

Energize New Mexico

New Mexico EPSCoR Strategic Plan for RII Implementation 2013-2018

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Submitted: 24 October 2013

Award Date: 1 June 2013

Expiration Date: 31 May 2018

Award Number: IIA-1301346



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I. Executive Summary

A. Introduction

This document summarizes the New Mexico EPSCoR Track 1 strategic planning process and includes the plans and related documents resulting from that effort. New Mexico was awarded $20M on 1 June 2013 for its 5-year Track 1 project, entitled "Energize New Mexico." Upon official notification, the PI (Michener) and Co-PI (Daniel) held meetings with the project's Management Team and our external facilitator (New Mexico First (NM First)) to initiate the planning effort. A capstone meeting was organized by NM First in conjunction with the PI and Co-PI, and held August 19-20, 2013 in Albuquerque, NM. The meeting attracted approximately 70 participants including component leads and team members, New Mexico EPSCoR State Committee members, a representative of the external advisory board, the project's external evaluator, and two NSF Program Officers. More detail about the planning process, including the agenda and participants, may be found in the Introduction (II. A.).

New Mexico has immense, largely untapped energy reserves in the form of ample sunshine and wind, oil and natural gas reserves, extensive low-temperature geothermal energy sources, proven uranium deposits, and large brackish water aquifers with high total dissolved solids (i.e., supporting osmotic power development). Consequently, "energy, environment and water" was recognized by current Governor Susanna Martinez and former Governor Bill Richardson as one of seven priority areas in the State Science and Technology Plan. New Mexico must harness its abundant renewable energy resources and sustainably capitalize on other resources such as geothermal and uranium reserves without adversely affecting the environment and water resources. Furthermore, New Mexico must improve its Science, Technology, Engineering, and Math (STEM) pipeline and Research and Development (R&D) capacity (i.e., education), creating new businesses and industries (i.e., economic development). The New Mexico RII project will provide cutting-edge research facilities and activities, as well as new education and economic development programs to enhance strengths and resolve shortcomings identified in the New Mexico Science and Technology Plan.

B. Energize New Mexico Strategic Plan

Energize New Mexico is built upon a compelling vision (III. A.) and mission (III. B.) that have been reviewed and endorsed by the New Mexico State EPSCoR Committee, the Management Team, and project participants:

Vision: Energize New Mexico will help lead the nation in harnessing and promoting sustainable energy resources, cultivating a well-qualified STEM workforce, and developing a sustainable culture of innovation and entrepreneurship.

The project **mission** is two-fold:

1.) Develop the research infrastructure that will enable New Mexico to address fundamental basic and applied research questions related to improving energy extraction efficiencies and promoting sustainable resource development; and
2.) Develop the human resources necessary to improve the state's research competitiveness in sustainable energy development, STEM education, and workforce and economic development capacity.

The project is organized into thirteen components, each of which is associated with a strategic priority, one or more specific objectives, a set of SMART activities and milestones, anticipated impact(s), and

an identified team that typically includes participants from multiple institutions and two co-leaders from different institutions (described in detail in Section III. C.):

1.) Bioalgal energy development
2.) Solar energy research
3.) Osmotic power development
4.) Uranium transport and site remediation
5.) Geothermal energy resources and sustainability
6.) Social and natural science nexus
7.) Diversity
8.) Workforce development
9.) Cyberinfrastructure
10.) External engagement
11.) Assessment and evaluation
12.) Sustainability
13.) Management

The activities and milestones are presented in the form of an easy-to-interpret Gantt chart so that Management Team members, project leadership, NSF Program Officers, and external evaluators (including Reverse Site Visit panel members) can easily track and review progress, as well as address emerging challenges.

One of the principal opportunities afforded during a strategic planning workshop is to identify ideas and strategies that may result in desirable, but unanticipated project synergies. Workshop participants engaged in four concurrent, facilitated breakout sessions that cumulatively arrived at ten different actions and strategies that could lead to synergies across different strategic components such as: (1) across two or more research components; (2) among research components, CI, and external engagement; and (3) between diversity and all research areas. (III. D.).

Section III. E. lists the provisional baseline, year five and cumulative performance metrics associated with each of the strategic components. This information is being used by the external evaluator, Kirk Minnick and Associates, to design the project's evaluation and assessment activities for the next five years.

Risk exists and no large project is immune to risk. Project participants identified 19 project risks (9 high impact, 7 moderate impact, 3 low impact), of which one was viewed as being highly likely to occur (III. F.). Mitigation strategies were proposed for each risk and it was recognized that management had already discussed and/or planned for many of these—possibly reducing the perceived likelihood that risks would come to fruition at maximal impact. For example, one risk is that key personnel will change over time. Mitigation strategies include having a succession plan in place that, when implemented, can reduce or eliminate the adverse impact to the project. In this case, a Succession Plan (III. G.) has been prepared and vetted by the New Mexico EPSCoR State Committee and the Management Team.

The Evaluation and Assessment Plan (III. H.) is focused on performing formative and summative evaluation so that the project leadership and others can assess where the project stands with respect to meeting targets. Feedback from the two external evaluators (Kirk Minnick & Elsa Baliey), the External Advisory Board, and the AAAS is used to constantly refine the EPSCoR program. Project leadership has been very responsive to evaluative feedback and has worked diligently to improve programs in ways that maximize

their impact. Should it be determined that any given area is underperforming, project leadership will work cooperatively with the cognizant NSF Program Officer to improve functionality of the component in question or redirect funds from that component to other, more promising and productive areas.

C. Appendix

Energize New Mexico is a large and complex project, with many organizations and specific pieces to each component. A Glossary of acronyms has been provided.

II. Introduction

A. The Strategic Planning Process

Following several weeks of preliminary planning and discussions by the Project Management Team, nearly seventy attendees participated in a two-day strategic planning retreat, August 19-20, 2013 convened for the purpose of identifying:

- SMART goals, activities, milestones, and metrics
- Project synergies
- Project risks and mitigation strategies

Participants included component team leads and team members, NM EPSCoR Management Team, NM EPSCoR State Committee members, a representative of the external advisory board, the external evaluator, and NSF Program Officers. New Mexico First, an external facilitator, provided an effective, collaborative process for the large, diverse group to reach consensus on each of the retreat goals. The strategic planning retreat required significant advance planning on the part of New Mexico First, project leadership, and project participants. Each participant was provided with a Retreat Guidebook that included the agenda, activities and examples, and a list of participants.

The retreat opened with Dr. Bill Michener, PD, and Dr. Jeanne Small, NSF Program Officer, reviewing the objectives of the day and NSF expectations. New Mexico First introduced the small group process and tools to be used for the rest of the day, releasing the teams to begin their work. Participants were divided into eight groups by project component topic and facilitated by a team member from that component; each group also selected a recorder. The full group reconvened at the end of the day to briefly highlight the project milestones identified by each component.

Day two began with a brief review of project plans and an introduction by New Mexico First of different processes and tools to be used for the day. Participants were divided into four groups, each comprised of a mix of the component teams, to identify project synergies and risks. Everyone reconvened to discuss the potential synergies identified and proposed strategies. Returning to their small mixed groups, they next discussed and voted on their top seven or eight selections for project risks. The full group, facilitated by New Mexico First, determined the level of impact and likelihood of each of the top selections and small groups reconvened to identify mitigation strategies. The retreat closed with comments from Dr. Jeanne Small.

B. Alignment with the New Mexico Science and Technology Plan

The ideas driving this project emerged over several years. NM EPSCoR played a key role in developing the State Science and Technology (S&T) Plan by engaging Governor Bill Richardson's Office and key stakeholders via statewide focus meetings that culminated in the publication of the first S&T Plan in 2009. The S&T Plan identified seven priority areas for New Mexico: (1) energy, environment, and water; (2) aerospace; (3) bioscience; (4) nanotechnology; (5) information technology; (6) education; and (7) economic development. The seven priority areas of the S&T Plan were updated and endorsed by Governor Susanna Martinez's administration in 2012. The S&T Plan can be found at http://www.gonm.biz/Science_Technology.aspx.

New Mexico's future depends upon achieving success in three key areas that are identified in the S&T Plan and that serve as the basis for this project: energy, education, and economic development. New

Mexico must harness its abundant renewable energy resources and sustainably capitalize on other resources such as geothermal and uranium reserves without adversely affecting the environment and water resources. The state must also improve its STEM pipeline and R&D capacity (i.e., education), creating new businesses and industries (i.e., economic development).

