Phase VI
Climate Change and Energy:
Basic Science, Impacts, and Mitigation

Strategic Plan

August 2013

EPS-0903806
PI: Kristin Bowman-James
October 1, 2009 – September 30, 2014

Climate Change and Energy:
Basic Science, Impacts, and Mitigation
Strategic Plan Executive Summary

INTRODUCTION

This document represents the Strategic Plan for Kansas NSF EPSCoR RII Track 1 award # EPS-0903806: *Phase VI: Climate Change and Energy: Basic Science, Impacts, and Mitigation* that began October 1, 2009 and continues through September 30, 2014.

The vision, mission and goals of Kansas NSF EPSCoR are in alignment with the current science and technology direction of the state. In early February 2011, Governor Sam Brownback issued a new Economic Development Plan for Kansas. In that plan he noted the important contributions of university research to the state's economy. In 2011 the Kansas Board of Regents charged the Council of Chief Research Officers of the Regents' Universities to create a new Kansas Science and Technology Plan. In June 2012 the plan was presented to the Kansas Board of Regents, who approved it as a draft to go forward and undergo refinement over the next several months. The plan, Kansas Building an Environment for Science and Technology for Innovation (Kansas B.E.S.T. for Innovation), builds on traditional and emerging research strengths in Kansas for future economic growth and development. Climate and energy are cited as key areas of opportunity for research growth.

The RII Track 1 project on Climate Change and Renewable Energy is a multidisciplinary, multi-institutional, multi-sector partnership consisting of four universities and several private-sector companies. Institutions participating are the University of Kansas (KU), Kansas State University (K-State), Wichita State University (WSU) and Haskell Indian Nations University (Haskell) within the major research initiative. Additionally the program also is partnering with the regional universities, Emporia State, Fort Hays State, Pittsburg State, and Washburn, through other targeted initiatives within Track I. The program has one major initiative, consisting of three interrelated projects in climate change and renewable energy and a fourth interwoven educational initiative that will create a pathway for Native American students into STEM careers. Additional initiatives included in the RII are First Awards (research awards for new faculty), Education and Diversity Awards (awards open to faculty at the regional universities), and supplemental funding for the McNair Program (a summer research program for disadvantaged students).

VISION

To raise the competitiveness of Kansas researchers by enhancing the research infrastructure in areas of global challenges, including assessing and understanding accelerating climate changes and exploring new sources of solar based renewable energy.

MISSION

To address global climate change and renewable energy challenges by targeting basic science, impacts and mitigation with a fresh perspective that bridges natural sciences, social sciences and engineering.

GOALS

- To stimulate integrative and transformative *basic science* research on renewable energy, climate change, and human behavior.
- To utilize this research to enable a better understanding of the *impacts* of climate change and renewable energy usage.
- To translate this research into *mitigation* by applying new technology.
- To inform effective policies for economic development and natural resource protection.
- To educate a diverse workforce and the next generation of leaders.

The organization of the Track 1 project is provided in the section on Research Initiatives.

ORGANIZATIONAL STRUCTURE

The Kansas NSF EPSCoR initiative is headed by Professor Kristin Bowman-James, Project Director and University Distinguished Professor of Chemistry. Her responsibilities include providing scientific and technical leadership, program coordination, reports to NSF and the EPSCoR oversight committees, visiting campuses throughout the state, and insuring that the program runs as a cohesive research enterprise. She is assisted by Doug Byers, Assistant Director and Candi Wilbur, Business Manager. A description of the Management Structure is provided in Appendix A.

PROJECT INITIATIVES

This project integrates scientific, educational, and outreach efforts within an evaluation and management structure that is designed to enable success in establishing Kansas as Climate and Energy Central. The scientific aspects of the initiative are outlined in a format similar to recent Intergovernmental Panel for Climate Change (IPCC) assessment reports, which divide climate change issues into 1) physical science basis, 2) impacts, adaptation, and vulnerability, and 3) mitigation of climate change. This project uses a similar format because of the clarity provided by the IPCC reports in examining a very complex issue from the three different, but yet intertwined, viewpoints.

