

**V(A). Planned Program (Summary)**

**Program # 7**

**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	10%			
133	Pollution Prevention and Mitigation	10%			
203	Plant Biological Efficiency and Abiotic Stresses Affecting Plants	10%			
403	Waste Disposal, Recycling, and Reuse	10%			
601	Economics of Agricultural Production and Farm Management	10%			
602	Business Management, Finance, and Taxation	10%			
605	Natural Resource and Environmental Economics	20%			
608	Community Resource Planning and Development	20%			
	<b>Total</b>	100%			

**V(C). Planned Program (Inputs)**

1. Actual amount of FTE/SYs expended this Program

Year: 2012	Extension		Research	
	1862	1890	1862	1890
Plan	3.0	0.0	0.0	0.0
Actual Paid Professional	4.3	0.0	0.0	0.0
Actual Volunteer	1.0	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
209450	0	0	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
209450	0	0	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**

University of Wisconsin-Extension Cooperative Extension BioEnergy and the BioEconomy Team cross-program members and partners are conducting integrated research and extension programs, building capacity for developing sustainable energy and scalable conversion technologies among extension colleagues, communities, farmers and industry partners. Curriculum development teams are working on three courses: BioEnergy and Sustainability, On-Farm Energy Conservation and Efficiency, and Anaerobic Digestion - a proven waste-to-energy technology. While multi-million dollar anaerobic digestion systems only run economically on the waste from 500 or more cows, hundreds of thousands of farms worldwide use inexpensive ultra small-scale biodigesters as described in the external factors section of this report.

**Anaerobic digestion research and outreach:** Wisconsin is the leading state for on-farm anaerobic digestion with more than 30 operational systems. Since large-scale implementation is relatively recent, training is needed for safe production and use of biogas. Maintaining the economic viability of large-scale anaerobic digestion systems requires optimizing operation and assessing feedstocks. Feedstocks are identified and evaluated in extension biowaste specialist Rebecca Larson's lab, then implemented in the field. As a result, facilities are increasing biogas production and more importantly, avoiding highly toxic feedstocks that cause catastrophic failures. Her recommendations have led to more efficient systems with greater economic sustainability.

**Anaerobic Digester Operator Training:** Trained large-scale operators now have a greater understanding of their systems, can implement strategies outlined in the training, and are connected with their peers. Collaboration continues - to develop materials on hydrogen sulfide mitigation and removal, record-keeping procedures for evaluation and system optimization, and a biogas network to strengthen communications among researchers, educators, industry partners, producers and operators.

**Building capacity for developing sustainable energy:** From 2008 to 2010, Wisconsin communities, businesses and tribes undertook energy initiatives in response to external factors and the state "Energy Independence" program. UW-Extension Cooperative Extension educators took part in more than 30 of these efforts - until the state program ended in 2011, along with grants to communities for sustainable energy efforts. Wisconsin Cooperative Extension obtained a 2-year grant from the U.S. Department of Energy, forming a partnership with the State Energy Office to boost energy efficiency, renewable energy and bioenergy progress. Extension educators in each county and 140 Energy Independent Communities were surveyed to form a list of local officials, school districts and others interested in being part of a statewide energy network. Results were used to design the new program Energy On Wisconsin. In 2012, the first 3 of 7 face-to-face meetings were held on topics from the survey. Much effort went into building

relationships with local officials, experts, businesses, nonprofits and state groups who are already sharing and acting on what they learned.

## **2. Brief description of the target audience**

The interdisciplinary BioEnergy and the BioEconomy Team is addressing statewide emerging bioenergy education needs. Farmers and foresters are interested in supplying feedstocks to the bioenergy industry as a potential alternative market and source of revenue. Communities are interested in developing renewable energy industries for energy independence, job creation, and economic development. Given Wisconsin's wealth of resources in forests and agricultural production, there is interest among state businesses and communities in producing alternative fuels and feedstocks from biomass. The audience includes municipalities, regional planning commissions, regulated and unregulated utilities, liquid biofuels, anaerobic digester and biomass conversion technology firms, biomass producers and aggregators, food processors, food services, school districts, loggers, procurement foresters, wood products professionals, haulers, farmers and their advisors, business owners, woodland owners, recycling volunteers, public and private agencies, local and tribal government officials, and others.