C. Anticipated Benefits to New Mexico's Academic Research and Education Infrastructure

Proposed cutting-edge research facilities and activities, as well as new education and economic development programs will enhance strengths and resolve shortcomings identified in the New Mexico Science and Technology Plan. These include purchasing much needed state-of-the-art equipment, filling critical gaps in expertise via faculty hires and by building new partnerships with the National Labs and industry, providing seed awards to the regional universities and Tribal colleges, and supporting Interdisciplinary Innovation Working Groups (IWGs). The proposed infrastructure and activities are designed to support shared use equipment, engage new research and community college faculty, and support the STEM pipeline by training teachers, undergraduate and graduate students, and post-doctoral fellows. Research findings will be communicated broadly through new partnerships with New Mexico's museum network, a citizen-centric designed web portal, and vibrant, experiential programs targeting K-12 students. The project will also enable our researchers to compete successfully for the array of new NSF programs included in the Clean Energy, Cyberinfrastructure Framework for 21st Century Science (CiF21) and Science, Engineering, and Education for Sustainability (SEES) portfolios.

III. Energize New Mexico Strategic Plan

A. Vision

Energize New Mexico will help lead the nation in harnessing and promoting sustainable energy resources, cultivating a well-qualified STEM workforce, and developing a sustainable culture of innovation and entrepreneurship.

B. Mission

The project mission is two-fold:

1. Develop the research infrastructure that will enable New Mexico to address fundamental basic and applied research questions related to improving energy extraction efficiencies and promoting sustainable resource development; and
2. Develop the human resources necessary to improve the state's research competitiveness in sustainable energy development, STEM education, and workforce and economic development capacity.

C. Strategic Priorities, Objectives, Activities and Milestones, Impacts and Team Participants

Our overarching goals are to improve the research, cyberinfrastructure (CI), and human resources required to enable New Mexico to achieve its energy, education and workforce development potential. We will accomplish this by: (1) investing in critical equipment, facilities, and faculty hires; (2) increasing the size and diversity of the STEM workforce, emphasizing community and Tribal colleges, and Hispanic-serving institutions; (3) building new interdisciplinary and inter-institutional collaborations; and (4) developing a culture of innovation and entrepreneurship.

For each of the project's thirteen strategic components, we (1) describe the Strategic Priority; (2) outline principal Objectives; (3) tabulate key Activities and Milestones; (4) highlight anticipated Impacts; and (5) list the Team Co-leads and Participants.

Strategic Component 1: Bioalgal Energy Development

Strategic Priority: Implement innovative new technologies that will support next generation biofuel production, pioneer the production of bio-crude oil from highly stable algal extremophiles with lower-lipid contents, and provide new knowledge in algal ecology, physiology, agriculture and biomass process engineering. The team and infrastructure will enable interdisciplinary training for graduate and undergraduate students statewide and support new interactions among universities, national laboratories, and industry in the state.

Objectives:

- Develop and optimize large- and small-scale facilities and critical instrumentation for algal cultivation and processing
- Develop inexpensive plastic photobioreactors (PBRs) that eliminate prohibitive evaporative water losses in summer and reduce radiative heat losses in winter via solar heat gain for large scale, highly productive algal cultivation in desert environments
- Develop the Small-scale Experimental Ecological Design (SEED) Facility

- Form collaborations in New Mexico among groups working on algal cultivation and wastewater management
- Provide training to graduate students using new and existing infrastructure

Activities and Milestones:

Bioalgal Energy	Year 1				Year 2				Year 3				Year 4				Year 5			
1: June-Aug; 2: Sept-Nov; 3: Dec-Feb; 4: Mar-May	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
GOAL 1: OPTIMIZE BIOLOGICAL PRODUCTIVITY																				
Outdoor Algal Performance (NMSU, UNM)																				
Evaluate *Galdieria* strains	■	■		■	■	■			■	■		■	■	■		■	■	■		
Reassess biomass and lipid productivity phenotypes of strains in cultivation			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Study the responses of algae through time and physical location													■	■	■	■	■	■	■	■
Micro-Photobioreactors (NMC, UNM)																				
Use hydrogels to encapsulate very high-density microalgal cells along with solid-state devices and/or fluorescent proteins				■	■	■	■													
Address optimization of giant quantum dot cell energy transfer						■	■	■	■	■										
Characterize mircro-encapsulated algal-growth and biomass partitioning									■	■	■	■	■	■	■	■	■			
Compare photosynthetic function between bacteria and algae in silica gel matrices		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
Compare biomass accumulation between bacterial and algae in multiple gel matrices	■	■	■	■	■	■	■	■	■	■	■	■								
Algal Community Ecology (UNM, SNL, NMSU)																				
Evaluate how diversity and trophic interactions influence lipid production						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Measure photosynthetic function in natural bacterial and algal communities			■	■	■	■	■	■	■											
GOAL 2: IMPROVE CULTIVATION PRACTICES																				
Outdoor Cultivation (NMSU)																				
Analyze *Nannochloropsis* (CCMP1776) and a fast-growing *Chlorella* strain for winter growth in the photobioreators		■	■			■	■			■	■			■	■			■	■	
Evaluate potential for using municipal and agricultural wastewaters in the photobioreactors					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Process Engineering (UNM, NMSU)																				
Evaluate effects of lipids on biomass density as a potential selectable characteristic					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Develop agent-based models of microbes with storage products in photobioreactors									■	■	■	■	■	■	■	■	■	■	■	■
Access how industrial, municipal, and agri-cultural wastewater affects system function					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
GOAL 3: ENHANCE ENERGY RETURN ON INVESTMENT AND WASTEWATER UTILIZATION																				

Bioalgal Energy	Year 1				Year 2				Year 3				Year 4				Year 5			
1: June-Aug; 2: Sept-Nov; 3: Dec-Feb; 4: Mar-May	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Extraction (NMSU)																				
Evaluate hydrothermal, microwave-assisted, and supercritical processing concepts for chemical extraction, fuel conversion, and easy nutrient recycling from process waste streams and inorganic carbon																				
Processing (NMSU)																				
Test hydrothermal processing technology on *Nannochloropsis*, *Chlorella*, *Galdieria* and also ecologically stable strain mixtures																				
Conversion (UNM)																				
Investigate transition-metal catalyzed decarboxylation processes tailored to de-oxygenation of biocrude oils in order to meet ASTM fuel standards																				
Wastewater Utilization (ENMU)																				
Test baseline performance of turf scrubber																				
Characterize wastewater for turf scrubber																				
Test turf scrubber with wastewater, and analyze nutrient and BOD removal																				
CROSS-CUTTING INFRASTRUCTURE																				
NMSU's Chemical Analysis and Instrumental Laboratory																				
Provide Overall Project Support (NMSU)																				
Provide centralized analytic processing and training																				
Develop biological standards (new strains as needed in out years)																				
Develop Standard Operating Procedures for algal sampling and lipid quantification																				
Purchase and Install Equipment (NMSU)																				
Continuous flow hydrothermal reaction system (1-L, 0-400 C, 0-400 bar)																				
Components, fabrication and utility modification costs for 24 Outdoor Algae Cultivation Systems																				
Harvesting System (Evodos, Origin Oil or dissolved air floatation (DAF))																				
Purchase and Install Equipment (ENMU)																				
Algae turf scrubber																				
Small-scale Experimental Ecological Design Facility (SEED) (UNM)																				
Provide Overall Project Support																				
High frequency chemical analyses																				
Flexible cultivation environments																				
Stable isotope measurements																				
Purchase and Install Equipment (UNM, NMC)																				
Waters UPC2																				

Bioalgal Energy	Year 1				Year 2				Year 3				Year 4				Year 5			
1: June-Aug; 2: Sept-Nov; 3: Dec-Feb; 4: Mar-May	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Raman plate reader			■																	
Digital compound microscope					■															
Photobioreactors					■				■				■							
GC/MS													■							
MIMS													■							
Isotopic laser																	■			
Hyperspectral imaging upgrades																	■			
Photochemical reactor					■															
Personnel (All)																				
Form collaborations in NM among groups working on algal cultivation and wastewater management	■	■			■				■				■				■			
Develop Mentoring and Training Plan		■	■																	
Hire new faculty in engineering		■	■																	
Hire research technician to run UPC2	■	■																		
UNM/NMC student support (1 per year)			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		
UNM student support (2.5 per year)					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
NMSU Faculty hire			■	■	■	■	■	■												
NMSU student hires		■	■			■	■			■	■			■	■			■	■	
ENMU entry-level technician hire	■																			
ENMU student hire		■			■				■											

Impact: This research component aims to generate fundamental knowledge about algal biology and scaling algal biofuels production from cells and populations to large reactors, leading to solutions to techno-economic problems that uniquely impact the nascent bio-algae industry in the desert Southwest.

