Energize New Mexico
Diversity Innovation Working Group
– Final Report –

Development of Primary to Bachelor's STEM Education Pathways for Underrepresented Populations of Northern New Mexico Using Sustainable Technologies Curricula.

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Jemez Ballroom

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Summary

The U.S. Department of Education recently declared "an absolute priority aimed at improving science, technology, engineering, and mathematics (STEM) education." "This priority aims to ultimately improve student outcomes by supporting projects that are designed to rapidly improve low-performing schools and, when appropriate, their feeder schools." (Federal Register, April 23, 2014). According to data from the Bureau of Labor Statistics, in May 2009 the average annual wage for all STEM occupations was $77,880 which is nearly 79% higher than the national average for all occupations. Only 4 of the 97 STEM occupations had mean wages below the U.S. average. A 2010 National Academy of Sciences study documented a 5.5 percent decline in the number of science and engineering degrees being awarded to U.S. citizens and permanent residents and projects a shortage of scientists and engineers starting as early as 2015. The problem is exacerbated by national security regulations that sharply limit how many foreign nationals can attend American universities or are eligible to fill these key jobs.

Many Northern New Mexico school districts have low graduation rates (average 53%) and have some of the lowest math proficiency scores in the state. The majority (75%) of the student population at Santa Fe Community College (SFCC) is over 25 years old, indicating that SFCC is a re-entry point for students into the educational system. While older returning students are more motivated to get an education, these returning students have many extra challenges to completing their degree or certificate programs; i.e. deficiencies in math and English skills, deficiencies in study skills, young children, divorce, multiple jobs and probation, to list a few. Younger students who are engaged and encouraged to complete high school greatly improve their chances of success at college. Keeping young students in school until they graduate and continuing to college, instead of returning at a later date with extra burdens, is a main objective of this Diversity Innovation Working Group (D-IWG).

The Biofuels Center of Excellence at SFCC provides a STEM-based education focused on 4-year transfer degrees, or career pathways to the sustainable technology industries of New Mexico. SFCC is a Hispanic Serving Institution (HSI) for federal funding purposes and is a minority-majority institution with a high percentage of 1st generation Hispanic and Native American college students. Sustainable Technology is an excellent means of introducing STEM to non-traditional students due to the perception among students that it is not a STEM-related program. During its four year existence, 95 students have enrolled in the Biofuels program, 9 have continued on to STEM fields at a 4-year university, 5 have been employed in the biofuel/algae industry and 7 have created businesses employing 22 people in the Santa Fe region. SFCC "walks the walk" when it comes to sustainability. The campus generates most of its own electricity and heat via solar and biomass energy and nearly all degree programs have a sustainability component.

The D-IWG explored extending the Biofuels program to northern NM rural/tribal schools (K-12) in order to engage young students in "hands-on" citizen science and math activities. The activities would continue through high school directing students to SFCC for the first two years with a seamless transfer to UNM or NMSU to complete their Bachelor's degree. The D-IWG brought together vested individuals from SFCC, UNM, NMSU, ENMU, U. Wisconsin – Stevens Point, Tesuque Pueblo, NCGR, LANL/NMC, SNL, US Army Corps of Engineers, Girl Scouts, NM-MESA, private industry, NM-PED and representatives of Senators Heinrich and Udall to develop a pathway for entry and retention of non-traditional students in STEM education and to identify funding sources.

The 1.5 day workshop was split into a ½ day session on Thursday and full day on Friday. The Thursday session provided an opportunity for all the participants to give short talks on sustainability

or educational components at their institution that could be a part of the STEM pathway of the proposal. The Friday working groups were preceded by two talks on laboratory design and teaching methods for non-traditional students at community colleges; two short talks by current SFCC Sustainable Technologies students on projects that they have initiated in Puerto Rico and Jemez Pueblo as a result of class projects and the final talk was about the Professional Science Masters (PSM) degree as another option for students to pursue. The last topic generated considerable interest among the participants. After the PSM talk, "MS to MS" (Middle School to Masters of Science) was proposed as the slogan for future workshops.

Results

The most immediate and pronounced result of the D-IWG was getting representatives of the 4-year universities and national laboratories to be physically present at the SFCC Biofuels Laboratory. Nearly all the participants were aware that there was an Algal Biofuels Program at SFCC, but none were aware of the scale of the program or the scale of the cultivation equipment in the lab. SFCC provides the opportunity for the universities and national labs to scale up the production of novel algal strains on equipment they do not have at a very low cost. Several possible collaborations were discussed during the workshop and are listed in the appendix.

The proposed topic of the D-IWG was to offer "hands-on" STEM education/community programs that will engage young students in sustainable technology science by using a proven program in algae prospecting and characterization. The program for younger students will be to expose them to opportunities for higher education, self-sustainability and community impact. Over the duration of the working group and after tours of the sustainable technologies facilities at SFCC, the topics broadened and eventually settled into two general areas of discussion;

- A program to generate interest in northern NM middle and high school students in sustainable technology careers that require STEM education.
- A program for transfer of students from SFCC to 4-year universities and how to address major roadblocks, including:
    - Provincialism and the reluctance of SFCC students to leave Santa Fe or nearby communities, even temporarily, to pursue education elsewhere.
    - The lack of transferable courses in Sustainable Technologies and/or the lack of 2x2 articulation agreements between SFCC and the 4-year universities.
    - The low number of women in the Sustainable Technology program.

I. Stealth-STEM in Middle and High schools

Biofuels is perceived as a "tree-hugger" program that tends to attract non-STEM degree seeking students. At SFCC the Biofuels program has been referred to as "stealth-STEM". The approach is to let students enter the program, immerse them in a laboratory-based hands-on curriculum and "discover" that math and science are integral to their success. Entering students have little interest in the required STEM courses, but by the 2nd semester are in a panic when math and science classes are closed. SFCC Biofuels students change from "I hate science" to "Should I take chemistry or biology first?" in a very short period of time. By the very nature of the student population at SFCC many may still require remedial courses, especially in math. For such an approach to succeed, students starting the programs must be exposed to material relevant to their degree. Their perception of relevance is very important in keeping them engaged, especially when the material becomes difficult.

In order to make the high school to college transition less terrifying, we propose to set up a vertical educational program using demonstrated biofuels curricula to engage students early. The aim of this D-IWG is to extend this approach to the public school system to attract students into math and

science before college by letting them discover that math and science are an integral part of their future career goals.

The title of the working group describes the use of algae prospecting to engage students, but the ultimate goal is not to solely teach algae cultivation. The model that the working group started with was the Backyard Biofuels program (http://danforthcenter.org/news-media/roots-shoots-blog/blog-item/Part-1.-Backyard-Biofuels-Citizen-Scientist-Project, http://danforthcenter.org/news-media/roots-shoots-blog/blog-item/Part-2.-Backyard-Biofuels-Citizen-Scientist-Project) run by the St. Louis Science Center and the Donald Danforth Plant Science Center. The program culminated in a conference called "Algaepalooza" where all the participants had the opportunity to present their discoveries. A local citizen-scientist model that was discussed is Bernalillo County Open Space Division's Get Involved Project (http://www.bernco.gov/get-involved-3998/). Algae prospecting/cultivation is used as a "hook" to get the students involved and then introduce them to the broader topics of water, climate change, food security, carbon-, nitrogen- and water cycles. The working group concluded that the other subject areas of the Sustainable Technologies program at SFCC are equally "interesting and exciting" for using as "hooks" for STEM education. The areas include solar power (photovoltaic and solar thermal), aquaponics/hydroponics/sustainable greenhouse management and water/wastewater operations.

