V(A). Planned Program (Summary)

Program # 2

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
511	New and Improved Non-Food Products and Processes	20%		100%	
608	Community Resource Planning and Development	80%		0%	
	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	2.0	0.0	3.5	0.0
Actual Paid Professional	4.5	0.0	1.8	0.0
Actual Volunteer	15.0	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**
260678	0	195619	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
260678	0	601377	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

On-going research activities to inform sustainable energy and advanced materials programs include both basic and applied research. This research takes place in all academic departments/schools within the College of Food, Agricultural, and Environmental Sciences. Laboratories for experiments, pilot plants, a feedstock processing plant, greenhouses, and research plots and stations support this program. All functional laboratories and sites are improved over time as program need warrants. OSU Extension provides parallel programs in this Planned Program to advance knowledge, promote adoption and change, develop human capital, and support economic development activities. OARDC and OSU Extension faculty and staff engage in appropriate levels of outreach, engagement, and consultation, with both internal and external stakeholders, to ensure the research has the greatest chance of effecting change within society.

2. Brief description of the target audience

Targeted audiences include, but are not limited to: business, industry, and residents that have expressed a need for sustainable energy and advanced materials information that is derived through new research, extracted from on-going research, or is derived from scientific literature; other stakeholders, with particular focus on consumers; fellow academic units that partner with program scientists to create systems and processes needed to support not only the research, but also the adoption of the research findings by industrial partners; fellow agencies or support organizations who will not only use the information but will also be brokers of that information, including embedding it into groups to encourage change; populations who have not requested the information but will likely benefit from that information, e.g. community leaders, general public; other scientists and scientific groups; political entities; other education, outreach, and extension personnel; students from elementary school to post doctorate studies; and news organizations.

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2012	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	1000	15000	50	150

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	8	8	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of graduate students completed.
  Not reporting on this Output for this Annual Report

Output #2

Output Measure

- Educational Workshops and Seminars

Year	Actual
2012	60

Output #3

Output Measure

- Research based assessments of energy project sites
  Not reporting on this Output for this Annual Report

Output #4

Output Measure

- Community energy project assistance & planning
  Not reporting on this Output for this Annual Report

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Programs in this area will develop strategies to engage producers, industrial partners, and consumers groups over a 5-year period resulting in effective leadership-oriented partnerships.
2	The program will build scientist/stakeholder cores to guide/provide biological, chemical, physical, engineering, and social research necessary to create new and improved processes and products commensurate with demand.
3	Annually the program will report, in conjunction with industrial partners, non-proprietary research gains made to the consuming public to garner interest in adoption of new products and processes when released.
4	Maintain an ongoing needs assessment program to identify yet to be determined needs of society for bio-based products as crude oil and natural gas supplies decline, as well as assessing impacts from other external factors.
5	By 2012, the program will contribute at least one alternative to a petroleum-based product or process that meets client needs with an acceptable point of purchase price.
6	Support, though research, the building of biobased development that annually, beginning in 2012, utilizes Ohio and the region's plentiful supply of biomass, including waste steam materials in such manner as to improve the economy.
7	Support the building of biobased development that, beginning in 2012, effectively utilizes agriculture's production capacity to produce plants that have the desired attributes for manufacturing.
8	Increased understanding of energy alternatives, resources and project support
9	Implement change in energy usage by workshop participants
10	Complete installation of alternative energy activity
11	Complete plan for community or business energy activity

Outcome #1

1. **Outcome Measures**

   Programs in this area will develop strategies to engage producers, industrial partners, and consumers groups over a 5-year period resulting in effective leadership-oriented partnerships.

   Not Reporting on this Outcome Measure

Outcome #2

1. **Outcome Measures**

   The program will build scientist/stakeholder cores to guide/provide biological, chemical, physical, engineering, and social research necessary to create new and improved processes and products commensurate with demand.

   Not Reporting on this Outcome Measure

Outcome #3

1. **Outcome Measures**

   Annually the program will report, in conjunction with industrial partners, non-proprietary research gains made to the consuming public to garner interest in adoption of new products and processes when released.

   Not Reporting on this Outcome Measure

Outcome #4

1. **Outcome Measures**

   Maintain an ongoing needs assessment program to identify yet to be determined needs of society for bio-based products as crude oil and natural gas supplies decline, as well as assessing impacts from other external factors.

   Not Reporting on this Outcome Measure

Outcome #5

1. **Outcome Measures**

   By 2012, the program will contribute at least one alternative to a petroleum-based product or process that meets client needs with an acceptable point of purchase price.

