this project:

- General Chemistry I and II
- Organic Chemistry I and II

### Students interested in these majors should consider this project:

- Chemistry, Physics, Optics, Biology, and/or Chemical Engineering (A.S., B.A., B.S.)
- Science and Pre-engineering (A.S.)

**Students involved in this project will work both at New Mexico Tech in Socorro and on the main campus of The University of New Mexico in Albuquerque. Housing in the NMT and UNM dorms will be provided.**

## **URANIUM: Assessing Uranium Contamination on the Navajo and Laguna Reservations**

**Locations:** New Mexico Tech and Diné College

**Project Supervisors:** Dan Cadol (NMT Earth Science), Bonnie Frey (New Mexico Bureau of Geology)

### **Project Description:**

Native lands are home to many closed and/or abandoned uranium mines, including on the Navajo



Nation and Laguna Pueblo. The waste materials left at these mines represent a potential hazard to the citizens of these areas, through groundwater, soil, and dust contamination. While some cleanup of these sites is either underway or completed, some sites remain a concern for local communities. Students working on this project will research the history and locations of these mines and their waste materials. They will visit the sites and talk with local community members. They will collect and preserve water, soil, and dust samples. Working at New Mexico Tech, the students will analyze these samples for their uranium concentrations. Finally,

the students will return to the reservations and report their results to local communities.

### **During this project, students will:**

- Research the history and impact of uranium mining
- Talk with local community members about the history of mining and their concerns about possible mining contamination
- Collect and preserve well water, soil, and dust samples
- Prepare and analyze samples for uranium
- Report analysis results back to local communities

### **Students must have completed the following courses to be eligible to participate in this project:**

- General Chemistry
- Navajo and Laguna students will be given preferred consideration for this project

### **Students interested in these majors should consider this project:**

- Chemistry (B.A., B.S.)
- Environmental Science (A.A.S., A.S., A.A., B.S., B.A.)
- Science and Pre-engineering (A.S.)

**Students involved in this project will work on the Navajo Reservation, Laguna Pueblo, and at New Mexico Tech in Socorro. Housing will be provided. Significant travel and working outdoors will be involved in this project.**