Any curriculum developed would need to both engage students with hands-on activities and meet the NM State Standards, including the Common Core for math and literacy and the Next Generation Science Standards. The current state of public education in NM in relation to the Common Core curricula may make it difficult to implement any new programs in math or science classrooms due to reluctance on the part of school systems to modify already approved curricula. Integrating the sustainable technology curriculum into the science classroom would be the ideal choice, but the consensus of the working group is that afterschool or summer programs would be a better/easier approach to get stealth-STEM into the K-12 school systems. Afterschool program would require additional funding, but would allow the implementation of STEM-based sustainable technology modules in a fairly rapid time frame with a minimum of administrative hurdles.

There was considerable discussion about the target geographic location, target age group, target ethnic/economic group and final educational outcome. Although the proposal was to pilot programs in rural/tribal schools, the consensus was that the Santa Fe Public Schools should be the initial school system for the following reasons:

- The Santa Fe Public School system has among the lowest graduation rates and math proficiency scores in the state
- The close proximity would allow for better use of initial funding towards curriculum development, instead of travel
    - High school students would have easy access to the SFCC Biofuels lab
    - SFCC students would be more readily available to function as mentors at the middle/high schools
- Santa Fe Public Schools requires each student to take an honors, an advanced placement (AP) or a dual-credit course in order to graduate. SFCC's BCX Biofuels curriculum is already approved dual-credit with the Santa Fe Public School system
- SFCC has already offered the BCX program to Masters Program students (a charter high school of the Santa Fe Public Schools housed within the SFCC campus) with great success.
- SFCC and Santa Fe High School (SFHS) are partners the Academy of Sustainable Education (ASE) at SFHS.
    - ASE a new in-school academy at SFHS starting in the 2014/15 school year.

- 300 students (68 seniors) in grades 9-12 have enrolled in the academy – out of 1500 total enrollment, indicating that the students have considerable interest in learning about sustainability and a sustainable life-style.
- SFCC is currently training the ASE faculty in the BCX curriculum to be used at the Academy.
- Many of the courses in ASE are dual-credit. When ASE students receive their high school diploma, many will also have a SFCC certificate in Sustainable Technology, while the more ambitious may have a SFCC AAS degree in Sustainable Technology.

Afterschool or Summer Programs

Several local organizations, including existing afterschool programs and school-based clubs could be possible hosts for STEM programs. These organizations have considerable experience in running programs for early education and intervention and are ideal partners for the early stages in the sustainable technology pathway to college. The organizations identified to partner with (but not limited to) are:

- Girl Scouts of New Mexico Trails
- NM MESA
- Boy Scouts – Great Southwest Council
- Boys and Girls Clubs
- Girls, Inc.
- Municipal/County Afterschool/Summer Programs
- 21st Century Afterschool Programs
- 4-H
- Future Farmers of America
- Museums
- Zoos/Aquariums/Botanical Gardens
- Libraries

Some of these organizations would target K-5 students, others middle to high school students and others cover the entire K-12 age populations. These organizations make extensive use of peer-to-peer education which further reinforces the lesson that STEM education is valuable for their future. NM MESA and the Girl Scouts already have implemented rigorous STEM curricula in their programs. SFCC would provide:

- Campus open houses and family days as a culminating event offered to schools that participate in the program. The more access students have to the campus the better!
- Student guest speakers to occasionally visit schools and share their work.
- Content experts and access to specialized equipment.

Most museums and libraries are not tied to the same standards as schools and can be more flexible in programming. They may be able to host or offer similar programs as those for schools, but with fewer restrictions. Examples of programs that are offered by local museums:

- Santa Fe Children's Museum
  - Weekly programs in literacy (some bilingual) and hands-on art activities
  - Explorer's Summer Camps (week long camps in STEM areas)
  - SFMaker's Workshop (800 ft^2 workshop for 8-14 yr olds. Open to additional projects. Opportunity for introducing biofuels/sustainability workshop)
- El Rancho de las Golondrinas
  - Opportunities for workshops/camps that teach and compare traditional agriculture to modern agriculture, incl. greenhouse culture
- Rio Grande Nature Center State Park
  - Offers educational programs in ecology and natural systems.

    - NM State Parks has the Kids 'n Parks Transportation Grant Program to provide funds for buses. Teachers must connect classroom learning to the outdoors and must evaluate their experiences.
- Los Alamos National Laboratory – Bradbury Science Museum
    - Algae to Biofuels: Squeezing Power from Pond Scum
- Several museums in the Albuquerque area offer STEM programs including;
    - New Mexico Museum of Natural History and Science
    - Explora Science Center and Children's Museum
    - National Atomic Museum
    - National Hispanic Cultural Center
    - Albuquerque Biopark (Zoo/Aquarium/Botanical Garden)

Ideally, a long-term program is created that re-engages the same students over the course of their K-12 experience and reinforces their knowledge that a college education is a desirable and achievable goal. Introducing a college degree as a goal is especially important for potential 1st generation college students who have not been exposed to the benefits of higher education. The proposed project would involve algae bioprospecting, but could also be coupled to SFCC programs in sustainable agriculture/greenhouse cultivation, solar projects or water projects. A tracking study to determine if the program is effective should be matched with a College of Education at UNM, NMSU or NMHU. This main program goal should be to develop an integrated vertical STEM education pathway from elementary school through a Bachelor's degree using sustainable technology curricula coupled with effective tracking studies.

Kindergarten – Fifth grade

Elementary schools do not have dedicated science teachers on staff. Some school districts have traveling science teachers that may visit a few times a month. Afterschool programs are probably the best mechanism for more frequent interaction with students. NM MESA and the Girl Scouts have considerable experience in funding/managing these types of programs. These programs should inspire and encourage science engagement with short, hands-on, "splashy" results type of activities.

- Series Program – weekly or monthly sessions, that will engage children for four to six weeks. This can be done as part of the school day or in an afterschool program.
- Two part events – visit identified schools twice a year, spring and fall. If using Backyard Biofuels as a model, have children collect specimens in fall and have a follow-up session to explore what they have learned and report back on findings in the spring.
- Family Science Nights – Provide a program for the entire family that involves stations and food. This will expose children and parents to STEM opportunities and reinforce the perception of SFCC as part of the community.