2. **Associated Institution Types**

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
As the US seeks to become more energy independent we are seeking biobased products to replace those from non-renewal sources such as petroleum. Likewise we are seeking materials to make greater use of the nation?s plentiful biomass supply.

What has been done
OARDC has partnered with Natural Fiber Composites Corporation (NFCC), to engineer composites from jute, soy hulls, corn, and wheat straw, and other plant-based sources to replace materials such as fiberglass. These natural fiber-reinforced composites are targeted for use in transportation, construction, packaging and industrial products. Project support has come from the Ohio Corn Growers Association, Ohio Soybean Council, and Ohio Wheat Growers Association, OARDC, and the state of Ohio's Third Frontier program.

Results
NFCC and OARDC scientists, in cooperation with CFAES - Ohio Bioproducts Innovation Center, have built capacity to annually produce some six million pounds of composite materials for various product formulations.

4. Associated Knowledge Areas

KA Code	Knowledge Area
511	New and Improved Non-Food Products and Processes

<u>Outcome #6</u>

1. Outcome Measures

Support, though research, the building of biobased development that annually, beginning in 2012, utilizes Ohio and the region's plentiful supply of biomass, including waste steam materials in such manner as to improve the economy.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Most anaerobic digester technology are dependent on a supply of wet feedstocks. A large amount of dry organic products would lend themselves to anaerobic digestion if the technology were available.

What has been done
OARDC scientists explored how to build an anaerobic digester that accepts dry matter such as such as yard trimmings, crop residue, corn silage, and lignocellulosic food waste; these are not suitable to existing anaerobic digestion systems. This allows for the production of biogas from a large number of organic materials with high solids content. This solid state technology, reported in an earlier ROA, has now been fully tested, linked with a wet digester, and is ready to be commercialized.

Results
OARDC scientists have developed an integrated system, known as iADs.
It is known as an integrated system in that it couples the traditional wet digester technology with the new dry technology. A Cleveland-based company, quasar energy group, has broken ground on installation of this integrated anaerobic digestion system, a patent-pending technology developed by the OARDC to increase the types of waste that can be converted to biogas for energy and fuel uses. The fully commercialized system is currently under construction in Zanesville, Ohio. This digester annually processes close to 30,000 tons of agricultural and food waste and can produce 7,800 megawatt-hours of electricity. The company operates additional digesters in Ohio and Massachusetts, including its flagship facility on the OARDC - Wooster campus.

4. Associated Knowledge Areas

KA Code	Knowledge Area
511	New and Improved Non-Food Products and Processes

Outcome #7

1. **Outcome Measures**

Support the building of biobased development that, beginning in 2012, effectively utilizes agriculture's production capacity to produce plants that have the desired attributes for manufacturing.

Not Reporting on this Outcome Measure

Outcome #8

1. **Outcome Measures**

Increased understanding of energy alternatives, resources and project support

2. **Associated Institution Types**

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	168

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Due to their abundance of natural resources and extensive open spaces, rural Ohio communities are positioned to play a central role in future energy development. Energy development presents both opportunities and challenges to the impacted communities. "Energize Ohio", an OSU Extension signature program, provides non-biased, research-based information to address critical energy issues impacting Ohioans. The ultimate goal of "Energize Ohio" is to enhance community leaders' and local residents' knowledge of energy drivers and development in order to promote informed decision-making and best practices.

What has been done
Roughly 35 educational sessions have been conducted producing an estimated 45 local community volunteer hours.

Results
Results from a pre/post test evaluation survey indicated 98% of the program participants felt the program provided valuable information that they would recommend to other Ohio communities.

4. Associated Knowledge Areas

KA Code	Knowledge Area
608	Community Resource Planning and Development

Outcome #9

1. Outcome Measures

Implement change in energy usage by workshop participants

Not Reporting on this Outcome Measure

Outcome #10

1. Outcome Measures

Complete installation of alternative energy activity

Not Reporting on this Outcome Measure

Outcome #11

1. Outcome Measures

Complete plan for community or business energy activity

Not Reporting on this Outcome Measure

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
- Populations changes (immigration, new cultural groupings, etc.)
- Other (Supply and cost of crude oil)

Brief Explanation

While all factors noted above still effect the outputs and impacts in this area, the greatest impact may be the rapid development of shale gas in Ohio. The plentiful supply of

natural gas will more than likely directly compete with adoption of biobased products made from renewable biomass. Given this is a market force decision, the real outcomes/impacts will not be known until market decisions are made.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

The Ohio BioProducts Innovation Center (**OBIC**), a research and extension center within the College of Food, Agriculture, and Environmental Sciences, connects different segments of the bioproducts community to nurture business ecosystems and facilitate commercialization of new sustainable bioproduct technologies. Out of these alliances come our most relevant sources of feedback.