The project is divided into three components: (1) using climate and weather data to create more accurate models of past events in order to predict future scenarios, i.e., climate modeling; (2) assessing the factors that contribute to farmers' decisions concerning what crops to plant, i.e., climate impacts; (3) a multifaceted exploration of energy derived from the sun, i.e. solar $\rightarrow$ biofuels/energy/organic. The latter project is divided into two focus areas. One is to develop improved methodologies for biomass (fed by solar energy) conversion to biofuels. A second is to use technology at the nanoscale to develop more efficient photovoltaic devices (energy) and to explore photoactivation of catalysts for water splitting and CO_2 activation. Taken together, the results from these initiatives will allow for better informed policy makers. Because of the close interrelatedness of workforce development and diversity, these two areas have been combined. They are also included under the research goals, because they are an inherent part of any research program that hopes to be successful.

In addition to the five major goals of the project under basic science, impacts and mitigation, cyberinfrastructure improvements, educational programs, and outreach efforts all integrate with the thematic areas of climate and energy. The goal of the cyberinfrastructure plan is to create a data sharing cyberinfrastructure encompassing all facets of data gathering, data analysis, and visualization to meet the dynamic needs of the research team and the expansion of a collaborative cyber community. The outcome will be an extended collaborative cyber community. In outreach and communication, a targeted strategy will be used to reach stakeholders, researchers, policy makers, and the future STEM workforce in order to expand the awareness of climate and energy research and issues. These efforts will result in global recognition of researchers in Kansas as leading authorities in climate and energy research and will additionally engage a broad spectrum of the Kansas student population. An aggressive evaluation and assessment program will apply a rigorous, multi-faceted evaluation of the program that 1) tracks and assesses student, faculty research, collaboration and outreach outcomes, 2) provides periodic feedback to inform program direction, and 3) demonstrates progress toward program goals and overall program impacts. Not only will this evaluation quantitatively assess outcomes, but the feedback will provide program direction.

These efforts, taken together, will help to implement sustainable practices that encourage the development of faculty and student researchers, while expanding the collaborative opportunities with other universities, researchers, and industries in such a way that permits long-term funding streams to support the project elements as independent initiatives. The outcomes will include sustainable student and faculty development, new collaborations across universities and sectors, the leveraging of Kansas' S&T strengths for long term federal funding, and especially sustainability of the climate and energy projects in Kansas. To insure the success of the project the management structure is designed to oversee and guide the project in such a way that supports research and education, builds collaborative relationships, strengthens institutional research infrastructure, and develops the leadership skills of others.

Table 1 provides an overall view of the objectives for each of the research goals, along with the lead of the specific subproject and the lead researchers for each of the initiatives. The attached Tables provide a detailed summary of objectives, strategies, milestones, timelines, and outcomes as related to the five Research goals.