**Reaching under-served communities:** Crawford County agriculture agent Vance Haugen has worked around the globe helping small producers (1 to 150 cows) construct affordable ultra small-scale biodigesters. When his neighbors read about his global work, they asked for the same for Wisconsin. In 2012, Haugen provided an overview of biogas production, physical properties of animal manure as it relates to biogas production, practical examples of low-cost production methods for small-scale biogas digesters from India, China, Nicaragua, Cuba, Vietnam, the Philippines and the United States, and small-scale digester designs for the Midwest - reaching 85 U.S. National Guard troops attending the Babcock Agriculture 101 session at the Arlington Agricultural Research Station and 34 attendees of the Oneida Bioenergy Update at the Oneida Tribal Headquarters. The Wisconsin National Guard troops have constructed a small-scale biodigester, and the Oneida Nation Bioenergy committee continues to gather information for theirs. Haugen's biogas introduction resources are housed with others on the Wisconsin Chapter of the American Society of Farm Managers and Rural Appraisers web site: <http://www.wcasfmra.org/biogas.htm>

## **3. How was eXtension used?**

Wisconsin Cooperative Extension campus and county faculty and staff participate in various communities of practice, engaging with colleagues around the country to improve the educational content of research-based programs and assistance delivered to residents across the state and region. Extension colleagues are connected by email ListServ, blogs and online newsletters, and shared resources such as teleconferences and webinars, eXtension Communities of Practice, and the national Extension Disaster Education Network (EDEN) to quickly address critical and emerging issues such as responding to extreme weather during 2012. Interdisciplinary colleagues and other professionals in this network include University of Wisconsin researchers on the Madison, Platteville, River Falls, Stevens Point and Superior campuses and centers, working with 3 tribes, the Institute for Environmentally Integrated Dairy Management at the UW-Madison Marshfield Agricultural Research Station, 10 other agricultural research stations and the USDA Dairy Forage Research Center.

## **V(E). Planned Program (Outputs)**

### **1. Standard output measures**

2012	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	4341	0	0	0

**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	2	0	2

**V(F). State Defined Outputs**

**Output Target**

**Output #1**

**Output Measure**

- {No Data Entered}

**V(G). State Defined Outcomes**

**V. State Defined Outcomes Table of Content**

O. No.	OUTCOME NAME
1	Develop biomass use for biofuels.
2	Build capacity to create, refine and implement scalable conversion technologies.
3	Design forestry and crops for bioenergy production.
4	Building capacity for developing sustainable energy.

### **Outcome #1**

#### **1. Outcome Measures**

Develop biomass use for biofuels.

Not Reporting on this Outcome Measure

### **Outcome #2**

#### **1. Outcome Measures**

Build capacity to create, refine and implement scalable conversion technologies.

#### **2. Associated Institution Types**

- 1862 Extension

#### **3a. Outcome Type:**

Change in Action Outcome Measure

#### **3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2012	0

#### **3c. Qualitative Outcome or Impact Statement**

##### **Issue (Who cares and Why)**

Anaerobic digestion is a proven waste-to-energy technology. Wisconsin is the leading state for on-farm anaerobic digestion with more than 30 operational systems. The last decade created demand for knowledge of system components, processes and mechanisms, operation skills, safe production and use of biogas. Maintaining the economic viability of large-scale anaerobic digestion systems requires optimizing operation, assessing feedstocks, and managing manure streams in accordance with nutrient management plans.

##### **What has been done**

UW-Extension Cooperative Extension biowaste specialist Rebecca Larson works with USDA, OSHA, campus, county, Michigan State University and national colleagues, industry partners and farmers developing and sustaining safe, practical and economical anaerobic digestion. After training 40 large-scale dairy producers, operators and agency staff in 2011, Larson is conducting further research to evaluate operation choices to improve system efficiency using life cycle assessment methodologies. She will share results with digester operators and update the Anaerobic Digester Operator Training Program curriculum. Throughout 2012, research on operational trouble-shooting was conducted at 10 on-farm anaerobic digesters. Anaerobic digestion systems were investigated for biogas production optimization, feedstock degradation,

co-digestates, use of end products, and other operational issues.