Team Co-Leads: Peter Lammers (NMSU), David Hanson (UNM)

Team Participants (42: 22 faculty, 2 techs, 16 grad students, 2 undergrads): ENMU: Manuel Varela, Juchao Yan; NMSU: Wiebke Boeing, Shuguang Deng, Robert Hagevoort, C. Meghan Starbuck-Downs, Omar Holguin, Shanna Ivey, Nirmal Khandan, Tanner Schaub, Adrian Unc; UNM: Becky Bixby, Ramesh Giri, Keith Lidke, Andrew Schuler, Andrew Shreve, Olga Pontes, Christina Takacs-Vesbach, Jerilyn A. Timlin (SNL); LANL: Richard Sayre (NMC); 2 technicians; 16 graduate students; 2 undergraduate students.

Strategic Component 2: Solar Energy Research

Strategic Priority: Forge a research collaboratory and invest in spectroscopic instrumentation that will enable us to: (1) explore the potential of solar energy in reducing atmospheric CO_2 to methanol, an alternative transportable fuel; (2) develop a solar-driven water oxidation process that uses inexpensive catalysts to generate H_2, a high-energy fuel that does not emit C; and (3) design more efficient organic solar photovoltaic cells.

Objectives:

- Use nanoparticle ZnS semiconductor materials to catalyze the reduction of CO2

- Develop new organic dyes that efficiently augment ZnS performance by lowering the semiconductor band-gap to use the visible solar spectrum
- Develop an artificial photosynthetic process for production of H2, a high-energy fuel that does not produce CO2, using well-defined manganese complexes as catalysts for the electrolytic water oxidation
- Develop ordered and thermodynamically stable bulk heterojunctions (BHJs) from a single polymer system using self-assembly strategies with the goal of understanding the emergent properties and assemblies of these novel molecules

Activities and Milestones:

Solar Energy	**Year 1**				**Year 2**				**Year 3**				**Year 4**				**Year 5**			
1: June-Aug; 2: Sept-Nov; 3: Dec-Feb; 4: Mar-May	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1. Build solar team (All)																				
Hire/train graduate students					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Identify team member at NMSU		■																		
Hire physical or inorganic chemist						■														
Incorporate new team member's expertise (NMHU, NMSU)		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
2. Purchase and install equipment (NMT, UNM)																				
MCD Magnet System	■	■																		
Time Resolved Spectroscopy					■	■														
Fluorolog spectrophotometer					■	■														
Raman Microscopy									■	■	■	■	■	■	■	■	■	■	■	■
3. Use nanoparticle ZnS to catalyze reduction of CO2 (NMT, UNM, NMHU, NMSU)																				
Obtain preliminary data on ZnS NPs vs. microparticle	■	■	■	■																
Explore and develop dye photosensitizers for ZnS catalysts			■	■	■	■	■	■	■	■	■									
Investigate semiconductor catalysts MoS								■	■	■	■	■	■	■						
Obtain spectroscopic characterization of NP catalysts							■	■	■	■	■	■	■	■	■	■	■	■	■	
4. Develop stable BHJs from a single polymer system (NMT, UNM, NMHU, NMSU)																				
Synthesis of new polymeric systems and characterization	■	■	■	■	■	■	■	■												
Incorporate non-covalent guests/C60 porphyrins							■	■	■	■	■	■								
Spectroscopic characterization / fluorescence lifetime									■	■	■	■	■	■	■	■	■			
9. Connections between EPSCoR teams (NMT, SFI, UNM, NMHU, NMSU)																				
Outreach to K-12 students via SFI/GUTC				■				■				■				■				■
Explore collaboration w/ geoscientist for zeolite carbon capture		■	■	■	■	■	■													
Explore collaboration w/ biologist using bioalgal carbon capture							■	■	■	■	■	■								

Impact: This research component aims to help New Mexico transition from fossil fuels to renewable energy by improving the state's ability to use solar energy.

Team Co-Leads: Michael Heagy (NMT), Marty Kirk (UNM)

Team Participants (19 total: 6 faculty, 8 grad students, 5 undergrads): NMHU: Tatiana Timofeeva; UNM: John Grey, Yang Qin; 8 graduate students; 5 undergraduate students.

Strategic Component 3: Osmotic Power Development

Strategic Priority: Further develop osmotic power, and, if viable, extract clean energy from "waste products," thereby off-setting the disposal cost and lowering the carbon footprint of the oil and gas industry.

Objectives:

- Acquire critical instrumentation (a membrane osmometer, a pressure retarded osmosis system, and a scanning electron microscopy / energy dispersive spectroscopy (SEM-EDS)
- Determine membrane properties and module designs that maximize osmotic power generation
- Determine whether membrane fouling can be controlled to minimize the impact on PRO
- Provide support for students, specialized post-docs, and a research chemist with expertise relevant to the proposed research
- Develop collaborations among researchers at different institutions and employees of the oil and gas industry and water treatment companies

Activities and Milestones:

Osmotic Power	Year 1				Year 2				Year 3				Year 4				Year 5			
1: June-Aug; 2: Sept-Nov; 3: Dec-Feb; 4: Mar-May	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Purchase and install equipment (major pieces) (NMT)																				
Membrane Osmometer																				
Pressure Retarded Osmosis (PRO) System																				
SEM-EDS																				
Research																				
Identify potential sources of produced water (NMT, UNM)																				
Characterize the compositions of source waters (NMSU, ENMU)																				
Evaluate the achievable trans-membrane pressures (NMT, UNM)																				
Assess the design requirements of membranes and membrane modules (All)																				
Design, construct, and modify bench-scale osmotic power systems (All)																				
Develop new thin film composite (TFC) membranes and modules to maximize power generation (NMT, UNM)																				
Investigate the occurrence, prevention, and mitigation of membrane fouling (All)																				
Perform cost-benefit analysis (NMT, UNM)																				

Osmotic Power	Year 1				Year 2				Year 3				Year 4				Year 5			
1: June-Aug; 2: Sept-Nov; 3: Dec-Feb; 4: Mar-May	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Personnel																				
Develop Mentoring and Training Plan (All)																				
Hire/train graduate students (NMT)																				
Hire/train post-docs (NMT)																				
Hire/train research chemist (NMSU)																				

Impact: This research component aims to investigate and resolve issues related to membrane properties and fouling that prevent osmotic pressure systems from becoming commercially viable sources of power.

Team Co-Leads: Frank Huang (NMT), Bruce Thomson (UNM)

Team Participants (24: 11 faculty, 1 chemist, 2 post docs, 2 grad students, 8 undergrads): ENMU: Juchao Yan; LANL: Jeri Sullivan; NMT: Corey Leclerc, Mike Riley, Snezna Rogelj; NMSU: Tanner Schaub; SNL: Pat Brady; UNM: David Hanson, Cristina Takacs-Vesbach; 1 chemist; 2 post doctoral fellows; 2 graduate students; 8 undergraduate students.

Strategic Component 4: Uranium Transport and Site Remediation

Strategic Priority: Improve laboratory capabilities to: enable faster, more sensitive analyses, including low-level speciation and isotopic measurements; conduct research to improve our understanding of Uranium (U) biogeochemistry and occurrence; and develop tools for predicting and controlling U mobility in the environment.

