

V(A). Planned Program (Summary)

Program # 6

1. Name of the Planned Program

Sustainable Energy

Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
102	Soil, Plant, Water, Nutrient Relationships	20%		20%	
121	Management of Range Resources	20%		20%	
131	Alternative Uses of Land	0%		10%	
133	Pollution Prevention and Mitigation	0%		10%	
401	Structures, Facilities, and General Purpose Farm Supplies	10%		10%	
402	Engineering Systems and Equipment	20%		20%	
608	Community Resource Planning and Development	30%		10%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2012	Extension		Research	
	1862	1890	1862	1890
Plan	4.0	0.0	3.0	0.0
Actual Paid Professional	4.0	0.0	3.1	0.0
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
61581	0	142369	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
61581	0	142369	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	0	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Media will be used to familiarize the public with UW College of Agriculture and Natural Resources areas of programming and personnel in regard to sustainable energy. Media releases in local newspapers, radio spots and television advertisements will inform the public of upcoming extension programs. Newsletter articles distributed both electronically and through the mail by county offices, area teams, and the University of Wyoming will reach general public and agriculture producers locally, regionally, and statewide. Public educational programs with invited speakers and extension specialists and educators presenting research-based information will continue to be held in response to local, state, and national energy sustainability. Demonstrations of technology and skills training will be included in education curriculum to enhance educational effectiveness. Field tours will be organized to provide producers with the opportunity to observe industry procedure (i.e., tour of an ethanol plant).

The Sustainable Agriculture Research and Extension Center (SAREC) located at Lingle, Wyoming will provide a resource base for integrating agriculture production and renewable energy based programs.

Educational programs will emphasize sustainable energy practices such as bio-fuels and wind energy, reclamation and restoration of disturbed lands, and energy conservation practices. Other methods will include individual interaction with landowners educating them on resources available to assist them with sustainable energy practices. UW Extension will provide coordination with other colleges on the UW campus such as Engineering and the School of Energy Resources, state and federal agencies to provide education on this topic, and funding for this effort. UW Extension will also provide educational opportunities for professionals involved with reclamation and restoration of disturbed lands.

The UW Energy Extension Coordinator conducted five energy audits for businesses to identify potential energy and cost savings.

The University of Wyoming's College of Agriculture and Natural Resources will conduct research and direct extension programming efforts to help ensure prudent use of the state's precious resources.

2. Brief description of the target audience

The University of Wyoming is committed to reaching underrepresented groups and individuals and to implementing the objectives of equal opportunity regulations relative to the consideration and treatment of clientele for participation in all programs regardless of their race, national origin, gender, age, religion, or

disability. Participants will include policy makers for county, state, and federal government agencies, crop producers, livestock producers, energy companies, general public, and the scientific community. An existing secondary audience will be the media, general public, and interest groups not directly involved in production agriculture (i.e., environmental groups). Energy conservation methods will be targeted at both agriculture and general public audiences.

3. How was eXtension used?

The UW Extension energy extension coordinator serves on the eXtension energy community of practice. eXtension is used as a resource for educators and the public. the Web site link is prominently displayed on the UW Extension home page. UW Extension educators are aware of professional development opportunities available through eXtension.

V(E). Planned Program (Outputs)

1. Standard output measures

2012	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	1200	10000	342	1000

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year: 2012
 Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2012	Extension	Research	Total
Actual	11	16	27

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of individuals participating in sustainable energy programs. Target is the number of contacts.

Year Actual

2012 1200

Output #2

Output Measure

- Determine ecosystem services affected by energy development and reclamation efforts. Target is number of publications, reports, bulletins, and presentations.

Year	Actual
2012	39

Output #3

Output Measure

- Evaluate the potential for production of bioenergy. Target is number of publications, reports, bulletins, and presentations.

Year	Actual
2012	6

Output #4

Output Measure

- Number of educational programs or activities focusing on sustainable energy by CES. Target is the number of educational programs implemented.