### Results

Anaerobic digestion research and outreach: Research results are critical to providing guidance to operators, system owners and the industry on decreasing system failures and downtime, increasing biogas production and profitability, and reducing environmental impacts. Feedstocks are identified and various blends evaluated in Rebecca Larson's lab, then implemented in the field. As a result, many facilities are increasing biogas production and more importantly, avoiding feedstocks with high toxicity that cause catastrophic failures. Her recommendations have led to more efficient systems with greater economic sustainability. For example, when a scalable system constructed for 200 milking cows was producing much lower biogas than predicted, she worked with the operator and company owner to double biogas production. The industrial provider also changed the engineering design to increase biogas production in future installations.

Anaerobic Digester Operator Training: Trained large-scale operators now have a greater understanding of their systems, can implement strategies outlined in the training, and are connected with their peers. Collaboration continues - to develop materials on hydrogen sulfide mitigation and removal, record-keeping procedures for evaluation and system optimization, and a biogas network to strengthen communications among researchers, educators, industry partners, producers and operators.

Digestion and solid-liquid separation: Tracking nutrients and pathogens through anaerobic digestion systems including solid-liquid separation has improved manure management, allowing producers to better manage manure streams in accordance with their nutrient management plans, reducing spreading costs and environmental impacts.

### 4. Associated Knowledge Areas

KA Code	Knowledge Area
403	Waste Disposal, Recycling, and Reuse
601	Economics of Agricultural Production and Farm Management
602	Business Management, Finance, and Taxation
608	Community Resource Planning and Development

### Outcome #3

#### 1. Outcome Measures

Design forestry and crops for bioenergy production.

Not Reporting on this Outcome Measure

## **Outcome #4**

### **1. Outcome Measures**

Building capacity for developing sustainable energy.

### **2. Associated Institution Types**

- 1862 Extension

### **3a. Outcome Type:**

Change in Action Outcome Measure

### **3b. Quantitative Outcome**

<b>Year</b>	<b>Actual</b>
2012	0

### **3c. Qualitative Outcome or Impact Statement**

#### **Issue (Who cares and Why)**

Wisconsin imports almost all its energy (most from fossil fuels), spending \$24 billion per year. Efficient, renewable energy reduces fossil fuels' impacts, mitigates carbon emissions and creates jobs. Wisconsin needs resources, assistance, funding approaches and technology to reduce carbon-based energy use and assess and install renewable energy systems. From 2008 to 2010, Wisconsin communities, businesses and tribes undertook energy initiatives in response to external factors and the state "Energy Independence" program. University of Wisconsin-Extension Cooperative Extension educators took part in more than 30 of these efforts. In 2011, the state program ended, along with grants to communities for sustainable energy efforts.

#### **What has been done**

With fewer resources for communities, UW-Extension Cooperative Extension obtained a 2-year grant from the US Dept. of Energy, forming a partnership with the State Energy Office to boost energy efficiency, renewable energy and bioenergy progress. Extension educators in each county and 140 Energy Independent Communities were surveyed to form a list of local officials, school districts and others interested in being part of a statewide energy network. The survey gauged interest, needs, challenges and preferred methods of information delivery. Results were used to design a new program called Energy On Wisconsin. In 2012, the first 3 of 7 face-to-face meetings were held on topics from the survey. Much effort went into building relationships with local officials, experts, businesses, nonprofits and state groups.

#### **Results**

Building capacity for developing sustainable energy: Attendees' follow-up surveys identified actions taken within 8 months after Energy on Wisconsin meetings.

- As a result of the meeting on education and outreach, 100% of respondents planned and conducted an energy education event; wrote and distributed an energy education piece; and applied for funding with another partner. Half applied an educational approach that they learned

at the meeting.