Objectives:

- Invest in critically needed equipment (i.e., inductively coupled plasma mass spectrometry (ICP-MS), microwave digestion and field-flow fractionation (FFF) for NMT, and high-performance liquid chromatography (HPLC) for UNM)
- Develop methodologies for rapid, sensitive measurement of environmental U speciation
- Examine the kinetic stability of bio-reduced monomeric and colloidal U(IV) species in solution under anoxic and sub-oxic conditions
- Develop and test novel technologies for U de/mobilization
- Assess, delineate, and predict potential in situ mining impacts as well as contaminant plumes from legacy mining operations
- Perform field-scale mapping and modeling of subsurface U mobility
- Evaluate the potential roles of wind-born dust and animal (or human) vectors in the arid lands of the Diné reservation
- Develop collaborations with SNL and the Navajo Nation (NN)

Activities and Milestones:

Uranium	Year 1				Year 2				Year 3				Year 4				Year 5			
1: June-Aug; 2: Sept-Nov; 3: Dec-Feb; 4: Mar-May	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Purchase and install equipment (major pieces)																				
ICP-MS (NMT)																				
Microwave digestion system (NMT)																				

Uranium	Year 1				Year 2				Year 3				Year 4				Year 5			
1: June-Aug; 2: Sept-Nov; 3: Dec-Feb; 4: Mar-May	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
FFF (NMT)																				
HPLC Upgrades (NMT)																				
Research																				
Plan for CI needs (All)																				
Develop and apply methodologies for rapid, sensitive measurement of U speciation (NMT, UNM)																				
Examine the kinetic stability of bio-reduced monomeric and colloidal U(IV) species in solution under anoxic and suboxic conditions (UNM, NMT)																				
Develop and test novel technologies for U de-mobilization (UNM, NMT)																				
Locate and characterize a site to study groundwater contamination (UNM, NMT)																				
Assess, delineate, and predict potential in situ mining impacts as well as contaminant plumes from legacy mining operations (UNM, NMT)																				
Perform field-scale mapping and modeling of subsurface U mobility at the field site (UNM, NMT)																				
Evaluate the potential roles of wind-born dust and animal (or human) vectors in the arid lands of the Diné reservation (NMT, UNM)																				
Develop collaborations with Sandia National Labs and the Navajo Nation (UNM, NMT)																				
Education and outreach program for Navajo students on the reservation (NMT, UNM)																				
Personnel																				
Develop Mentoring and Training Plan																				
Hire/train graduate students (UNM, NMT)																				

Impact: This research component aims to improve our understanding of uranium (U) biogeochemistry and mobility in natural and contaminated environments and increase our capacity to control transport of U during and after mining.

Team Co-Leads: Michael Pullin (NMT), Steve Cabaniss (UNM)

Team Participants (21: 9 faculty, 7 grad students, 5 undergrads): NMT: Bonnie Frey, Mike Timmons; SNL**:** Patrick Brady; UNM: Abdul-Mehdi Ali, Bruce Thomson, Gary Weissman; 7 graduate students; 5 undergraduate students.

Strategic Component 5: Geothermal Energy Resources and Sustainability

Strategic Priority: Develop geothermal energy as a viable and sustainable resource in New Mexico based on new understanding of the underlying natural hydrothermal systems and of the practical limitations and human technologies involved in its application.

Objectives:

- Acquire critical infrastructure (i.e., a Phoenix-Geophysics magnetotelluric (MT) System; visualization workstations, U-series and water and gas analysis, and autonomous sensors) for sensing, measuring and visualizing hydrothermal systems
- Determine the longevity and potential sustainability of fault controlled and topography-driven geothermal systems within New Mexico
- Determine the extent of degradation of groundwater and surface water quality from hydrothermal systems in New Mexico

Activities and Milestones:

Geothermal Energy	**Year 1**				**Year 2**				**Year 3**				**Year 4**				**Year 5**			
1: June-Aug; 2: Sept-Nov; 3: Dec-Feb; 4: Mar-May	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Personnel and collaborations																				
Develop Mentoring and Training Plan																				
Recruit students for yrs. 2 & 4 (UNM, NMT)																				
Develop recruiting brochure (UNM, NMT)																				
Explore wider collaborations across institutions and tribes (UNM, NMT)																				
Develop partnerships with private sector, governmental agencies, and national labs (NMT, UNM)																				
Hire/train graduate students																				
Develop outreach and educational materials (NMT, UNM)																				
Engage with Geothermal Resources Council (NMT, UNM)																				
Develop IWGs for geothermal (UNM, NMT)																				
Purchase and install equipment (major pieces)																				
Magneto-telluric system (NMT)																				
Visualization work stations (NMT)																				
Autonomous sensors/field mass spectrometers (UNM)																				
Research																				
Select geothermal systems in New Mexico for analysis (NMT, UNM)																				
Characterize the compositions of waters and gases in these systems using published and new data (UNM, NMT)																				
Assess influence of geothermal systems and systems development on potable water quality (UNM)																				
Measure the magneto-telluric signature and resistivity of the subsurface below the targeted areas (NMT)																				
Determine the temperature of these systems using published and new data and develop new techniques to determine temperatures (NMT, UNM)																				

Geothermal Energy	Year 1				Year 2				Year 3				Year 4				Year 5			
1: June-Aug; 2: Sept-Nov; 3: Dec-Feb; 4: Mar-May	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Determine radiometric dates of geothermal deposits and cosmogenic dates of fault systems to evaluate the longevity of geothermal systems (UNM, NMT)																				
Add new data to existing databases and link to other databases (NMT)																				
Make 2D geologic cross sections, 3D geologic block diagrams, and 2D and 3D conceptual model system (NMT, UNM)																				
Develop high performance 2D and 3D hydrothermal computer models (NMT, UNM)																				
Model sustainability of geothermal production over several decades (NMT, UNM)																				
Evaluate & categorize thermal energy in place and potential power sources (NMT, UNM)																				

Impact: This research component aims to develop a better understanding of factors that affect the viability and sustainability of New Mexico's underlying natural hydrothermal systems.

Team Co-Leads: Mark Person (UNM), Laura Crossey (UNM)

Team Participants (15 total: 7 faculty, 7 grad students, 1 undergrad): NMT: Shari Kelly; Mark Person, Fred Phillips, Glenn Spinelli; UNM: Laura Crossey, Karl Karlstrom; VCNP: Robert Parmenter; 7 graduate students; 1 undergraduate student

Strategic Component 6: The Social and Natural Science Nexus

Strategic Priority: Develop a cutting-edge multidisciplinary model that links natural and human systems based on a systems dynamics (SD) modeling framework and detailed water, energy, environment, and socio-economic budgets.

Objectives:

- Build an SD infrastructure to integrate social and natural sciences by developing three dynamic budgets (energy, socio-economic, and water) that provide the relationships between inputs and outputs of a resource over time: (1) the energy budget based largely on parallel work in this overall RII proposal, (2) socio-economic budgets incorporating a newly developed data gathering mechanism for human perceptions; and (3) a statewide water budget adding other river basins and groundwater basins to the Rio Grande database already incorporated into the existing SD toolbox
- Enhance collaboration with policymakers and stakeholders from the community at large
- Reach out to state agencies (e.g., Office of the State Engineer, New Mexico Environment Department, and Taxation and Revenue) that can contribute to our model's relevance, the utilization of our products, and future research

Activities and Milestones:

Social & Natural Science Nexus	Year 1				Year 2				Year 3				Year 4				Year 5			
1: June-Aug; 2: Sept-Nov; 3: Dec-Feb; 4: Mar-May	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Build an SD infrastructure to integrate social and natural sciences by developing energy, socioeconomic and water budgets (All)																				
Create an infrastructure to collect and use human perceptions data (UNM)																				
Develop data to fill data gaps on human perceptions and attitudes (UNM)																				
Develop and administer an initial statewide survey to provide baseline data on attitudes about energy/water issues																				
Develop a statewide dynamic water budget that is linkable through the SD model to other science and social data models (NMSU)																				
Merge existing and new water resource data to establish dynamic water budgets that researchers and policymakers can access when they need integrated current status water budgets (NMSU)																				
Develop statewide model that crosses disciplines, incorporating modules from disparate fields into a decision support system designed with flexible scale and focus (All)																				
Assemble team for data integration and modeling workshops with the CI team and for research team meetings and visits to data repositories (All)																				
Develop database of existing data soures, including socioeconomic, water, energy, legal, environmental, and physical infrastructure (All)																				
Reach out to state agencies that can contribute to the model's relevance, the utilization of our products, and future research (All)																				
Collaborate across EPSCoR research teams to integrate research into database and integrated decision support system (All)																				
Enhance collaboration with policymakers and stakeholders (All)																				
Develop Mentoring and Training Plan																				
Hire/train graduate students (UNM, NMSU)																				
Hire/train post-docs (NMSU)																				

Impact: This research component aims to better understand the trade-offs that occur between different energy and economic development choices while considering the potential for sustainable socio-economics, environment, and water use.