Sixth – Twelfth grade

Middle and High schools have dedicated science teachers. These teachers should be offered continuing education credit for participating in sustainable technology training workshops/courses. These teachers that have completed the training would be able to introduce students to more in-depth sustainability topics and reinforce academic concepts taught in the science classroom. Students will complete engaging hands-on activities that increase academic proficiency for future STEM engagement and academic success. Areas where the SFCC Sustainable Technology program could contribute include:

- Sustainable technology training for science teachers.
- Transfer the BCX Biofuels Curriculum to High School science classes. (http://granteeproducts.workforce3one.org/grants/product/2584)
- Regular meetings that engage middle school students in biofuel science. Led by a paid facilitator, perhaps school staff or SFCC intern. This would follow the NM MESA model and involve consistent engagement by students from elementary school through high school that require students to prepare regular written reports on their projects.
- Day camp program that includes the same ideas as above, but is a condensed week long program.
- Farm to Fork Program that includes compost and biofuel generation
    - either as part of science education or afterschool club
    - greenhouse/hydroponic food production on unused space at middle/high school
        - several middle schools in the Albuquerque Public Schools use greenhouses as part of the science curriculum and afterschool programs
    - biomass or bio-digester could be built at each high school
    - program can be expanded to include energy education
    - food waste education – food waste should go to compost/biogas, not landfill
- Energy education in high school

Summer Institutes -Supplemental for ninth-twelfth grade

Students will explore STEM/Sustainable Technology topics during in-depth Summer Institutes at SFCC. These Institutes will include ACT/SAT preparation courses for high school students. These programs will be three to four week camps at SFCC (or UNM, UNM-branch campuses, NMHU and NNMU) that engage students in considering career opportunities and STEM education, as well as, expose them to college life and share how a college education can change their lives and communities.

- Biofuels Institute – The summer course will expose students to Biofuels Technology and Algae Cultivation. During the summer the students will become exposed to energy, water and carbon cycle issues and their impact on the students and their community.
- Agriculture Institute - The summer course will expose students to Aquaponics Technology, Hydroponics Technology and Sustainable Greenhouse Agriculture. During the summer the students will learn biology and chemistry and be exposed to food security, land use, water use, social justice issues and their impact on the students and their community.
- Water Institute – The summer course will expose students to Water Conservation, Water Treatment technologies, Wastewater Treatment technologies, Rain water catchments and Biology of water systems. The program is heavy in chemistry and biology.
- Solar Institute – The summer course will expose students to the various aspects of solar energy including; Passive solar heating, Solar thermal heating, Photovoltaic power generation and community based solar projects. The program includes introductory geometry and optical physics. Advanced math concepts are introduced as part of the solar project.
- Farm to Fork to Fuel (in development at SFCC) – The Greenhouse Management Program and the Culinary School at SFCC are developing a Farm to Fork summer program. The Biofuels program is developing the "to fuel" content to include into the program. The program is an 8 week summer course targeted to students who do not have the ability to attend the usual summer camps in the area. 1 week will be devoted to introducing sustainability, 2 weeks each to greenhouse cultivation, biofuel production and culinary arts. Daily math and science tutorials will be held and concepts such as; Life Cycle Analysis,

Water Conservation, Carbon Footprint, Recycling and Biofuel Production will be continually reinforced. The final week will be devoted to preparation of the "harvest banquet" where students prepare and serve the food they grew to their parents and families. Weekly movie/planetarium nights are to be included for the students and families.

Summer Research Jobs

A barrier to completion of high school, possibly unique to the Hispanic population, is the cultural belief in being a "good worker", not necessarily a "good student". Retention can be difficult if the choice is between staying in high school (having to trust the teachers that graduating will increase your income), or taking an immediate construction job that pays $15-$25 per hour. Many of these students have the self-perception that they are only smart enough for manual labor. One of the best tools the Biofuels Program has used to keep these at-risk students in the program is to offer paid summer internships that require some research project on the part of the student. The realization that they can get paid for doing research using their STEM education is an "eye-opening" experience for many of them. Paid summer internships for at-risk high school students would "open eyes" much sooner. This program would be a longer term goal, hopefully including local sustainable industries to provide internships. Long-term funding needs to be obtained in order for the program to succeed with students and local businesses.

Long-term Projects

NM Algaepalooza

Creation of an annual NM Algaepalooza style event for bio-prospecting would be a great success for the D-IWG. Various ecological systems would be targeted in different years including;

- the Bosque del Apache (a major flyway) during and between migrations;
    - to assess introduction of new species carried by migrating birds
- various rivers systems above and below treated wastewater discharge points
    - to measure the change in algal populations after introduction of treated wastewater
- a survey of the various hot springs in NM
    - to find extremophile algae that can withstand high temperature and mineral content
- wastewater retention ponds from mining, hydraulic fracturing, and municipal runoff
    - to find algae that can survive in high metal content or extreme pH environments
- a range of other extreme or unique environments across the state.

These samples could by analyzed for potential use as biofuel (lipid or carbohydrate based), bioremediation (to clean metal contamination or to lower salinity), nutritional value for both humans and livestock or simply to create a database of algal markers to monitor movement of species into the state. This program would involve elementary and middle school students, at the collecting end, all the way to graduate students at universities and postdocs at national laboratories, at the comprehensive analysis end. Web-based access and videos would be available to all participants to follow the progress of their sample. Ideally, each of the "steps" should be in place and demonstrated before approaching the federal government for long-term funding.

Heritage Energy Program

The Biology Department at UNM envisions developing a Heritage Energy program between Tesuque Pueblo, UNM, SFCC and others. This exchange program would have students from the various institutions participate in the Tesuque seed bank program learning to grow heritage plants in sustainable ways. Studies would produce data on agronomic, physiological, genomic and metabolomic properties of heritage plants grown in a sustainable manner. The data would be analyzed to understand how heritage plants have unique, or unusual, physiologies that may be useful

for world agricultural or for energy needs (i.e. why preserving heritage lines is essential for our future). The heritage plants would be harvested for seeds (to maintain viable seek banks) and also for energy and food activities. Bagasse left over from harvest would be put into the SFCC biodigester to produce biogas. The students who worked on the Tesuque farm would burn this gas in a grill at SFCC to cook the harvested edible parts of the heritage plants they grew during the summer. Preserving Tesuque's cultural heritage by teaching new generations about traditional farming practices and traditional recipes using modern sustainable technologies would educate everyone on the importance of the heritage varieties and demonstrate that environmentally responsible agriculture is possible. It is also possible to develop a related Heritage Aquaculture program using native fish and plants in the aquaculture greenhouses at SFCC. The connection would be made as to why preserving the heritage lines and growing methods is essential for preserving culture.

Model Program - The Detroit Area Pre-College Science and Engineering Program

The Detroit Area Pre-College Engineering Program (DAPCEP - http://www.dapcep.org/) is non-profit that annually provides more than 4,000 preK - 12th grade students with hands-on exposure to STEM topics through in-school and out-of-school educational programs. DAPCEP has a 38-year track record of motivating minorities to pursue careers in STEM fields. DAPCEP offers high-quality programming in many areas including renewable energy. Partnerships with 8 Michigan universities to offer Saturday science and math classes to 4th-12th graders during the school year, as well as summer camp sessions, have been in operation for several years. Approximately, 60% of students attending the summer engineering academy at the University of Michigan School of Engineering applied to and were accepted by the school. Of those surveyed, 80 % of alumni affirmed that DAPCEP prepared them for higher education and careers in STEM fields and medicine. DAPCEP has a large pool of funders including; the Detroit Public Schools, NSF, Michigan Dept. of Education, Big Brothers/Big Sisters, GM and Ford Foundations and the UAW. This is a model system that should be established in New Mexico in the near future.