Table 1. Climate and Energy Objectives and Researchers

Category	Lead PI(s)	Subproject	Lead Researcher(s)
Goal #1: Basic Science			
Create consistent climate and weather simulations	Rice (K-State)	Climate Modeling	Feddema (KU)
Develop better variables and statistics for extreme climate change scenarios	Rice (K-State)	Climate Modeling	Feddema (KU)
Create an understanding of Kansas farmers' land and water use decisions	Earnhart (KU)	Climate Impact	Brown, Egbert, Sturm, Earnhart (all KU), Peterson (K-State)
Develop an economical method for conversion of biomass to fuels and chemicals	Wu (KU)	Solar → Biofuels	Sun, Hohn (K-State)
Design chemical systems that mimic photosynthesis	Wu (KU)	Solar → Electric	Richter (KU), Jankowiak, Bossmann, Chikan, and Higgins (all K-State)
Goal #2: Impacts			
Create assessment of farmers' adaptation to climate	Earnhart (KU)	Climate Impact	Earnhart, Gibson, Feddema (all KU), Peterson (K-State)
Provide adaptation strategies for agricultural systems	Rice (K-State)	Climate Modeling	Harrington, Hutchinson, Prasad, and Staggenborg (all K-State)
Goal #3: Mitigation			
Develop catalysts for fuel and other usable organic products	Wu (KU)	Solar → Organic	Klabunde (K-State), Rillema (WSU)
Determine plant-microbe-soil interaction (C sequestration)	Rice (K-State)	Climate Modeling	Rice (K-State)
Develop pilot system for oil extraction and conversion to biodiesel	Wu (KU)	Solar → Biofuels	Sun (K-State), Sturm, Williams (KU), Schneegurt (WSU)
Develop prototype photovoltaic device based on nanomaterials	Wu (KU)	Solar → Electric	Wu (KU), Li (K-State)
Goal #4: Inform Policies			
Predict impacts of land use	Rice (K-State)	Climate Modeling	Bergtold (K-State), Hanley, Smith, Sturm (KU)
Assess environmental benefits and impacts of nano-materials	Twomey (WSU)	Solar → Electric	Twomey (WSU)
Facilitate creation of Kansas S&T Plan	Bowman-James (KU)	Kansas NSF EPSCoR	Bowman-James (KU), Guikema (K-State), COCRO
Provide policy-relevant information to policymakers	Earnhart (KU)	Climate Impact	Peterson (K-State), Earnhart (KU)
Goal #5: Diversity and Workforce			
Create Pathways for Native Americans	Wildcat (Haskell), Nagel (KU)	Pathways	Nagel (KU), Wildcat (Haskell)
Leverage McNair program in Kansas	Kamatuka (KU)	Summer REU	Kamatuka (KU), Greene (K-State), and Holt-Fields (WSU)
Provide REU programs across subprojects at KU, K-State, and WSU	Wu (KU), Rice (K-State), Earnhart (KU)	Summer REU	Wu (KU), Rice (K-State), and Earnhart (KU)

CRITICAL SUCCESS FACTORS

The success of the five research goals relies heavily on the supporting infrastructure. These are organized into five sections: cyberinfrastructure; outreach and communication; evaluation and assessment; sustainability; and the project management. Goals are also provided for each of these sections, along with objectives, strategies, milestones, timelines, and outcomes in the attached tables and the paragraphs above. Without this infrastructure support, the research vision of a single merged initiative encompassing both energy and climate research cannot be realized.

SHORT TERM OUTCOMES

As part of the strategic planning effort, a number of actions were identified that will help to ensure the success of this multi-faceted research undertaking. These are expressed below.

- The project must generate new basic and applied science. These findings should advance our understanding of critical components of climate change and renewable energy.
- The project must morph from multidisciplinary to interdisciplinary and finally to transdisciplinary to achieve the maximum impact. There must be definable links between the subprojects that can only be achieved by frequent interactions and meetings, working together on co-authored interdisciplinary papers, including the publication of a treatise in a major scientific journal such as *Scientific American* on how technology and climate could change farming in the Midwest
- The project must garner both institutional and industrial support. This can be accomplished by working together with University and private sector leaders to convince them of the benefits that such a comprehensive research project can bring to Kansas. In addition to providing research that will provide a better foundation of climate change and renewable energy issues to policy makers, the project will also impact key Kansas stakeholders, the agricultural producers. The private sector will also benefit from the more discipline-diversified workforce graduating from the program.

LONG TERM OUTCOME

By successfully fulfilling the goals and objectives outlined in this strategic plan, Kansas could become both the geographic and intellectual “Energy and Climate Central,” of the nation, offering education and career opportunities for a diverse workforce and technological solutions for a sustainable future.

Phase VI
Climate Change and Energy:
Basic Science, Impacts, and Mitigation
Strategic Plan

Goals, Objectives, Strategies, Milestones, Timelines and Outcomes

August 2013

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October 1, 2009 – September 30, 2014

Climate and Energy: Basic Science, Impacts, and Mitigation

Kansans have been leaders in the past in developing new ideas and strategies for mitigating economic and environmental threats. This NSF EPSCoR project builds on that history with the development of new technology for capturing solar energy, producing biofuels from algae, and with a better understanding of soils and agroecological processes for greenhouse gas sequestration. Through outreach and communication efforts, project scientists will provide policy relevant information related to the challenges of future climate change and the need for natural resource protection.