The most important accomplishment this reporting year in terms of feedback was the establishment of The Bioproduct Network, established in November of 2012. It is an OBIC program to link members across the bioproduct supply chain.

Biomass producers, processors, chemical and polymer companies, product manufacturers, researchers and procurement officials (corporate and governmental) can network with each other under the guidance of the nation's leading bioproduct commercialization organization. Members collaborate to drive "bottom-line" value and support consumers seeking products in line with environmental stewardship values.

In terms of specific feedback, a key biomass-to-energy research partner at the BiOhio Research Park on the OARDC Wooster campus provided the following assessments.

"This technology (referring to the iADs dry biodigester developed by OARDC researchers) will allow quasar to accept and process a wider range of high-solids feedstocks, including high-volume off-spec and major market recall material--expanding our business to offer customers a full-service solution to their waste management challenges. The partnership with OARDC applies research to improving the way we do business."
- Mel Kurtz, President, quasar energy group.

"The OARDC/quasar CNG conversion pilot project is a great example of university research institutions and industry working together to develop real-world solutions to meet our energy challenges. OARDC and quasar were already well out in front on the issue of utilizing CNG as an alternative transportation fuel and have emerged as clear leaders in this important market--a market that promises significant economic growth potential for our region."
- Dave Karpinski, vice president, NorTech, and director, NorTech Energy Enterprise,

Cleveland

One key goal of OSU Extension work is to enhance community leaders' and local residents' knowledge of energy drivers and development in order to promote informed decision-making and best practices. Roughly 60 educational sessions were conducted producing an estimated 45 local community volunteer hours. Retrospective pre/post-test evaluation results indicated 98% of the program participants felt the program provided valuable information that they would recommend to other Ohio communities.

In 2012, OSU Extension professionals taught more than 1,000 Ohioans how to

prepare for and attract potential renewable energy developments. Also of note in 2012, OSUE and the OSU Subsurface Energy Resource Center (SERC) had conducted 149 programs, reaching more than 14,000 people on shale energy-related topics, such as legal and financial aspects of leases, and water and environmental issues. The benefits of that education can be seen in Jefferson County, Ohio. In Jefferson County alone, landowners who participated in OSUE programs received, on average, $402 more per acre for shale mineral leases.

Key Items of Evaluation

Bioenergy & Bioproducts Education Programs provide professional development and hands-on teaching tools for educators (grades 6 - 16 in service and pre-service teachers and Extension educators) who want to learn and teach about the Bioenergy and Bioproducts systems currently in use and under development in the United States. Through the collaborative efforts and expertise of six institutions of research and higher learning, this program aims to inspire today's students to pursue careers in math and science by aligning concern for the natural environment with the emerging bioenergy and bioproducts industries. OBIC participates in this program

To date, 20 teachers have participated in the Bioenergy and Bioproducts Education Program (NIFA Education CAP with Cornell). These teachers have subsequently reached out to other teachers in their discipline and communities. An additional 25 teachers were trained via ATI's Bioenergy workshop. It is estimated that these efforts have reached between 1,500 and 2,000 students in Ohio.

Campus-based activities have reached nearly 100 fourth and fifth grade students, 150 undergraduate students, and 35 graduate students. These efforts have increased awareness of the bioproduct industry as an emerging sector within the larger industry of agbioscience.

During 2012, 23 Ohio State students were employed by OBIC in bioproduct development projects. These activities ranged from technology assessment, market studies, business case reviews, industrial design, and bioproduct educational/ communication activities.

This level of participation is viewed as a surrogate measure of importance in this program area.

OSU Extension evaluation noted that more than 98% of program participants increased their knowledge of energy drivers and energy development opportunities leading to better-informed decision-making and best practices.

In 2012, OSU Extension professionals taught more than 1,000 Ohioans how to prepare for and attract potential renewable energy developments. Also of note in 2012, OSUE and the OSU Subsurface Energy Resource Center (SERC) had conducted 149 programs, reaching more than 14,000 people on shale energy-related topics, such as legal and financial aspects of leases, and water and environmental issues. The benefits of that education can be seen in Jefferson County, Ohio. In Jefferson County alone, landowners who participated in OSUE programs received, on average, $402 more per acre for shale mineral leases.