Model Program – Boston Area Girls STEM Collaborative

The Boston Area Girls STEM Collaborative (http://www.bostongirlsstem.org/) was created in 2008 by local nonprofits, universities and museums united in their commitment to advocate for girls' participation in STEM areas. The Collaborative develops and implements programs for girls to learn about current research, interact with female role models, and access STEM information and resources. Members of the Collaborative include: Ben Franklin Inst. of Tech., Boston U., Emmanuel Coll., Harvard U., M.I.T., Northeastern U., Simmons Coll., UMass Boston, Wentworth Inst. of Tech., WGBH. Biogen Idec, Girl Scouts of Eastern MA, IBM, the Microsoft NERD Center and the Society of Women Engineers. During the academic year several one-day events are held were girls can learn about cutting-edge research and careers first-hand from women in science and engineering at multiple sites in the Boston area. During the summer several "science camps" are held for middle and high school girls in various disciplines at various institutions depending upon the girl's interest. While New Mexico does not have the same density of college and universities as Boston, there are several world class laboratories that could participate with NM colleges and universities in a similar collaborative, namely; Sandia National Laboratory, Los Alamos National Laboratory, New Mexico Consortium, USAF Phillips Research Laboratory, White Sands Missile Range, National Radio Astronomy Observatory's Very Large Array, the Corps of Engineers, US Fish and Wildlife Service, US Bureau of Reclamation and WIPP. This model could be followed for girls, Native students, Hispanic students or even more narrowly defined groups. The low numbers of women in STEM fields could be changed in the long term if young girls are encouraged and shown that they can participate in STEM activities just as well as the boys.

Model Program – O'Keeffe Art and Leadership Programs for Girls and Boys

The Georgia O'Keefe Museum Art and Leadership Programs for Girl and Boys are gender-specific camps for adolescent girls and boys, 11-13 years, with opportunities for independent thinking, skill-building, problem solving and the development of their artistic talents. For girls topics include concentrations on identity, creativity and self-esteem. This interactive program seeks to create a support system for girls, utilizing art-making and women artist role models to promote girls' creative abilities. For boys the program focuses on the exploration of creativity through art making, writing, music, and exercises that promote non-violent behavior. Professional male museum staff, artists and interns lead the program and serve as role models. The program is free, but students must be nominated by a middle school art teacher. These programs are focused on providing a "summer camp" experience to students who do not otherwise have access to such programs. Creation of a STEM summer camp with the same philosophy of targeting those that would not normally be able to attend summer camps should be a major objective of any summer program set up by the D-IWG. The separation of sexes in public school education is a very contentious and controversial issue and illegal under Title IX, except is very specific circumstances. There is accumulating data that suggests that girls do better in math and science and that boys are less "unruly" in single sex classrooms*. The success of the O'Keeffe Leadership Program and Boston Area Girls STEM Collaborative should be considered when creating afterschool programs for middle school students. Public support of separate Boy and Girl Scouts programs and vigorous opposition to the periodic suggestions that they become integrated indicates a public acceptance that these gender-specific programs may be in the best interest of the children.

II. Transfer of students from SFCC to 4-year universities

Peer Mentors

Discussion during the D-IWG consistently returned to the concept of peer mentoring as an effective way to train students and improve the success rate of incoming students. Peer-to-peer mentoring involves taking "best" students who have completed a course/section and pay them to mentor students at the lower levels. This helps to reinforce the mentor's mastery of the subject (You learn by teaching!) and provide more personalized interactions for newer students. The Biofuels Program at SFCC makes use of an informal peer-to-peer mentoring system where the mentors are paid lab interns who as part of their duties are directed to monitor students in the lab. A more formalized system with greater institutional support for peer-to-peer mentoring should be established. NMSU is establishing a peer mentoring system that could be extended to summer peer mentoring programs at SFCC for summer classes and "real-world" advice about college.

Model Program - STEM Mentors at Kapi'olani Community College

The STEM Mentors at Kapi'olani Community College (KCC) in Hawaii are STEM students who have already completed the required number of courses in their subject area with high grades (http://stem.kapiolani.hawaii.edu/peer-mentors/). Funding for the program was originally from NSF – Tribal Colleges and Universities Program (TCUP). Native Hawaiian students were the original paid mentors. Mentors are required to set a schedule for 15 hours/week and paid monthly stipends ($3000/month). New mentors begin by mentoring recently graduated high school students in a summer bridge program to increase math proficiency among entering students. Each mentor keeps a log of students they mentor and the subjects they cover. Mentoring is free to all students

* (http://www.nap.edu/download.php?record_id=12062#, http://www.jstor.org/stable/1002093, http://sfonline.barnard.edu/sfxxx/documents/bailey1.pdf)

enrolled in any STEM classes at KCC. STEM instructors actively encourage their students to take advantage of the program. SFCC in not a TCUP institution, but is an HSI and eligible for funding for similar programs from the Dept. of Education, USDA, NSF and EPA.

Internships, Exchanges and Summer Research Programs

As stated previously, the SFCC Biofuels Program makes extensive use of paid internships as a means of encouragement and retention in the program. The majority of SFCC students are attending college in the hopes of landing a better paying job. In our experience, getting paid to perform science and engineering related jobs does more to convince students to pursue a 4-year degree than any other recruitment strategy. In order to maximize funds available for student stipends, SFCC will generally waive indirect costs and faculty salaries for "small" grants.

The Biofuels program at SFCC budgets 2-3 stipends for student internships each semester. During the application process for the D-IWG we became aware of the STEM Advancement Program (STEMAP) funded by New Mexico EPSCoR. All 2nd-year Biofuels students were required to apply for the program and two were accepted. The SFCC students were identified because of the D-IWG funding and will be the first test students for migrating community college students onto 4-year institutions such as UNM. SFCC also received a 2014 EPSCoR SEED grant that included stipends for 4 internships. Two are currently working in the summer session and two more will intern in the fall semester.

UNM recently confirmed that students from 2–year colleges will have enough transfer credits (60) to be eligible for summer research support through the UNM McNair and ROP programs. Given the rolling admission for these programs, they would be great opportunities to build a support community and contribute to the success of transferring students. The IMSD and MARC programs in Biology at UNM would be able to provide financial support during the academic year for transferring students. These programs also provide a community of peers to help with transition to UNM. The Biology Dept. at UNM will be seeking McNair/ROP and IMSD/MARC support for the current STEMAP students should they desire to attend UNM this, or next, year.

NMSU would like to set up a summer internship program where the students would learn about methods for laboratory algae culture and outdoor cultivation in both open raceway systems and closed, plastic, horizontal photobioreactors. Culture monitoring techniques will be covered along with algal pigment and fatty acid analysis as well as PCR-based algae identification. Algae harvesting methods will be covered. Demonstrations of hydrothermal liquefaction and chemical analysis of the resulting bio-crude oil will be included. A small pilot cultivation system set up at the Las Cruces Wastewater Treatment Plant could be part of future training opportunities. Funding would be needed for the interns and a graduate student to run the program.