Goals for this Strategic Plan for Kansas NSF EPSCoR RII Track 1 award # EPS-0903806: *Phase VI: Climate Change and Energy: Basic Science, Impacts, and Mitigation* include basic research activities in climate science and renewable energy along with efforts to improve cyber infrastructure; outreach and communication; evaluation and assessment; sustainability; and in project management. Goals build from the design and completion of basic science in the arenas of climate science, renewable energy, and in developing a better understanding of human behavior related to changing opportunities in water availability, land use and related resource management. Within the renewable energy aspects of the project, researchers will attempt to harness the power of solar energy through three major initiatives: the fabrication of more efficient photovoltaic devices through the use of nanotechnology; examining energy prospects for the production of biofuels from algae; and exploring the use of catalysts to capture the energy of small molecules such as hydrogen and carbon dioxide. Within climate science, the project is designed to improve the ability to downscale climate models and to better understand the frequency and impact of extreme weather events on Kansas farmers and ranchers. The improved understanding of human response to change and the more likely climate scenarios for future climate within the region will enable project scientists to develop guidelines for future adaptation.

The project management plan is designed to insure success as scientists build collaboration across the multiple scientific efforts. Outreach activities are planned that will enable a next generation of students to find excitement and careers in STEM related disciplines. The innovative Pathway model is documenting how Native American students can find success in scientific endeavors and in graduate school. An effective evaluation and assessment program is helping to improve the efficiency, build collegiality, and maintain focus as the researchers follow this strategic plan 'road map' to success. The end product promises to be long term sustainability with a future goal of Kansas becoming known as 'climate and energy central.'

The tables on the following pages present specifics related to the goals, major objectives, detailed strategies, milestones, responsible individuals, a tentative timeline, and expected outcomes. These tables provide a 'road map' for project scientists to assess where they are and to reorient themselves, if necessary, to insure overall project success. Appendix B contains a glossary of terms used within this document.

RESEARCH GOAL #1

To stimulate integrative and transformative basic science research on renewable energy, climate change, and human behavior.

Objective 1: Create internally consistent present and future climate and weather simulations that are directly (statistically) comparable to historical observations.

Why? One of the most urgent needs in climate science modeling as identified by the U.S. Climate Change Science Plan is the need to move from models that are reliable at global and continental scales to models that address regional and local scales.

Strategies		***Milestones***	***Contact***	Year-1			Year-2			Year-3			Year-4			Year-5		
				Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su
1	Develop models and simulations that incorporate locally important climate processes that traditionally are not included in global model applications.	Modification of Weather Research Forecast (WRF) model to simulate irrigation	Feddema							■								
		Creation of datasets for representing irrigation											■					
		WRF simulations of climate scenarios														■		
2	Create a methodology to generate consistent sets of climate/weather variables.	Initial water balance model developed in Excel to assist with variable selection								■								
		Second model in MATLAB/FORTRAN for process gridded datasets.														■		

Objective 2: Develop better variables and statistics for extreme climate change scenarios such as drought, floods and severe storms.

Why? Extreme events impact agricultural systems, natural resources, and thus the economy of Kansas and the Great Plains.

Strategies		***Milestones***	***Contact***	Year-1			Year-2			Year-3			Year-4			Year-5		
				Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su
1	Identify universally applicable climate variables to inform other parts of the project.	Creation of variable list for economic and ag models for testing in the Excel water balance model	Feddema						■									
		Procession of gridded and larger datasets in Coded version													■			
2	Use extreme value statistics and information theory to derive better methods for analyzing the variables selected in Objective 1.	Identification of norms and trends in short and long term weather/climate variables													■			

Objective 3: Create a better understanding of Kansas farmers' land and water use decisions.

Why? By exploring the influence of subtle and not-so-subtle factors such as climate conditions, water availability, government policies, food commodity prices, and biofuel crop prices, along with geographically situated local knowledge, we can advance our big-picture understanding of farmers' behavioral decisions regarding land and water use.