Year	Actual
2012	56

Output #5

Output Measure

- Number of collaborative partnerships formed to address sustainable energy in Wyoming. Target is the number of partnerships.

Year	Actual
2012	25

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Awareness created focusing on sustainable energy topics. Target is the number of individuals reporting this outcome.
2	Partnerships will be developed with agencies and organizations to expand sustainable energy efforts. Target is the number of partnerships formed.
3	New technologies or devices used in ag production systems and/or farmsteads. Target is the number of new technologies developed.
4	Research: Create awareness of ecosystem services affected by energy development and reclamation efforts. Target is number of projects reporting this outcome.
5	Research: Create awareness on the potential to produce bioenergy. Target is number of projects reporting this outcome.

Outcome #1

1. Outcome Measures

Awareness created focusing on sustainable energy topics. Target is the number of individuals reporting this outcome.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	1200

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The State of Wyoming is well known for being a critical source of the nation's supply of natural resources. Because fossil fuels are essentially an irreplaceable base for Wyoming's vibrant energy industry, the College of Agriculture and Natural Resources conducts research and direct extension programming efforts to help ensure prudent use of the state's precious resources. In addition to fossil fuel resources, Wyoming also possesses abundant renewable energy resources including wind, solar, hydroelectric, geothermal, and biomass. Both small-scale, such solar photovoltaics or geothermal heat pumps, and utility-scale, primarily wind energy, are important issues. Development of renewable technologies such as specific systems that can be used in agriculture production and/or farmsteads and small-scale power generation where power can be sold such as wind energy are also important issues. Conservation and preservation of our natural resources, both land and water is an ongoing effort for both extension and research.

What has been done

The University of Wyoming College of Agriculture and Natural Resources research and extension efforts in sustainable energy focus on efficiency and conservation specifically in relation to farm and agriculture production. In addition, residential and public conservation education is targeted toward the general public and businesses. In fall 2009, UW Extension partnered with the School of Energy Resources at UW to fund an energy extension coordinator who provides leadership and coordination for extension energy programs in the college. Initial training for field extension educators was conducted; a Western SARE grant (\$110,000) was obtained by Montana State University in collaboration with the UW Extension energy extension coordinator to implement a Western Region training on energy issues (release of funds has delayed this until Fall 2011). In addition to educational programs to raise awareness and knowledge, UW Extension has developed a Web site for information, publications, and a set of educational videos. To maximize outreach efforts, partnerships have been developed with the College of Engineering and Applied

Science, School of Energy Resources, the Wyoming State Energy Office, Wind Energy Research Center, USDA Rural Development, Natural Resource Conservation Service, and the Wyoming Business Council. UW Range specialists and area educators have partnered with the UW Reclamation and Restoration Center to develop and implement Reclamation 101 schools for agriculture land owners and agency personnel.

Results

In 2011, UW Extension initiated an issue team focusing on sustainable energy issues. 100 percent of participants in the 56 programs held reported gaining awareness of the topic and gaining knowledge. Early partnership efforts have resulted in increasing effectiveness of programs through multiple collaborators.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
121	Management of Range Resources
131	Alternative Uses of Land
133	Pollution Prevention and Mitigation
401	Structures, Facilities, and General Purpose Farm Supplies
402	Engineering Systems and Equipment
608	Community Resource Planning and Development

Outcome #2

1. Outcome Measures

Partnerships will be developed with agencies and organizations to expand sustainable energy efforts. Target is the number of partnerships formed.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	25

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The State of Wyoming is well known for being a critical source of the nation's supply of natural resources. Because fossil fuels are essentially an irreplaceable base for Wyoming's vibrant energy industry, the College of Agriculture and Natural Resources strives to conduct research and direct extension programming efforts to help ensure prudent use of the state's precious resources. In addition to fossil fuel resources, Wyoming also possesses abundant renewable energy resources including wind, solar, hydroelectric, geothermal, and biomass. Both small-scale, such as solar photovoltaics or geothermal heat pumps, and utility-scale, primarily wind energy, are important issues. Development of renewable technologies such as specific systems that can be used in agriculture production and/or farmsteads and small scale power generation where power can be sold such as wind energy are also important issues. As an energy rich state, conservation and preservation of our natural resources, both land and water is an ongoing effort for both extension and research.