During the D-IWG, the participants were made aware of the Dept. of Energy's Community College Internship (CCI) program. The CCI program seeks to encourage community college students to enter technical careers by providing technical training experiences at the DOE laboratories. CCI internships are only offered during the summer. Two nearby national laboratories (LANL and NREL in Golden, CO) are participating in the program. Sandia National Laboratories/Livermore, CA is also a participating laboratory, but SNL/Albuquerque is not. Discussions are underway to have SNL/Albuquerque become a participating laboratory. While students can intern at any of the 15 participating laboratories, the likelihood of SFCC students participating goes up the closer to Santa Fe the internship is located. Combating the reluctance of SFCC students to leave Santa Fe to pursue education elsewhere is a major obstacle; many students perceive a trip to Albuquerque as a major undertaking. The summer 2015 CCI application period will open in October 2014 and close in early January 2015. All Sustainable Technology students at SFCC will be required to apply for

summer 2015 CCI's at LANL and NREL, but will be encouraged to "take a risk" and apply to the other DOE labs. Few students may be awarded a CCI, but the process of applying will be an excellent stealth exercise in improving writing skills.

Student Exchanges

SFCC Biofuels students currently take field trips to learn about algal cultivation, processing and analysis to the New Mexico Consortium in Los Alamos, NMSU in Las Cruces and Sapphire Energy in Columbus. Future field trips, with NMSU, to the Global Alternative Fuels biodiesel plant in El Paso, TX are being planned. SFCC Sustainable Technology and STEM Club students have been invited to NREL in Golden, CO for tours and seminars. High school students in the BCX Biofuels program are encouraged to participate in these field trips.

During the D-IWG the idea of sending graduate students and postdocs from UNM, NMSU and LANL to SFCC for a semester was repeatedly introduced. The graduate students and postdocs would either teach a semester-long topics course in Sustainable Technologies and gain teaching experience, or perform research projects on industrial scale algae cultivation equipment not available at those institutions. Several postdocs at NMSU were especially interested in this opportunity to enhance their teaching credentials and will be attending a meeting at SFCC in the beginning of August to begin organizing the exchange.

New Mexico EPSCoR also has student externships for graduate students and exceptional undergraduates to provide additional research experiences at other institutions in the state. The externships are designed to be exchanges between institutions. It is not clear if "exceptional undergraduates" includes community college students (sophomore level). Inquiries should be made to explicitly determine if community college students are eligible. SFCC would be willing to take undergraduates from UNM, NMSU, NMT, ENMU and NMHU who wish to conduct independent research projects using the facilities of the SFCC Biofuels program.

The Wisconsin Institute for Sustainable Technology (WIST) at UW-Stevens Point has a wastewater operators program that complements the wastewater operators program at SFCC. The emphasis of the WIST wastewater program is industrial wastewater treatment (specifically, pulp and paper industry wastewater), where the SFCC wastewater program emphasizes treatment of municipal/domestic wastewaters. Both institutions would like to create a summer student exchange program where SFCC students travel to WIST and vice versa to learn the technologies and problems specific to each type of wastewater treatment system. Each institution would be able to leverage the expertise of the other to turn out more marketable graduates.

Transfer and Articulation

The issue of articulation is thorny and political. Successful articulation agreements are more common when faculty from the 2-year institution and the 4-year institution actually sit down together and go over course requirements. Universal 2x2 articulation agreements for all NM universities and colleges have been discussed for decades. Distance learning has become much more common recently and may have changed the environment sufficiently to make Universal 2x2 articulation agreements more desirable and necessary. The focus of any articulation agreement should be on the student and how to prevent them from repeating content because of administrative, bureaucratic or territorial technicalities. Trying to convince faculty at a 4-year institution that a 100-, or 200-level course at a community college may be more rigorous than a 300-level course offered at a 4-year university can lead to very heated conversations. Students with a certain background in AS or AAS programs may be successful in a junior level course at the 4-year institution, but should be monitored and placed in a lower level course immediately if lack of performance warrants it. Economic development in NM requires that more 2x2 articulation

agreements be made between the 2-year and 4-year institutions because, employees who possess the hands-on experience gained from 2-year college programs, along with the theoretical knowledge gained from 4-year institutions are highly prized by industry.

SFCC currently does not have written 2x2 articulation agreements with any of the 4-year universities in NM. The College of Engineering at NMSU and SFCC have a "verbal" agreement for transfer of students with an AS in General Engineering to NMSU. The college is working with Northern New Mexico University on an articulation agreement in for the proposed AS in Environmental Sciences. Discussions started during the workshop on the possibility of future workshops between SFCC Algal Biofuels Program and similar programs at UNM and NMSU. Sustainable Technology could transfer to either Biology or Engineering at UNM, or Biochemisty or Engineering at NMSU. SFCC is currently modifying the Sustainable Technology curriculum to align with the current AS degrees in General Studies, Biology, or Engineering to make the possibility of 2x2 articulation agreements more likely.

In spring of 2016 UNM will offer a Biological Energy course that is cross-institutional. It will be based on the cross-college Algal Biofuels course offered previously at UNM by Dr. Hanson and will eventually become part of the UNM Sustainability Studies minor at UNM. The goal of the course will be to have students enroll at multiple home-institutions and have some lectures at each location and all lectures presented live online throughout the state. Sustainable Technology lectures from SFCC should be included in this course. Students from across the state who participate in this course would be an ideal source for conducting a state-wide test run for a program like Algaepalooza.

Conclusions

The fundamental problem with US higher education occurs during K-12 education where students are unprepared to pursue careers in STEM, and/or they are turned off from pursuing STEM degrees. The subject has been studied and examined for years and several reports from the National Academies of Science and Engineering, the Institute of Medicine and National Research Council.* In the 1970's fundamental changes in science education were being developed through environmental education, at the time referred to as outdoor education. The focus was on discovery and hands-on learning. During this time, many school systems required science teachers to actually have a science degree in order to teach science courses. That requirement has been removed from many schools, while science learning objectives have been increased. It is imperative that K-6 teachers have more science knowledge before they are allowed to teach science. It is well understood that teacher knowledge is important for successful teaching. Techniques and style of teaching are important, but effective teaching skills cannot compensate for lack of scientific knowledge. The goal of getting elementary school and high school students interested in STEM fields is related to teacher readiness to convey knowledge and excitement about the subject. The changes required are generational, not a one or two year solution, and will require political will (which is presently not forthcoming).

Since it is unlikely that science degrees will be required for science teachers in the near future, development of the activities for students discussed during the workshop should be complemented with courses that also educate teachers in STEM. Working with K-8 and high school on achieving the goals of the workshop requires that the community colleges and universities provide clear learning objectives and outcomes that can be reached. Providing teachers with good background information that provides knowledge beyond the lesson is necessary so students will have questions

*(http://www.nap.edu/catalog/12984.html, http://www.nap.edu/catalog/13099.html, http://www.nap.edu/catalog/13151.html, http://www.nap.edu/catalog.php?record_id=13398)

answered in a satisfactory fashion. Getting excitement from students about science is one thing, and it is a worthy goal, but getting students to pursue an AS, BS, or even graduate degrees is more difficult. Creating teachers and mentors to fuel the excitement using community college students is an excellent approach, as long as the teaching and outcome goals are clearly defined.