- 93% are likely to contact UW-Extension for sustainable energy information and assistance.
- 93% are likely to seek information about sustainable energy from Energy On Wisconsin.
- 88% talked with others in their communities about the need for clean energy; two-thirds identified grant opportunities; and 50% used and shared the online resources presented. Tours to renewable energy installations provided ideas that two-thirds of respondents are trying to use in their communities.
- 87% are likely to take part in programs from Energy On Wisconsin.
- 87% said representatives of other communities should attend Energy On Wisconsin meetings.
- 80% looked into approaches described in the energy efficiency meeting. Half followed up with other attendees on their initiatives; 40% contacted or planned to contact the Wis. Board of Commissioners of Public Lands who discussed funding; 40% planned to apply for funding from the Board.
- 71% are likely to contact the State Energy Office.
- Half of respondents contacted another attendee to follow up on energy information; half shared meeting notes with others; 41% shared meeting information with influential community members.

#### 4. Associated Knowledge Areas

KA Code	Knowledge Area
602	Business Management, Finance, and Taxation
605	Natural Resource and Environmental Economics
608	Community Resource Planning and Development

#### 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
- Other (Developing low-cost, ultra small-scale biodigesters; Database development)

##### Brief Explanation

**Developing ultra small-scale biodigesters for under-served communities:** While multi-million dollar anaerobic digestion systems only run economically on the waste from 500 or more cows, hundreds of thousands of farms worldwide use ultra small-scale biodigesters costing only a few hundred dollars in climates as harsh as Wisconsin's. University of Wisconsin-Extension Cooperative Extension biowaste specialist Rebecca Larson works with USDA, OSHA, campus, county, Michigan State University and national colleagues, industry partners and farmers assessing on-farm economic and environmental benefits of small-scale anaerobic digesters - building a mobile dry biodigester to compare with wet biodigestion, and comparing 9 on-farm solid-liquid separation systems coupled with digesters.

In 2011, UW-Extension Cooperative Extension presented the nation's first Small-Scale

Anaerobic Digester Conference for more than 60 dairy producers and agency staff on technology processes and value-added products. As a result of the conference, the only small-scale operator in Wisconsin has begun to make changes to his operation, and a second producer is installing a small-scale digester. Since the conference, Larson and colleagues are addressing areas that require attention for small-scale adoption through small-scale anaerobic digester research at the Institute for Environmentally Integrated Dairy Management at the UW-Madison Marshfield Agricultural Research Station.

Increased efficiencies can decrease system size, increase biogas production and the value of asset streams to produce an economically viable option reducing costs and increasing revenues for smaller operations. Separated liquids can be land applied as fertilizer, improving nutrient management. Solids are used on-farm as bedding or sold as a value-added product. With detailed herd management, milk quality and pathogen data, best practice recommendations can improve herd health in dairies using recovered manure solids as bedding.

Crawford County agriculture agent Vance Haugen has worked around the globe helping very small producers (1 to 150 cows) construct affordable ultra small-scale digesters. When his neighbors read about his global work, they asked for the same for Western Wisconsin. In 2012, Haugen provided an overview of biogas production, physical properties of animal manure as it relates to biogas production, practical examples of low-cost production methods for small-scale biogas digesters from India, China, Nicaragua, Cuba, Vietnam, the Philippines and the United States, and small-scale digester designs for the Midwest - reaching 85 U.S. National Guard troops attending the Babcock Agriculture 101 session at the Arlington Agricultural Research Station and 34 attendees of the Oneida Bioenergy Update at the Oneida Tribal Headquarters. The Wisconsin National Guard troops have constructed a small-scale biodigester, and the Oneida Nation Bioenergy Committee continues to gather information for theirs. Haugen's biogas introduction resources are housed with others on the Wisconsin Chapter of the American Society of Farm Managers and Rural Appraisers web site: <http://www.wcasfmra.org/biogas.htm>

## **V(I). Planned Program (Evaluation Studies)**

### **Evaluation Results**

{No Data Entered}

### **Key Items of Evaluation**

{No Data Entered}