Strategies		***Milestones***	***Contact***	Year-1			Year-2			Year-3			Year-4			Year-5		
				Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su
1	Construct a micro-level, spatially-referenced dataset on land use/land cover and water use, for Kansas.	Construction of *field-level* measures of land use/land cover for years 2005 to 2009	Brown, Egbert					■										

		Construction of *field-level* measures of land use/land cover for years 2000 to 2004 and 2010 to 2013																		
		Compilation of *county-measures* of groundwater and surface water use for years 2000 to 2009	Sturm																	
		Compilation of *county-measures* of groundwater and surface water use for years 2010 to 2013																		
2	Perform quantitative analysis of three waves of surveys distributed to Kansas farmers.	Analysis of the first survey wave	Peterson																	
		Analysis of the first and second waves																		
		Combined analysis of all waves																		
3	Perform qualitative analysis of two waves of interviews conducted with Kansas farmers.	Analysis of first wave	Gibson																	
		Analysis of both waves																		
4	Construct an integrated social scientific conceptual framework.	Construction of disciplinary conceptual frameworks	Earnhart, Peterson																	
		Integration of the disciplinary conceptual frameworks into a unified framework	Earnhart																	

Objective 4: Develop an economical method for utilizing algae biomass for fuels and chemicals.

Why? Algae are a prevalent and economic source of carbohydrates, and their extraction would not only provide an economic source of energy, but also help in cleaning up waste water.

Strategies		***Milestones***	***Contact***	Year-1			Year-2			Year-3			Year-4			Year-5		
				Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su
1	Use acid-functionalized nanoparticles to increase the conversion rate of cellulosic biomass.	Synthesis of heterogeneous Brønsted acid and base nanoparticle catalysts	Hohn															
		Selection of the most efficient nanoparticles																

Objective 5: Design chemical systems that can mimic naturally occurring photosynthetic and enzymatic processes in order to build efficient photovoltaic cells.

Why? Biological systems are the most efficient role models for catalytic process such as solar energy conversion.

Strategies		***Milestones***	***Contact***	Year-1			Year-2			Year-3			Year-4			Year-5		
				Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su
1	Identify the basic principles of biochemistry that allow for natural photosynthetic solar energy capture.	Identification of the mechanistic pathways in *Chlamydomonas reinhardtii* and *Rhodobacter sphaeroides* using hole-burning spectroscopy	Richter, Jankowiak															
		Establishment of a theoretical basis for a new generation of high efficiency biomimetic solar capture devices																
		Identification of the switch mechanism in ATP synthase utilizing high-resolution laser-based spectroscopies																

3	Use *bio/polymer-inorganic nanoparticle* composite materials as biomimetic photovoltaic systems for use in Goal #3, Objective 4.	Construction of stable channel porin for wide-band capturing devices	Bossmann, Chikan, and Higgins																
		Integration of protein-based wide-band capturing devices with photovoltaics devices																	

Outcomes:

- New models that can be applied in other jurisdictions to enable more precise climate change scenarios.
- Information that will advance Kansas citizens' and Kansas agriculture enterprise's understanding and response to climate change.
- Expanded understanding of farmers' agricultural land and water-use decisions.
- Long-term solutions to global energy demands via solar and biofuel-based research discovery.
- High yield, low-cost system for using algae as a source of biofuels.

RESEARCH GOAL #2

To utilize this research to enable a better understanding of the impacts of climate change and renewable energy usage.

Objective 1: Create an assessment of farmers' adaptation to changing climate conditions in order to understand more accurately the impact of future climate change.

Why? By failing to appreciate farmers' adaptation to changing climate conditions, any analysis of future climate change would overestimate the impacts of climate change on agriculture.

Strategies		***Milestones***	***Contact***	Year-1			Year-2			Year-3			Year-4			Year-5		
				Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su
1	Explore responses to surveys distributed to Kansas farmers.	Compilation of responses to the first survey	Peterson															
		Compilation of responses to the first and second surveys																
		Compilation of responses to all three surveys																
2	Explore interviews of farmers conducted in 2011 and 2013.	Compilation of first set of interviews	Gibson															
		Compilation of both sets of interviews																
3	Use predictions from meso-scale modeling of climatic change to inform hypothetical scenarios.	Generation of predictions from meso-scale modeling of climatic change	Feddema															
		Incorporation of climate predictions into survey-based hypothetical scenarios	Earnhart															
		Analysis of responses to hypothetical scenarios	Earnhart															

Objective 2: Provide effective adaptation strategies for agricultural systems to projected climate change specific to the central US.																				
Why? Development of innovative management practices can help agricultural production systems adapt to climate change.																				
Strategies		***Milestones***	***Contact***	Year-1			Year-2			Year-3			Year-4			Year-5		
				Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su
1	Develop water budget-based scenarios of how climate change will impact moisture surplus and deficits.	Document outlining scenarios	Harrington, Hutchinson															
2	Develop crop management strategies that address local and regional impacts of climate change.	Document outlining strategies	Prasad, Staggenborg															

Outcomes:
- An expanded understanding of farmers' responses to changing climate conditions and biofuel market conditions.
- Long term assessment and understanding of climate change on Kansas economy, in particular, agriculture.