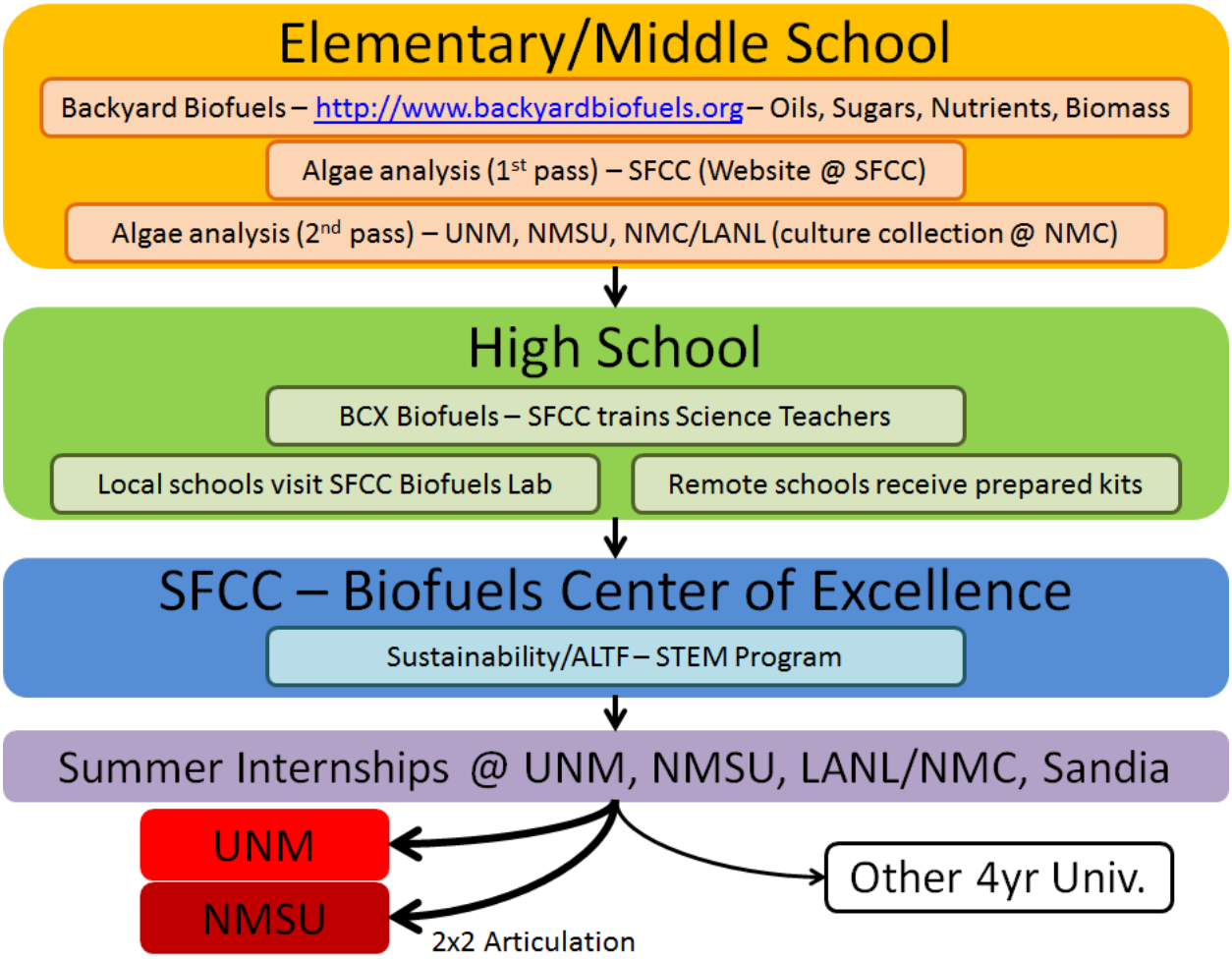
Hands-on STEM education by using citizen-scientist programs engages entire communities in educating young students. We propose to use Sustainable Technology to introduce STEM with a proven program in algae prospecting and characterization. Younger students would be exposed to opportunities for higher education, an especially desirable outcome for children from families that have never had a college graduate. Creating a pathway from elementary school to a bachelor's degree is an ambitious goal. Successful implementation of each "module" in the pathway should be the near-term goal, but with the expectation that each module will be integrated into the whole at a later date. Constant interaction between the groups responsible for creating each step in the path is necessary to ensure that topics and projects are presented in a coherent manner, i.e. moving from middle school to high school should not have students repeat material learned in middle school nor leave a large "gap" in knowledge. If 'gaps" or "redundancies" are discovered, then modifications can be made to correct these problems. Concurrent with development of these programs for students there should be professional development curricula for the science and math teachers to maintain consistency in the curricula and expected outcomes.

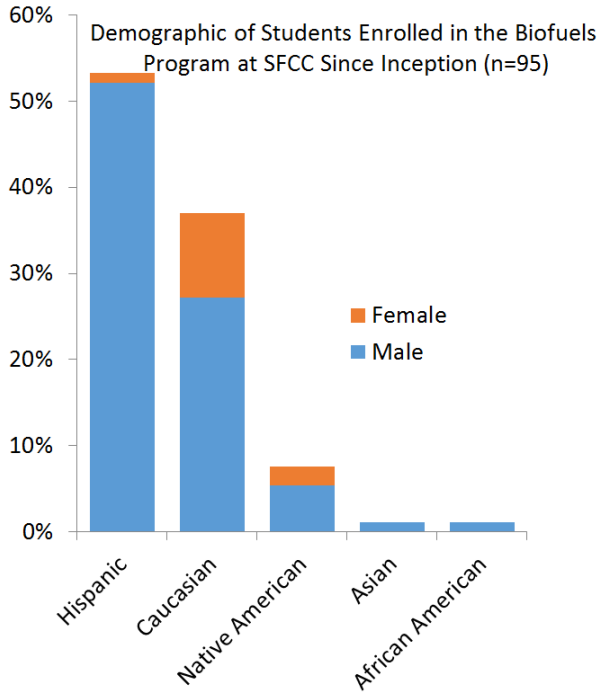
A follow-on D-IWG should be held in 1 year in order to keep the process on track, to assess the progress in each module, compare curricula to ensure that each module will seamlessly connect to the next and that consistent progress is being made. Any new organizations brought into the process should be invited to the follow-on D-IWG.