What has been done

To maximize outreach efforts, partnerships have been developed with the College of Engineering and Applied Science, School of Energy Resources, the Wyoming State Energy Office, Wind Energy Resource Center, USDA Rural Development, Natural Resource Conservation Service, and the Wyoming Business Council. The UW Reclamation and Restoration Center, Energy Industry, local partners focusing on local food production are additional partners.

Results

Partnerships have increased resources, both financial and human capital to maximize outreach efforts. Partnerships have leveraged funding to support an innovative energy internal grant program for UW Extension. Integrated program efforts are in progress.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
121	Management of Range Resources
401	Structures, Facilities, and General Purpose Farm Supplies
402	Engineering Systems and Equipment
608	Community Resource Planning and Development

Outcome #3

1. Outcome Measures

New technologies or devices used in ag production systems and/or farmsteads. Target is the number of new technologies developed.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Over 137 million people in more than 70 countries are affected by arsenic poisoning through drinking water supplies. Studies have shown that long-term human exposure to drinking water containing arsenic in excess of 50 µg/L causes increased risk of skin, lung, bladder, and kidney cancer and increased risk of premature death. U.S. Environmental Protection Agency (EPA) proposed a new limit of 10 µg/L for arsenic for human drinking water, effective January 26, 2006.

What has been done

A flow-through filtration system for field applications was designed, developed, and tested to remove arsenic from groundwater. Several groundwater samples were pumped through the flow-through reactor consisting of CuO nanoparticles.

Results

Cupric oxide nanoparticles effectively removed arsenic from groundwater samples across a wide range of pHs and concentrations of competing ions including, phosphate, silica, and sulfate. Removal of arsenic with CuO nanoparticles did not affect the chemistry of groundwater samples and most of the water quality parameters remained within the US EPA human drinking water limits.

4. Associated Knowledge Areas

KA Code	Knowledge Area
401	Structures, Facilities, and General Purpose Farm Supplies
402	Engineering Systems and Equipment

Outcome #4

1. Outcome Measures

Research: Create awareness of ecosystem services affected by energy development and reclamation efforts. Target is number of projects reporting this outcome.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	12

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Wyoming is currently one of the leading onshore producers of natural gas in the US. Most of the gas fields in the state are located on sagebrush steppe rangelands with short growing seasons, weakly developed soils, and very limited precipitation. Because of these extreme environmental conditions and problems with weedy species, restoration of these sites to their pre-disturbance vegetation and land uses has proven to be difficult. Of exceptional importance is restoration of wildlife habitat, particularly sage grouse habitat because this bird is a threatened species. If operators are not capable of restoring lands impacted by drilling to pre-disturbance land uses including wildlife habitat, especially sage grouse habitat, they will not be able to obtain permits for further drilling.

What has been done

The Wyoming Reclamation and Restoration Center in collaboration with BP and Conservation Seeding and Restoration, Inc. has constructed a database framework with the purpose of creating a restoration decision management tool by compiling oil and gas pad reclamation data to identify successful restoration practices. Data were collected from three large Wyoming production fields. The framework includes tables for measurements of reclamation practices (e.g. soil handling methods and amendments, seeding mix and timing, and weed management), geographical and climate data (e.g. precipitation, slope, aspect, elevation and temperature) and monitoring data (e.g. vegetation composition and structure along with soil analysis and grazing). Microsoft Access and ESRI ArcGIS were employed to build the reclamation database for consistent and reliable data storage, manipulation and retrieval.