Team Co-Leads: Sam Fernald (NMSU), Janie Chermak (UNM)

Team Participants (Total 27; 12 faculty, 1 post doc, 8 grad students, 6 undergrads): Navajo Nation

Environmental Protection Agency: Steve Austin; NMSU: Steve Guldan, Caiti Steele; NMT: Mike Pullin, SNL: Vince Tidwell; UNM: Jennifer Thacher, Bruce Thomson; VCNP: Bob Parmenter; 1 post-doc; 8 graduate students; 6 undergraduate students.

Strategic Component 7: Diversity

Strategic Priority: Have 50% representation by women and underrepresented minorities in all EPSCoR-supported programs.

Objectives:

- Hire a Diversity Coordinator
- Update and disseminate the Faculty Diversity Plan and Diversity Strategic Plan
- Create researcher mentoring and training plans for all research teams that employ research-based practices that support retention of females and under-represented minority students
- Diversity team meets monthly to track progress on diversity initiatives (e.g., faculty and students, mentoring, Seed awards, workforce development, external engagement, STEMAP), identify opportunities and resources for enhancing diversity, provide input to other teams for recruiting/retaining diverse students, faculty and other participants
- Network with existing programs focused on diversity (e.g., LSAMP, AISES, HACU)
- Support Diversity Innovation Working Group

Activities and Milestones:

Diversity	**Year 1**				**Year 2**				**Year 3**				**Year 4**				**Year 5**			
1: June-Aug; 2: Sept-Nov; 3: Dec-Feb; 4: Mar-May	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Hire Diversity Coordinator																				
Complete researcher mentoring plans																				
Diversity IWG																				
Project leadership attends SACNAS/AISES																				
Attend NM LSAMP Student Research Conference																				
Gather project diversity data; report at All Hands Meeting																				

Impact: This research component aims to actively seek and engage people with diverse backgrounds to participate in EPSCoR.

Team Co-Leads: Alice Loy (GCCE), Phyllis Baca (SFCC)

Team Participants (10 total: 8 faculty, 2 EPSCoR staff): ENMU: Juchao Yan; NM EPSCoR: Mary Jo Daniel, Chelsea Chee; NMC: Steve Buelow; NMT: Michael Pullin; SFCC: Dana MacArthur; SFI: Irene Lee; UNM: Laura Crossey

Strategic Component 8: Workforce Development

Strategic Priority: increase student access to and engagement in research at the K-12, undergraduate and graduate levels, improve post-doc and STEM faculty effectiveness, and equip faculty with tools and skills to become creative entrepreneurs.

Objectives:

- Support Growing Up Thinking Computationally (GUTC) which will engage middle school students (ages 11-14) in an after-school program focused on computational science, and provide related professional development for teachers to be club leaders
- Implement STEM Advancement Program (STEMAP) to provide summer research experiences for undergraduate STEM students from Primarily Undergraduate Institutions (PUI) and academic year programming to support their success in STEM
- Support a Graduate Student Externship Exchange whereby five NM EPSCoR graduate students will receive support in Years 3-5 to spend a semester at a different institution or national laboratory
- Design and support Postdoctoral Fellowship Leadership Workshops in Years 2 and 4 supporting fellows from Idaho, Nevada, and New Mexico
- Support the Faculty Leadership and Professional Development Institute for STEM faculty from New Mexico community and Tribal colleges and non-research universities to improve undergraduate STEM instruction for diverse student populations
- Create the Institute for Creative and Cultural Entrepreneurship (ICCE) training 180-200 entrepreneurs

Activities and Milestones:

Workforce Development	**Year 1**				**Year 2**				**Year 3**				**Year 4**				**Year 5**			
1: June-Aug; 2: Sept-Nov; 3: Dec-Feb; 4: Mar-May	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
GUTC Curriculum Units	■		■		■		■		■		■		■		■		■		■	
GUTC Summer Professional Development Workshop (5 days)	■				■				■				■				■			
GUTC Fall Professional Development Workshop (1 day)		■				■				■				■				■		
GUTC Spring Professional Development Workshop (1 day)			■				■				■				■				■	
GUTC Club meeting (13 weeks per semester)		■	■	■		■	■	■		■	■	■		■	■	■		■	■	■
Career Connections Conferences		■	■			■	■			■	■			■	■			■	■	
Student Roundtables			■	■			■	■			■	■			■	■			■	■
STEMAP web materials developed		■				■				■				■						
STEMAP recruitment at PUIs		■	■			■	■			■	■			■	■					
STEMAP summer program					■				■				■				■			
STEMAP quarterly webinars						■	■	■		■	■	■		■	■	■		■	■	■
Externship program guidelines/application				■	■															
Recruit & select externship students/labs						■	■			■	■			■	■					
5 graduate students placed in externships									■	■	■	■	■	■	■	■	■	■	■	■
Post-doc workshop (4 days)							■								■					
PUI Faculty Leadership and PD Institute		■				■				■				■				■		
Online folow-up learning sessions for PUI faculty		■	■	■		■	■	■		■	■	■		■	■	■		■	■	■
Form four colleague research teams (CC/ Univ. Researchers)		■			■				■				■				■			

Workforce Development	Year 1				Year 2				Year 3				Year 4				Year 5			
1: June-Aug; 2: Sept-Nov; 3: Dec-Feb; 4: Mar-May	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Training for Undergraduate Faculty Institutional Coordinators (FIC)																				
Create/update ICCE curriculum																				
Host ICCE																				
Host ICCE Fellows in New Mexico																				
On-going ICCE Fellows support/mentoring																				

Impact: This research component aims to build the human capacity New Mexico needs to realize its research, education, and economic development potential.

Team Co-Leads: Alice Loy (GCCE), Phyllis Baca (SFCC)

Team Participants (8 total: 6 faculty, 2 EPSCoR staff): NM EPSCoR: Selena Connealy; Mary Jo Daniel; NMC: Steve Buelow; NMT: Michael Pullin; SFCC: Dana MacArthur; SFI: Irene Lee.

Strategic Component 9: Cyberinfrastructure

Strategic Priority: make it easier for scientists, educators and the public to discover, acquire, and use data, information and learning modules developed and acquired by NM EPSCoR.

Objectives:

- Improve the integrated data storage and modeling portal
- Expanding our interoperability with national and international data networks
- Enhancing tools for collaboration

Activities and Milestones:

Cyberinfrastructure	Year 1				Year 2				Year 3				Year 4				Year 5			
1: June-Aug; 2: Sept-Nov; 3: Dec-Feb; 4: Mar-May	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Develop Mentoring and Training Plan																				
Integrated Data Storage and Modeling Portal (UNM)																				
Develop analytic services and client interfaces																				
Provide new capabilities for socioeconomic modeling and analysis																				
Ongoing data acquisition as requested to support project research																				
Expand the systems analytic capabilities																				
Document data producers and integrate them into portal																				
Include an education resources section																				
Evolve the current XML document-based data documentation model																				
Modify component services that deliver ISO metadata (Semantic-enabled)																				

Cyberinfrastructure	Year 1				Year 2				Year 3				Year 4				Year 5			
1: June-Aug; 2: Sept-Nov; 3: Dec-Feb; 4: Mar-May	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Expanding Our Interoperability with National and International Data Networks (UNM)																				
Continue the Western Consortium CI Working Group																				
Expand support for web service protocols used by networks																				
Connect to external geospacial platforms																				
Register project data products with international and national registries																				
Add project data products to LoboVault																				
Enhancing Tools for Collaboration (UNM)																				
Develop next generation data-centered collaboration capabilities																				
Support an online lab notebook system																				

Impact: This research component aims to expand the state's knowledge economy through development of broadly accessible and usable energy-related data and information.

Team Co-Leads: Karl Benedict (UNM), Julie Coonrod (UNM)

Team Participants (14 total: 8 faculty, 1 EPSCoR staff, 5 graduate students): NM EPSCoR: Mary Jo Daniel; NMSU: Sam Fernald, Caiti Steele; NMT: Michael Heagy, Frank Huang; UNM: Becky Bixby; 5 graduate students.

Strategic Component 10: External Engagement

Strategic Priority: Expand informal science education networking and engage the public via multiple modalities.