Potential Projects Resulting from the D-IWG

PROJECT	POTENTIAL FUNDING	TERM
STEM Advancement Program (STEMAP) Internships	NM-EPSCoR	Current
Graduate student/Postdoc exchange with NMSU	NMSU/SFCC (short term)	Current
Girl Scout of New Mexico Trails STEM Camporee – SFCC Biofuels booth Bernalillo, NM Sept 13, 2014	Booths are free. SFCC Biofuels confirmed. Other SFCC programs may participate. (in progress)	Near
Equipment for algae cultivation lab	LANL (in progress)	Near
Internship classes at High School and Community College	NSF - Advanced Technological Education (ATE) with LANL (proposal in progress)	Near
Environmental Algae Survey (local) – SFCC/Girl Scouts/NCGR	Albert I. Pearce Foundation (proposal in progress)	Near
Summer High School Biofuels class for at-risk STEM students (students who need support or inspiration in STEM classes)	Dual credit option with Santa Fe Public Schools-- Biofuels class is free to high school students (in progress)	Near
Field trips for MS/HS science classes to SFCC Biofuels lab	EPSCoR travel funds	Near
Invite SFCC Sustainability students to present to UNM's Sustainability Program about current research at SFCC	SFCC/UNM	Near
Community College Internship (CCI) Program	DOE (applications due Jan 2015)	Near
Explore opportunities for NIH SEPA award at NCGR for educational bioinformatics projects. Develop a STEMAP project for next year.	NIH/NM EPSCoR	Near
Explore MOU with Corps of Engineers and UNM to fund common research	UNM/USA Corps of Engineers	Near
Summer research for 2-yr students transferring to Biology at UNM	McNair/ROP and IMSD/MARC (in progress)	Near
Cross-institutional Biological Energy Course	UNM	Near
Field trips to Rio Grande Nature Center State Park – algae ecology (curricula created w/ SFCC and UNM)	Kids 'n Parks Transportation Grant Program	Mid
Summer Workshops	NM MESA	Mid
Middle/High school mentorships in algae bioinformatics with NCGR	NCGR educational mandates, Title V funding	Mid
STEM Teacher Training at SFCC in Sustainable Technologies	NM PED has STEM teacher stipends for training and program funding for FY16. NM MESA pays science teachers in the school systems.	Mid
Create PSM program at WIST	U. Wisconsin and Dept. of Ed.	Mid
Wastewater student exchange between SFCC and WIST	EPA	Mid
Sustainable Greenhouse Design – SFCC Greenhouse Management Program	NSF - Advanced Technological Education (ATE) with Sol-Dance Technologies	Mid
Peer Mentoring Program at SFCC	Title V - Developing HSIs Program US-Dept. of Ed., NSF, USDA, EPA	Long
Tracking of Students in the Program – SFCC/UNM/NMSU/NMHU/Local school districts	Investing in Innovation Fund Office of Innovation and Improvement, Department of Education.	Long
Create a Biofuels/Sustainable Technology badge for Girl/Boy Scouts	Girl/Boy Scouts and their traditional funding sources	Long
Wastewater Technology Program with NMSU	SFCC as collaborator on NMSU WWT grant	Long
2x2 Articulation Agreements between SFCC and UNM, NMSU, NNMU and NMHU	State and Federal Education Funds	Long
Environmental Algae Survey (Bosque del Apache/ Sevilleta LTER) – The Bosque del Apache is a major flyway. Survey during/between migrations. US-FWS/USA Corps of Eng./UNM/SFCC/ Schools & Youth Organizations/NCGR	NSF	Long

Proposed Biofuels pathway to STEM degrees.





Development of Primary to Bachelor's STEM Education Pathways for Underrepresented Populations of Northern New Mexico Using Sustainable Technologies Curricula.

2014 EPSCoR Diversity Innovation Working Group – Santa Fe Community College May 29/30, 2014

Participants		
Emigdio Ballon Head of Tesuque Farms Agricultural Initiative Tesuque Pueblo	Nicholas Kunz North Central Region Coordinator NM MESA, Inc. nkunz@nmmesa.org	John Roesgen - Graduate Student Department of Biology University of New Mexico jroesgen@unm.edu
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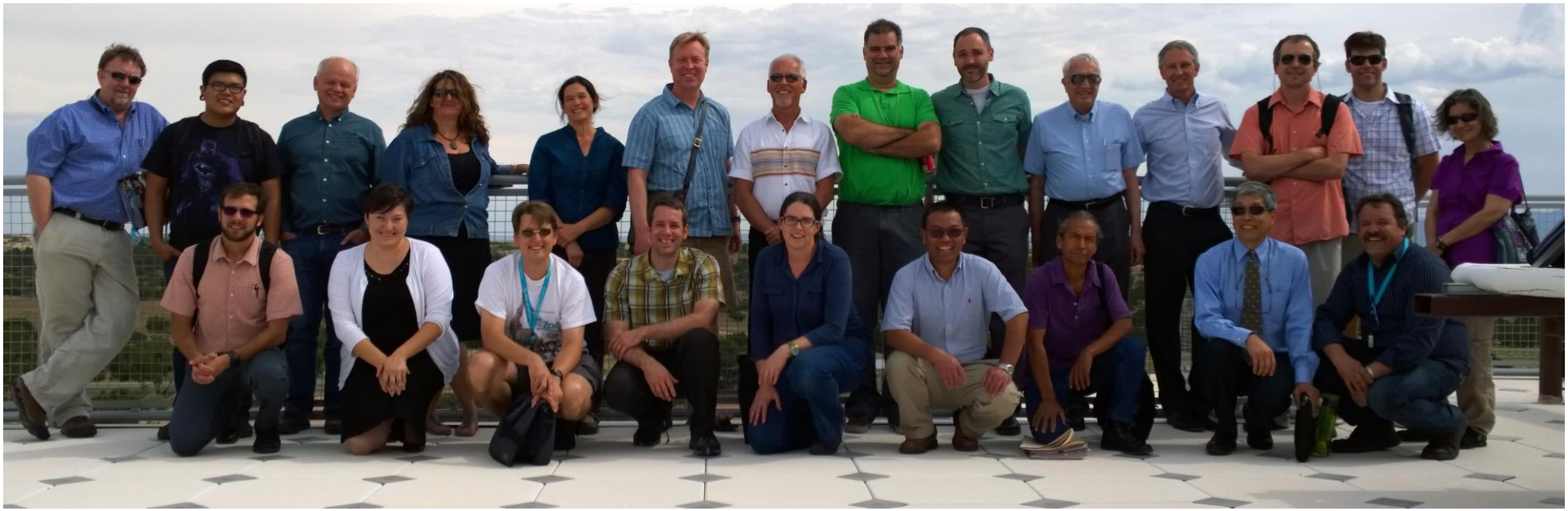
AGENDA