Results

The long-term goals of the project are threefold: to deliver an operational framework to analyze and isolate trends leading to reclamation success and failure; to provide a strong decision management tool for limiting uncertainty and estimating associated risk under variable environmental conditions; and to offer a flexible and sharable database that allows for additional data input from diverse sources. Use of this tool will facilitate successful reclamation and reestablishment of pre-disturbance land uses including suitable wildlife habitat and maintenance of economic health in Wyoming.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
121	Management of Range Resources
131	Alternative Uses of Land

402 Engineering Systems and Equipment
608 Community Resource Planning and Development

Outcome #5

1. Outcome Measures

Research: Create awareness on the potential to produce bioenergy. Target is number of projects reporting this outcome.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	6

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Farmers and ranchers in Wyoming operate under harsh climatological and economic constraints. New agricultural technologies that relieve these constraints and integrate with existing production are vital to healthy economic development in rural parts of the state. Aquaculture of oil-producing microalgae at large scales has been identified as an appropriate method of biodiesel production in arid regions of the Western US. It can be accomplished on non-agricultural land with relatively little water consumption and will not compete with existing agriculture. Moreover, microalgae can be used to feed animals and amend soils after oil and other useful chemicals have been extracted from them. In recent years, tens of billions of public and private dollars have been invested to realize the potential of large-scale microalgal aquaculture. But this technology is in its infancy and many biological and technological challenges have been encountered. Our research addresses some of these challenges in a series of overlapping field and laboratory studies.

What has been done

We have made progress on several projects intended to domesticate algae for large-scale culture in Wyoming. Most importantly, we have begun genetically modifying the single-celled green alga *Chlamydomonas* so that the individual cells can be induced to form multicellular clumps after accumulating oil. If successful, our technology will cause oil-laden algal cells to form large clumps and settle to the bottom of their culture vessel. Water can then be removed for recycling and the remaining algal sludge scooped out for processing. If successful, our strategy will dramatically reduce harvest costs for large-scale cultures of algae. So far, we have successfully expressed a cell adhesion molecule from the multicellular green alga *Volvox* in *Chlamydomonas*, causing it to form clumps. We have also begun developing algacide-resistant strains of *Chlamydomonas* that tolerate high levels of hydrogen peroxide-based algacides, which can be used as general

purpose biocides in algal culture systems.

Results

A graduate student working on the project won the Wyoming 30K Entrepreneurship Competition that was held in March 2012 and has started a small business that provides research services for algal aquaculture businesses now starting up all over the world. Most of these lack biological expertise specific to algae. The project employs two or more graduate or undergraduate students continuously, on average. These students are part of a growing technical workforce needed by the nascent algal biofuel industry and other sectors of the agricultural economy.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
133	Pollution Prevention and Mitigation
401	Structures, Facilities, and General Purpose Farm Supplies
402	Engineering Systems and Equipment

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges

Brief Explanation

Funding for this new program is essential in development and implementation of both research and extension efforts. Weather extremes are a factor in agriculture production outcomes regarding crops for alternative fuels. As a new planned program, the first year heavily involved training and awareness for extension educators. The community development partnership in Wamsutter to assist with infrastructure development ended in June 2011.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

End of session written evaluations were utilized to collect outcome data. In addition personal follow-up with the local educator or UW Energy Extension Coordinator was conducted. 100% of program participants indicated they increased awareness and knowledge as a result of educational efforts. Educators and professional agency personnel who participated in training on renewable energy and reclamation issues reported increased knowledge, skills and increased confidence in disseminating information on these topics.

Program participants reported that in some instances, alternative energy options are not cost effective therefore contributed to decision making which is a positive outcome.

Key Items of Evaluation

Increased awareness and knowledge on sustainable energy issues.

Program participants reported that in some instances, alternative energy options are not cost effective therefore contributed to decision making which is a positive outcome.