RESEARCH GOAL #3

To translate this research into mitigation by applying new technology.

Objective 1: Development of catalysts for fuel production and other usable organic products.																				
Why? Water splitting and H_2 and CO_2 activation catalysts provide direct and low-cost ways to convert solar energy into renewable fuels and other products.																				
Strategies		***Milestones***	***Contact***	Year-1			Year-2			Year-3			Year-4			Year-5		
				Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su
1	Identify new light-activated catalysts for conversion of H_2O to H_2 plus O_2.	Construction of titanium-indium oxynitrides and tantalum-bismuth mixed oxide nanocomposites	Klabunde, Rillema															
		Construction of a prototype fuel cell using H_2 from H^2O splitting																
2	Identify new catalysts for converting CO_2 to liquid hydrocarbon fuels and other usable organic products.	Construction of heterogeneous transition metal catalysts that activate CO_2																
		Construction of a combined catalyst system that utilizes the best catalysts from H_2O splitting (Strategy 1) and CO_2 activation to convert CO_2 to liquid hydrocarbons																
3	Use photoexcitation techniques to remove products from tungsten and molybendum-based catalysts.	Construction of photoactive transition metal complexes for CO_2 activation	Rillema															
		Identification of the most superior catalysts																

Objective 2: Reduce the uncertainty of mitigation and increase the understanding of the capacity of managed systems to store C by determining plant-microbe-soil interactions.

Why? Agriculture globally contributes 14% of greenhouse gas emissions but can offset 8-15% of emissions with appropriate management strategies while enhancing sustainability.

	Strategies	***Milestones***	***Contact***	Year-1			Year-2			Year-3			Year-4			Year-5		
				Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su
1	Design N strategies to reduce N_2O emissions from no-tillage systems using a process-based model.	Document outlining strategies	Rice							■								
2	Develop regional model estimates of N_2O emissions.	Document outlining estimates	Rice										■					
3	Identify the microbial and chemical contributions to enhance soil C sequestration.	Document identifying contributions	Hettiarachchi, Rice													■		

Objective 3: Develop a high-yield, low-cost pilot system for oil extraction from algae and conversion to biodiesel.

Why? Algae can be grown without competing with food crops for land, and the resulting biodiesel can replace greenhouse gas-generating petroleum fuels.

	Strategies	***Milestones***	***Contact***	Year-1			Year-2			Year-3			Year-4			Year-5		
				Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su
1	Combine the algae strain growth, biochemical characterization, and biodiesel production capabilities from three campuses on a focused result.	A pilot system for biodiesel production	Sun, Sturm, Williams, Schneegurt															■

Objective 4: Develop performance-cost balanced photovoltaic devices based on new nanomaterials and novel architecture.

Why? The utilization of large–scale solar energy is limited by the cost, and thus performance-cost balanced photovoltaic devices are critical for making real impact.

	Strategies	***Milestones***	***Contact***	Year-1			Year-2			Year-3			Year-4			Year-5		
				Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su
1	Explore low-cost nanomaterials assembled on novel nanostructured architecture.	Establishment of the core-shell nanowire array, dye-sensitized solar cell architecture	Li, Wu													■		
		Incorporation of broadband materials developed in Goal #1 Objective 5 into multiple photovoltaic platforms																■

Outcomes:

- Improved methodologies for solar energy conversion into fuels and other usable products
- Better management strategies for using agriculture to offset greenhouse gas emissions
- More efficient and low-cost nanostructured photovoltaic cells

RESEARCH GOAL #4

To inform effective policies for economic development and natural resource protection.

Objective 1: Predict impacts of land use decisions on future water quality and ground water availability using likely future economic and policy scenarios.