Thursday	
1:00 – 2:00 PM	Arrival and buffet lunch
2:00 – 2:10 PM	Welcome to Santa Fe Community College – Randy Grissom, Interim President
2:10 – 2:30 PM	Welcome and meeting outline/expectations - Gómez
2:30 – 3:00 PM	Overview of Sustainable Technologies Program at SFCC - Spangenburg
3:00 – 4:00 PM	Tour of the Sustainable Technologies Center at SFCC - Spangenburg
4:00 – 4:15 PM	Short Break
4:15 – 4:35 PM	Experiences with "Backyard Biofuels" – Sayer (w/ short discussion)
4:35 – 4:55 PM	Experiences with BCX Biofuels training program – Frauenglas (w/ short discussion)
4:55 – 5:15 PM	Experiences with STEM and organic farming - Ballon (w/ short discussion)
5:15 – 5:35 PM	Sustainability programs at ENMU – Yan (w/ short discussion)
5:35 – 5:55 PM	Sustainability programs at NMSU – Lammers (w/ short discussion)
5:55 – 6:15 PM	Sustainability programs at UNM – Hanson (w/ short discussion)
6:15 – 6:35 PM	Sustainability programs at U Wisconsin, Stevens Point – Singsaas (w/ short discussion)
6:35 – 6:50 PM	STEM programs at the US Army Corps of Engineers – Parrish
6:50 – 7:05 PM	STEM programs at the Girl Scouts of New Mexico Trails – Lujan
7:05 – 7:20 PM	Internship opportunities at LANL/NMC – Barry
7:20 – 7:35 PM	Internship opportunities at SNL - Matteo
7:35 – 7:50 PM	Internship opportunities at NCGR - Mudge
7:50 – 9:00 PM	Buffet Dinner and informal discussions
Friday	
8:30 – 9:00 AM	Breakfast
9:00 – 9:30 AM	Designing STEM lab courses for unprepared students - Divine
9:30 – 10:30 AM	Working group I – Backyard Biofuels – Elementary and Mid-school • What students/schools to initially approach? • Who receives and/or analyzes samples? • Identify institutions to maintain website, culture collection, etc? • Funding sources?
10:30 – 11:00 AM	Student sustainability projects from SFCC – Longo-Torres/Star
11:00 AM – 12:00 PM	Working group II – BCX as STEM – High School • What model to pursue? - Concurrent enrollment - Integrated high school curriculum • What students/schools to initially approach? • Funding sources?
12:00 – 1:00 PM	Lunch
1:00 – 1:30 PM	Stealth STEM - Gómez
1:30 – 3:30 PM	Working group III – AAS to AS degree in Sustainability at SFCC • What is an AS degree in sustainability? • What are minimal STEM requirements? • What existing courses transfer? • What new courses are needed to fill the gaps? • Identify individuals to negotiate 2x2 articulation agreements. • Funding sources?
3:30 – 3:45 PM	Break
3:45 – 4:15 PM	Professional Master's Science Programs - Nishio
4:15 – 5:30 PM	Working group IV – Internships and Summer research • What internships are available at the national laboratories? • What internships/summer research are available at the research universities? • What summer/part time jobs are available in the industry? • Initiate development of a clearing house/database of available programs? • How will internships integrate into degree programs? • Funding sources?
5:30 – 6:30 PM	Closing and preliminary consolidation of results and ideas.
6:30 – 8:30 PM	Dinner at Blue Corn Café.

Energize New Mexico

Diversity Innovation Working Group - Development of Primary to Bachelor's STEM Education Pathways for Underrepresented Populations of Northern New Mexico Using Sustainable Technologies Curricula.

Santa Fe Community College May 29/30, 2014



Back row: Kevin Divine, KD Consulting; Jeremiah Star, SFCC; Richard Sayre, NMC/LANL; Lesley Galyas, NM-PED; Ondine Frauenglass, SFCC; Eric Singsaas, UWisc-Stevens Point; Peter Lammers, NMSU; Stephen Gómez, SFCC; Nicholas Kunz, NM-MESA; Gerhard Salinger, retired; Luke Spanenburg, SFCC; Momchilo (Momo) Vuyisich, LANL; John Roesgen, UNM; Nadia Mabrouk Mujynya, SFCC.
Front row: Edward Matteo, SNL; Amanda Lujan, Girl Scouts of NM Trails; David Hanson, UNM; Shawn Starkenburg, LANL; Joann Mudge, NCGR; Juchao Yan, ENMU; Emigdio Ballon, Tesuque Pueblo; John Nishio, Sol-Dance Inc.; William Longo-Torres, SFCC/TISARE.
Not Pictured: Amanda Barry, LANL; Andrew Black, Senator Heinrich's office; Bobbie Ferrell, Senator Udall's office; Christopher Parrish, US Army Corps of Engineers.

Energize New Mexico

Diversity Innovation Working Group -Santa Fe Community College May 29/30, 2014

Working Group Photos

Luke Spangenburg, Director of SFCC Biofuels Program, explaining the SFCC algal photobioreactors to Dr. Lammers, Ms. Galyas, Dr. Sayre and Dr. Yan.

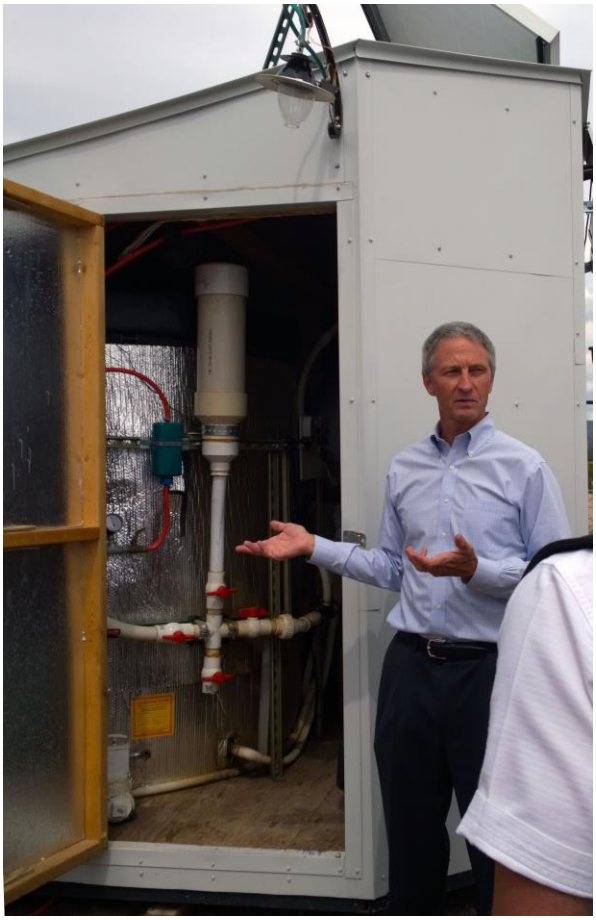
The solar-thermal collection system on the roof of the Sustainable Technology Center at SFCC. Dr. Gómez for scale

Luke Spangenburg showing the solar-thermal system to Dr. Yan, Dr. Lammers and Dr. Hanson

Energize New Mexico

Diversity Innovation Working Group -Santa Fe Community College May 29/30, 2014

Working Group Photos



Luke Spangenburg showing the anaerobic digester at SFCC

Eric Highfield, Aquaponics Program Manager, giving a tour of the aquaponics greenhouse to Ms. Galyas, Dr. Yan, Dr. Matteo, Mr. Kunz, Dr. Lammers and Mr. Roesgen

Dr. Singsaas observing the New Mexico skyline from the roof of the Sustainable Technologies Center at SFCC