Objectives:

- Establish the New Mexico ISE Network (NM ISE Net) to link research and informal education institutions (e.g., museums, professional associations, public media, cultural centers) with one another to build capacity for informal science education
- Create three distinctive museum exhibitions that interpret NM EPSCoR research (in Years 3 and 5)
- Organize a two-day Town Hall meeting to provide a forum for scientists, educators, policy makers and business people to discuss outcomes of NM EPSCoR research (Yr 5)
- Communicate findings within EPSCoR and throughout New Mexico

Activities and Milestones:

External Engagement	Year 1				Year 2				Year 3				Year 4				Year 5			
1: June-Aug; 2: Sept-Nov; 3: Dec-Feb; 4: Mar-May	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
ISE Net Annual Metting																				
Researcher/ISE Meetings																				
ISE Regional meetings (3/year)																				

External Engagement	Year 1				Year 2				Year 3				Year 4				Year 5			
1: June-Aug; 2: Sept-Nov; 3: Dec-Feb; 4: Mar-May	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Award museum programming mini grants																				
Exhibit front-end study																				
NMMNHS Exhibit planning and opening																				
¡Explora! Exhibit planning and opening																				
NMNSH Exhibit planning and opening																				
Town Hall																				
EPSCoR Newsletter																				
NM EPSCoR Website revised/updated																				

Impact: This research component aims to increase public understanding of New Mexico's potential for sustainable energy development, engage more New Mexicans in STEM-related activities and education, and disseminate EPSCoR results.

Team Co-Lead: Charles Walter (NMMNHS)

Team Participants (7 total): NM EPSCoR: Mary Jo Daniel, William Michener, Natalie Willoughby, Selena Connealy; ¡Explora!: Joe Hastings; NMNSH: James Walther

Strategic Component 11: Assessment and Evaluation

Strategic Priority: Implement a comprehensive assessment plan using both quantitative and qualitative methods to evaluate success of NM EPSCoR programs.

Objectives:

- Use the project strategic plan to finalize the project's assessment and evaluation plan
- Engage independent external experts who will monitor progress and regularly review and report on each of the programs to the State Director and Management Team
- Ensure the program components are collecting the data needed by EPSCoR and the external experts to assess and evaluate the impacts and achievements of the award

Activities and Milestones:

Evaluation and Assessment (E&A)	Year 1				Year 2				Year 3				Year 4				Year 5			
1: June-Aug; 2: Sept-Nov; 3: Dec-Feb; 4: Mar-May	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Finalize E&A plan																				
Collect baseline data																				
External E&A Report																				
External Advisory Board meeting																				
AAAS Review																				
Exhibit evaluation																				

Impact: This assessment and evaluation component aims to assess and improve the effectiveness of the research, workforce development, informal science and external engagement programs.

Team Co-Lead: Kirk Minnick (Minnick & Associates)

Team Participants (15 total): AAAS: 7 experts; Elsa Bailey Consulting: Elsa Bailey; External Advisory Board: Rose Ann Cattolico, Marianna Adams, Christopher Scott, Jennifer McIntosh, Christopher Andronicos, Rita Teutonico, Thomas Zawodzinski

Strategic Component 12: Sustainability

Strategic Priority: Create and enhance inter-institutional collaborations such as federal lab-university, university-university, and informal science education partnerships that lead to programmatic sustainability.

Objectives:

- Hire four faculty in areas of critical need for New Mexico
- Support STEM Professional Development for K-12 Teachers to improve the STEM education pipeline
- Improve success of faculty in securing NSF awards by offering NSF Day, a one-day workshop held in collaboration with the NSF
- Support I-IWGs that promote new research activities and foster collaborations
- Cyberinfrastructure developed under the current proposal will be integrated with the long-term geospatial data archive maintained by EDAC for the State of New Mexico with ongoing maintenance of the services being funded through a combination of base funding obtained from the New Mexico Legislature and proposals submitted to external funding sources such as NASA, NSF (CiF21), and other agencies
- Offer competitive Seed Awards (8) for critical laboratory and field instrumentation that will support innovative research, education and workforce development capabilities at community colleges, Tribal colleges, and regional universities (i.e., non-PhD granting institutions)

Activities and Milestones:

Sustainability	**Year 1**				**Year 2**				**Year 3**				**Year 4**				**Year 5**			
1: June-Aug; 2: Sept-Nov; 3: Dec-Feb; 4: Mar-May	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
New faculty hires (4)	■				■															
Teacher PD (Exploratorium)			■																	
ISE-led teacher workshops					■				■				■				■			
Follow-up teacher PD						■		■		■		■		■		■		■		■
NSF Day										■										
I-IWGs (3/year)					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Seed Awards			■	■	■	■			■	■	■	■	■	■	■	■	■	■	■	■

Impact: The sustainability component aims to sustain research and STEM competitiveness beyond the life of the 5-year project.

Team Co-Lead: William Michener (NM EPSCoR)

Team Participants (4 total): NM EPSCoR: William Michener, Mary Jo Daniel, Selena Connealy; NMMNHS: Charles Walter

Strategic Component 13: Management

Strategic Priority: Ensure accountability, assign responsibility, promote engagement, include diverse participants, and facilitate communication and coordination among the project components.

Objectives:

- Hold quarterly Management Team meetings to ensure the coordinated implementation of each component and its integration with the overall program, identify implementation problems and recommend solutions, review evaluation and assessment reports and recommendations, identify emerging opportunities, and assist in collecting data and information for project reports
- Visit institutions to improve communication with State Office
- Maintain adequate fiscal oversight of all project components
- Report to and seek guidance from the State EPSCoR Committee twice yearly.
- Report to and seek guidance from the Council of University Presidents annually
- Seek strategic planning guidance from the AAAS review team
- All teams hold monthly project team meetings to assure progress made on team objectives
- Hold an annual All Hands Meeting to track progress on strategic goals, facilitate collaboration and celebrate successes
- Develop, track progress on, and annually review/revise the Strategic Plan

Activities and Milestones:

Management	Year 1				Year 2				Year 3				Year 4				Year 5			
1: June-Aug; 2: Sept-Nov; 3: Dec-Feb; 4: Mar-May	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Strategic Plan development and review	■	■			■				■				■				■			
Subaward fiscal training including Yr. 5 closeout	■								■								■			
Component budget review				■				■				■				■			■	
Annual CUP presentation		■				■				■				■				■		
State Committee meetings		■		■		■		■		■		■		■		■		■		■
Campus visits (1/quarter)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Reverse site visit (estimated)					■								■							
Annual reporting			■				■				■				■					■
Monthly team meetings	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Quarterly collaboration meetings (2 teams/ quarter)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Quarterly Management Team meetings	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
All Hands Meeting			■				■				■				■				■	

Impact: The management component aims to coordinate project activities and ensure accountability to relevant stakeholders.

Team Co-Leads: Mary Jo Daniel (NM EPSCoR), Tracy Hart (NM EPSCoR)

Team Participants (4 total): NM EPSCoR: Megan Gallegos, William Michener

D. Project Synergies

All participants contributed to a brainstorming exercise that was designed to identify opportunities for project synergies as well as strategies for achieving the synergies. The table below lists the synergy ideas and strategies for combinations of strategic components or for the entire project.

Teams	Idea	Strategies
Geothermal / Bioalgal / Osmotic	Investigate use of water from osmotic power generation and /or geothermal sources for bioalgal fuel production	Need a technical analysis to determine feasibility; solicit input from industry about produced water and related policies
Geothermal / Uranium	Sharing of key equipment and analyses	Identify needs and timelines for use; possibly co-mentor graduate students
All Research Areas	Assess impacts of all research areas on the statewide water budget	Social/Natural Science Team develops instrument to quantify real and potential water impacts of other research areas; possible IWG
Research / External Engagement	Communicate research findings to public audiences; Science Center Field Day with exhibits and displays	Researchers attend ISE meetings/events and invite ISE members to research sites; researchers help develop exhibits and public programming at ISEs
Research / External Engagement	Develop citizen science opportunities	Identify data collection opportunities appropriate for citizen science (e.g. hot spring temperature readings); use ISE members to develop program
Research / Cyberinfrastructure (CI)	On-going project-wide training for faculty and student researchers on CI capabilities and processes	Identify value of data portal for researchers; provide templates and guidance for data submission; include CI topics in all team and management meetings
Research / Cyberinfrastructure / External Engagement	Develop data sets and visualizations that K-12 students and teachers can download and work with	Continue to use TeachData structure developed; use ISE/CI liaison to identify and translate data for public users
Research / Diversity / External Engagement	Leverage existing diversity programs	Use AMP network to disseminate information about graduate opportunities; connect with NM MESA to communicate EPSCoR opportunities
Research / Diversity	Mentor new faculty	Partner senior EPSCoR researchers with junior faculty; ensure that opportunities and resources are communicated
Research / Diversity	Explore funding opportunities	Collaborate on funding opportunities for diversity across research teams — e.g. use IWG model

E. Performance Metrics

In the table below, the Year 5 targets are based on proposed Year 1 baseline values. At the start of Year 2, the Management Team will use actual Year 1 numbers to renew and, where appropriate, revise Year 2-4 targets to achieve the Year 5 and cumulative targets.