Why? Policy makers would be better able to evaluate trade-offs inherent in promoting biofuel feedstock cultivation by predicting future land and water use and assessing their impacts on water quantity and quality.

	Strategies	***Milestones***	***Contact***	Year-1			Year-2			Year-3			Year-4			Year-5		
				Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su
1	Identify future economic and policy scenarios.	Document identifying future economic scenarios	Bergtold															
		Document identifying future policy scenarios	Hanley															
2	Measure water quality conditions and ground water availability.	Construction of datasets of water quality conditions and groundwater availability in Kansas for 2000 to 2009	Smith, Sturm															
		Construction of datasets of water quality conditions and groundwater availability in Kansas for 2010 to 2013																
3	Model the links from 1) land use to water quality, and 2) land use and water use to ground water availability.	Creation of model using Eutromod to link land use to water quality	Smith															
		Creation of model using SWAT to link land use to water quality																
		Prediction of the impact of future land and water use on future ground water availability using historical link above	Sturm															

Objective 2: Assess the environmental benefits and impacts of the use of nano materials for renewable energy.

Why? The nanomaterials field has a uneven set of profiles for the supply chain and manufacturing of these new materials, so a uniform, transparent approach will allow building gate-to-gate blocks of life cycle inventory information.

	Strategies	***Milestones***	***Contact***	Year-1			Year-2			Year-3			Year-4			Year-5		
				Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su
1	Use Life Cycle Assessment methodologies to include economic and social impact in parallel.	Life cycle analysis of algal fuel produced from wastewater sources and hydrothermal liquefaction	Twomey															

Objective 3: Facilitate the creation of a current Statewide Science and Technology (S&T) Plan

Why? Kansas must identify and leverage it's strengths in Science and Technology to compete nationally and globally for R&D funding.

	Strategies	***Milestones***	***Contact***	Year-1			Year-2			Year-3			Year-4			Year-5		
				Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su
1	Use agricultural, economic and research strengths, along with the Kansas Economic Development Plan to assist in crafting a Kansas S&T Plan.	Plan finalized	Bowman-James and COCRO (See Appendix C)															

Objective 4: Provide policy-relevant information to policymakers.

Why? Policymakers need access to accurate scientific data.

	Strategies	***Milestones***	***Contact***	Year-1			Year-2			Year-3			Year-4			Year-5		
				Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su
1	Identify federal, state, and local policies related to crop choices, water quality, and ground water availability (e.g., Kansas Conservation Reserve Program [KCRP], Kansas Watershed Restoration and Protection Strategy [WRAPS], Intensive Groundwater Use Conservation Areas [IGUCAs]).	Policies identified	Earnhart, Peterson															
2	Analyze the effects of policies on farmers' land use and water use, as well as agricultural outcomes (e.g., crop yields).	Analysis complete																
3	Communicate policy-relevant information to policymakers (e.g., Kansas Department of Health and Environment -- Bureau of Water, Kansas Department of Agriculture -- Division of Water Resources).	Generate and distribute policy white papers																
		Hold workshops on university campuses																
		Develop and implement focused policy workshops on-site at state agencies																
		Provide detailed analyses in response to questions raised at workshops																

Outcomes:

- Policy- and management-relevant information for improved mechanisms for adaptation, mitigation, and water and watershed sustainability.
- Creation of a Statewide Science and Technology Plan that is related to the Economic Development Plan in Kansas.
- More effective policies that address climate and energy issues based on accurate scientific data.

RESEARCH GOAL #5

To educate a diverse workforce and the next generation of leaders.

Objective 1: Create a Pathway model that advances Native American students from two year colleges and Tribal Colleges, through the higher education system, culminating in Ph.D. degrees in STEM areas.

Why? America can only compete in the advancement of science and technology for the future if it utilizes the full power of its potential workforce. By recruiting Native Americans in climate and energy research, we gain not only the collective intellect of an underutilized race, but the unique perspective that indigenous people can provide to climate issues and their effects on a significant world stakeholder.