Provisional Metrics	Year 1 Baseline	Year 5 Target	Cumulative
Research and Cyberinfrastructure			
Peer-reviewed publications	8	30	100
Conference presentations, seminars and posters	30	50	212
Extramural research grants submitted	9	25	115

Provisional Metrics	Year 1 Baseline	Year 5 Target	Cumulative
Extramural research grants awarded	1	4	14 (12%)
Data products created	10	50	175
Number of invention disclosures/patents	3	5	19
Diversity			
Underrepresented minorities (URM) / female undergraduates	7	18	66
URM / female graduate students	4	11	20
URM / female faculty / faculty equivalent (Cumulative equals percent of unduplicated faculty)	25	35	35%
Minority serving institutions involved	4	8	10
PUI Recruitment and Retention plans created / updated	6	8	25
Workforce Development			
Education / Outreach proposals	1	2	5
Undergraduate students in project	19	45	165
Undergraduates graduating	2	25	80
Undergraduates matriculating to graduate school	1	5	16
Graduate students supported	14	26	57
Thesis / dissertations completed	0	15	20
Graduate students employed by academic, industrial and government organizations	0	8	20
Leadership opportunities taken by junior faculty	5	20	50
Post-docs engaged in project and mentored	2	2	3
Faculty hires	2	0	4
Students in GUTC clubs	120	225	800
Teachers leading GUTC clubs	10	15	60
STEMAP students to 4-year programs	N/A	4	50%
STEMAP students to graduate programs	N/A	2	10%
Graduate students in externships	0	5	15
PUI faculty implementing new pedagogical techniques	7	15	75%
Post-docs in leadership workshop	Year 2: 15	Year 4: 20	35
Entrepreneurial ventures launched by ICCE	0	4	8
ICCE ventures receiving professional investment	0	3	6
Cyberinfrastructure			
Research data products ingested	10	50	175
Content in storage and modeling portal (TB=terabyte)	2 TB	3-4 TB	10-12 TB
Interoperable national and international data networks	2	0	5-6
Virtual lab notebook users	30	10	75
Hardware and software resources obtained beyond RII funds ($)	20,000	20,000	100,000
Data product downloads	1,000	5,000	20,000
External Engagement			
Outreach Presentations	16	38	155
Visitors at NM EPSCoR exhibits	0	200,000	380,000
ISE / Researchers joint public events	3	10	35

Provisional Metrics	Year 1 Baseline	Year 5 Target	Cumulative
Attending Town Hall	N/A	90	90
Town Hall recommendations implemented	N/A	5	5
NMEPSCoR.org website hits	20,000	75,000	200,000
Sustainability			
Collaboration of new faculty hires with other EPSCoR researchers	0	5	10
Inter-institutional and interdisciplinary collaborations among faculty and graduate students (includes co-authoring, co-presenting)	5	40	100
Collaborations between project participants and external partners	10	50	75
K-12 teachers using ISE resources	0	16 (80%)	64 (80%)
Proposals resulting from seed awards	0	1	3
Courses created / revised to include additional research opportunities (seed awards)	0	1	4
Publications resulting from IWGs	0	2	6
Proposals resulting from IWGs	0	1	3
New / sustained collaborations after IWG	N/A	3	12
Policy / curricular / synthesis documents and products resulting from IWG	0	2	6
New Mexico institutions engaged in IWGs	0	4	8
Management			
Annual reports submitted to NSF on time	Yes	Yes	All
Annual expenditures within 20% of awarded amount	Yes	Yes	Every year

F. Risk Management Plan

Retreat participants identified 19 project risks, the implications of such risks, the impact and likelihood of the risk (H-high, M-moderate, L-low), as well as one or more mitigation strategies in the table below.

ID	Risk	Implications	Impact	Likelihood	Mitigation Strategy
1	Changes in or loss of key personnel	Lack of continuity in the work; some research would cease completely; failure to meet project milestones	H	M	Develop succession plan for senior project personnel; mentor junior faculty and others; ensure multiple people are trained on key equipment; share information on recruiting efforts among project participants; cross-train individuals; document processes and procedures; be creative and flexible in meeting project objectives; support faculty, post-doc and student development to increase job satisfaction
2	Inability to recruit diverse students, faculty and participants	Project does not serve population of the state; lack of diversity in applicant pool/project partici-pants; diversity at all levels is not increased by the end of the project	H	M	Target outreach by identifying institutions/communities with a URM/F base; engage with URM teachers to recruit participants and students; support networking and informal team building; develop a strong presence by females and URMs at All-Hands meeting; routinely report on progress; provide communication from NM EPCoR office about priority and importance; develop strong and exciting programs and recruitment materials; attend, present and recruit at annual conferences like SACNAS; submit additional grant proposals; support faculty development
3	Ineffective project-wide communication	Decreased project effectiveness; lack of common vocabulary and synthesis among scientists; lack of coordination among project components; scientists work in isolation; missed opportunities; effort duplication	H	M-L	Hold regular meetings; provide a central voice to the public; update website and social media; encourage group to use communication channels; support networking and informal team building; encourage site visits; provide short, regular updates on progress; maintain EPSCoR newsletter
4	Failure to produce and/ or report deliverables in a timely manner	Real or perceived lack of progress in research, CI, workforce development, education, diversity, and outreach activities	H	L	Develop and follow project's Strategic Plan (SP); routinely revisit SP (e.g. risks, performance metrics, and "Gantt" chart of activities); establish good project communication (face-to-face, VTCs, etc.); PI and management team communicate to under-performers; chronic under-achievers are de-funded
5	Poor data management and failure to use data portal	Loss of data; decreased project accountability; inability to communicate and reproduce results	H	L	Provide good tools for data analysis and visualization as an incentive to use the portal; make it easy to input data once and reuse; survey capabilities most needed; provide access to and training for open-source and domain-standard software; have standard templates available to ensure data input is useful; have data available early in the projects that are of interest to users; record everything; back it up; educate about metadata early on

ID	Risk	Implications	Impact	Likelihood	Mitigation Strategy
6	EPSCoR researchers not willing to share data	Education groups can't move forward with activities; research teams may have to duplicate work	H	L	Provide training in data management and research ethics; communicate expectations to project participants; implement and monitor use of project's science notebook; de-fund project participants that insist on hoarding data
7	Failure to address the central research questions	Fail to do the groundbreaking work we have identified; loss of credibility	H	L	Hold regular meetings; encourage group to use communication channels; support networking and informal team building; provide short, regular updates on progress; provide routine reminders from leadership on initial goals
8	Inadequate attention to lab and field safety	Harm to students and others; project shut down; Federal non-compliance; lawsuits	H	L	Provide training in lab/field safety and research ethics; ensure GHS compliance
9	Cutbacks in federal and/or state funding	Re-evaluate project scope, budget and schedule; cutback in activities	H	L	Build strong relationships with federal and state policymakers and communicate value of work; ensure cuts are equitable; seek other funding sources; develop a scale-back contingency plan
10	Project scope creep	Inadequate resources; lack of focus on product(s).	M	M	Good project communication; routinely re-visit Strategic Plan; establish and monitor effectiveness of Management Team
11	Institutions involved are not set up for effective cross-collaboration	Reduced synergies	M	M	Encourage proactive approach from EPSCoR office to work with administration at institutions
12	Equipment damage, failure, or loss	Loss of investment; loss of time; inability to conduct research; data loss; delays in meeting project goals	M	L	Implement catastrophic failure planning (e.g., record serial numbers, keep up-to-date inventory, fireproof what you can, create an equipment maintenance and protection plan and refresh it annually); plan and budget for repairs and replacement; establish a budget category and populate with savings to use in emergencies; investigate insurance and maintenance policies/contracts for equipment; provide adequate training for all who use the equipment; build in redundancy where appropriate;
13	Failure to prioritize and reach public audiences	EPSCoR information is not disseminated; missed opportunities; lack of statewide support for EPSCoR and STEM	M	L	Clearly identify the target audiences and proper contact(s) for that audience; perform front-end evaluation; coordinate with EPSCoR public relations officers; provide feedback to researchers; identify someone on the team to be the bridge to connect researchers and EPSCoR office; communicate successful efforts to other groups in the project; build templates for research highlights; support more informal gatherings and IWGs when appropriate

ID	Risk	Implications	Impact	Likelihood	Mitigation Strategy
14	Inability to communicate complex (and, sometimes, controversial) ideas in simple, understandable terms to the public	Lack of public perspective and engagement; lose access to sites and public trust; research never goes beyond the lab and fails to affect decision-makers	M	L	Hold workshop on how to present research/data to the public; engage visitor studies to learn about public knowledge and thus learn how to present new information; involve public school pedagogy (K-12) for how to communicate with younger audiences; evaluate the effectiveness and reach of exhibits; mentoring from experienced to less experienced team members; identify potentially volatile public perceptions
15	Rigid allocation of limited EPSCoR funds, or funding loss	Prevent flexibility and adaptation to maximize productivity	M	L	Employ adaptive management strategies to maximize productivity; make effective use of cooperative agreement (EPSCoR and NSF); facilitate finding new funding for innovative ideas
16	Inability to access data held by industry	Incomplete data and analyses for publications and decision-making	M-L	H	Engage cooperation from New Mexico state government, EPSCoR, and other champions to provide credibility/assurance of importance and use of data; provide protection for the data; get industry involved in process early and demonstrate benefits to industry ; find alternatives if absolutely necessary (may have limited value); look at models for aggregating data that are acceptable for an industry
17	Delays in acquiring research permits and access to research sites	Delays in research; forced to choose non-ideal alternatives	L	M	Start the process early; identify alternative research sites; develop contacts and networks; establish good communication channels or agents
18	Groups not involved with EPSCoR feel left out	Criticism and lack of support for efforts	L	M	Be inclusive across the state and nurture new relationships
19	Lack of research infrastructure/culture of non-research partner schools (e.g., community colleges)	Non-productive; fewer connections between research and non-research schools; inability to recruit diverse participants; effects workforce development	L	L	Connect with associations of community colleges (e.g., NM Independent Community Colleges and NM Assoc. of Community Colleges); promote inter-institutional collaboration (research and non-research); demonstrate benefits to community college leaders of research experiences

G. Succession Plan

When the Project Director (PD) position becomes vacant, the NM EPSCoR by-laws require the SEC to conduct an open search for a successor. The Management Team (MT) and Project Teams provide a pool of replacements for senior-level EPSCoR vacancies. All vacancies are filled in accordance with UNM Human Resource procedures, including an open, competitive search by a diverse hiring team.

Major strategic components have at least two leaders (listed throughout the document) to ensure continuous leadership through the project; co-leader vacancies will be filled by the program membership working in conjunction with the State Office (PD and AD) to ensure that diversity objectives are maintained. A third co-leader, URM or female where possible, will be selected from within the project teams to be mentored and prepared for a leadership role (co-leader) should changes in team leadership occur or should it be deemed desirable to have three leaders for a component.

H. The Assessment and Evaluation Process

The assessment and evaluation (A&E) process is illustrated in Figure 1. According to the A&E Plan, within 90 days of the award, a 2-day facilitated retreat will lead to a Strategic Plan (i.e., this document) that is based on project objectives and activities. The Strategic Plan serves as the Project Blueprint and guides the development of evaluation tools including: a project logic model that starts with inputs such as funding for facilities, equipment, and human resources as well as contributions from our affiliated universities, colleges, business and industry partners, and governmental and non-governmental organizations; a detailed A&E plan; research plans; and milestones and metrics for all components of the project. The evaluation tools are created to provide the basis for the different needs for evaluation including: formative and summative evaluation, scientific merit, annual strategic planning, and external engagement. A&E activities are performed by: the external project evaluator, the informal science evaluator, the External Advisory Board, and the AAAS review team.

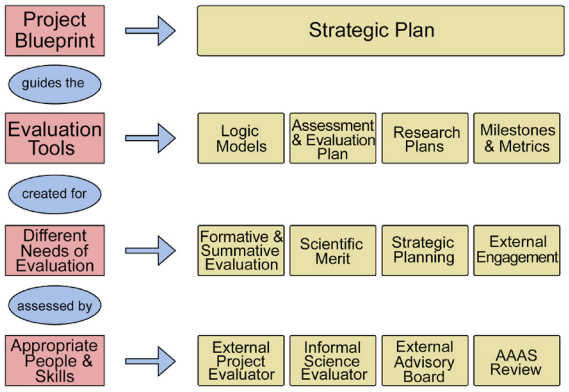

Figure 1: Assessment and Evaluation Process

The project's leadership and Management Team will track and review progress in meeting milestones and achieving goals (e.g., performance metrics) on a quarterly basis. Progress will be measured and reported in the annual report and in presentations to the External Advisory Board, AAAS, and NSF. Underperformance in any area will be discussed by the leadership and Management Team, and a reasonable time line will be provided for the team to respond to recommendations made by the two oversight bodies. Should the area continue to demonstrate underperformance, the project leadership will consult with NSF and, if appropriate, re-direct funds to other areas or engage other individuals that can meet programmatic objectives.

IV. Glossary

- A&E — Assessment and Evaluation
- AAAS — American Association for the Advancement of Science
- AD — Associate Project Director
- AISES — American Indian Science and Engineering Society
- AMP — Alliance for Minority Participation
- ASTM — American Society for Testing and Materials
- BHJ — Bulk heterojunction
- BOD — Biological oxygen demand
- CC — Community College
- CI - Cyberinfrastructure
- CiF21 — Cyberinfrastructure Framework for 21st Century Science
- CUP — Council of University Presidents
- DAF — Dissolved Air Flotation
- E&A — Evaluation and Assessment
- EDAC — Earth Data Analysis Center
- ENMU — Eastern New Mexico University
- FFF — Field-flow fractionation
- FIC — Faculty Institutional Coordinator
- GCCE — Global Center for Cultural Entrepreneurship
- GC/MS — Gas chromatography-mass spectroscopy
- GHS — Globally Harmonized System
- GUTC – Growing Up Thinking Computationally
- HACU — Hispanic Association of Colleges and Universities
- HPLC — High Performance Liquid Chromatograph
- ICCE — Institute of Creative and Cultural Entrepreneurship
- ICP-MS — Inductively Coupled Plasma Mass Spectrometer
- I-IWG — Interdisciplinary Innovation Working Group
- ISE Net — Informal Science Education Network
- ISO - International Organization for Standardization
- LANL — Los Alamos National Laboratory
- LSAMP — Louis Stokes Alliance for Minority Participation
- MCD — Magnetic Circular Dichroism
- MIMS — Membrane inlet mass spectrometry
- MoS — Metal oxide semiconductor
- MT — Magneto-telluric

- NM — New Mexico
- NMC — New Mexico Consortium
- NMHU — New Mexico Highlands University
- NMMNHS — New Mexico Museum of Natural History and Science
- NM MESA — New Mexico Mathematics, Engineering, Science Achievement, Inc.
- NMNSH — National Museum of Nuclear Science and History
- NMSU — New Mexico State University
- NMT — New Mexico Tech
- NN — Navajo Nation
- NP — Nanoparticle
- PBR — Photobioreactors
- PD — Professional Development
- PRO — Pressure Retarded Osmosis
- PUI — Primarily Undergraduate Institution
- R&D — Research and Development
- RII — Research Infrastructure Improvement
- S&T Plan — Science and Technology Plan
- SACNAS — Society for the Advancement of Chicano and Native American Scientists
- SD — Systems Dynamics
- SEC — State EPSCoR Committee
- SEED — Small-scale Experimental Ecological Design
- SEES — Science, Engineering, and Education for Sustainability
- SEM-EDS — Scanning Electron Microscopy-Energy Dispersive Spectroscopy
- SFCC — Santa Fe Community College
- SFI — Santa Fe Institute
- SMART — Specific, measurable, attainable, realistic, timely
- SNL — Sandia National Laboratory
- STEM — Science, Technology, Engineering, and Mathematics
- STEMAP — STEM Advancement Program
- TFC — Thin-film Composite
- UNM — University of New Mexico
- UPC2 — UltraPerformance Convergence Chromatography
- URM — Under-represented Minority
- VCNP — Valles Caldera National Preserve
- VTC — Video Teleconference
- XML — Extensible Markup Language