	Strategies	***Milestones***	***Contact***	Year-1			Year-2			Year-3			Year-4			Year-5		
				Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su
1	Recruit 10-15 Native American students each year into summer REU program.	Students recruited primarily from Haskell	Wildcat															
		Up to 25% of students recruited from outside Haskell																
		Up 50% of students recruited from outside Haskell																

2	Design bridging program for summer REU students to remain engaged in Pathways program during academic year.	Implementation of the program	Wildcat																	
		Graduate 3-5 Native American students each year from four year colleges/universities.	Nagel, Wildcat																	
		Enroll 1-3 Native American students each year in graduate programs.	Nagel																	

Objective 2: Leverage the number of fellowships in the McNair Scholars Program to reach at least two more disadvantaged students at each of the three research universities each summer.

Why? America can only compete in the advancement of science and technology for the future if it utilizes the full power of its potential workforce. By recruiting students from a variety of underrepresented groups, including those from rural and less affluent areas in Kansas, we gain the collective intellect and fresh perspective of often overlooked sectors of the populace.

Strategies		***Milestones***	***Contact***	Year-1			Year-2			Year-3			Year-4			Year-5		
				Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su
1	Each year recruit 6 students, 2 each for KU, KSU, and WSU for summer research.	Presentation of research projects at end of summer in a formal symposium	Kamatuka, Holt-Fields, Greene															

Objective 3: Provide undergraduate Summer REU program at all three universities in the areas of Climate and Energy.

Why? Summer REU projects that span the areas of climate and energy, and also link to all three institutions, provide multifaceted research experiences for undergraduates. First, many of the students come from small colleges without the opportunity to do research. Secondly, the combined REU programs will provide a unique viewpoint of both climate and energy issues, which will introduce them at an early stage in their career to multidisciplinary research.

Strategies		***Milestones***	***Contact***	Year-1			Year-2			Year-3			Year-4			Year-5		
				Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su
1	Provide fellowships for support of minorities and women in Climate and Energy REU subprojects.	Up to two additional minority students or women are recruited to summer REU programs at each university	Wu, Rice, Earnhart															

Outcomes:

- A network of climate scientists and technical experts linking research universities, tribal colleges, and indigenous communities.
- New strategies for indigenous communities to respond to climate related events and changes.
- A culture that invites diversity across ideas, institutions and disciplines.
- Participation of minorities and other underrepresented groups in all aspects of the project.
- Students graduate with interdisciplinary training and transdisciplinary skills in social and natural sciences and engineering.
- Training, research opportunities and guidance are provided to a diverse student population.

Glossary

BCC	Biofuels and Climate Change
CCM	Climate Change and Mitigation
COCRO	Council of Chief Research Officers
EPSCoR	Experimental Program to Stimulate Competitive Research
GIScience	Geographic Information Science
HERS	Haskell Environmental Research Studies Institute
IGUCAs	Intensive Groundwater Use Conservation Areas
IPCC	Intergovernmental Panel for Climate Change
IPSR	Institute for Policy and Social Research at KU
KARS	Kansas Applied Remote Sensing
KACD	Kansas Association of Conversation Districts
KATS	Kansas Association of Teachers of Science
KBOR	Kansas Board of Regents
KCRP	Kansas Conservation Reserve Program
KEEP	Konza Environmental Education Program (KEEP)
KNE	Kansas NSF EPSCoR
K-STATE or KSU	Kansas State University
KTEC	Kansas Technology Enterprise Corporation
KU	University of Kansas
LTER	Long Term Ecological Research
MATLAB/FORTRAN	Matrix Laboratory (Mathworks, Inc.)/Formula Translation/Translator (high-level programming language)
MCNAIR PROGRAM	A summer research program for disadvantaged students.
MT	Management Team
NRE	Nanotechnology for Renewable Energy
NISE	Nanoscale Informal Science Education (NISE) Network
NSF	National Science Foundation
PATHWAYS	KNE project for creating a new education model that will help to expand the Native American science and technology workforce.
REU	Research Experience for Undergraduates
RII	Research Infrastructure Improvement
S&T	Science and Technology
STEM	Science, Technology, Engineering, and Mathematics
SWAT	Strategic Ways to Acquire Technology
WRAPS	Kansas Watershed Restoration and Protection Strategy
WRF	Weather Research Forecast
WSU	Wichita State University