

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
131	Alternative Uses of Land	0%		10%	
401	Structures, Facilities, and General Purpose Farm Supplies	5%		10%	
402	Engineering Systems and Equipment	5%		10%	
501	New and Improved Food Processing Technologies	5%		0%	
511	New and Improved Non-Food Products and Processes	5%		40%	
601	Economics of Agricultural Production and Farm Management	0%		10%	
605	Natural Resource and Environmental Economics	80%		10%	
610	Domestic Policy Analysis	0%		10%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	36.7	0.0
Actual Paid Professional	16.2	0.0	50.3	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
273725	0	267560	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
1927991	0	2112500	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
1466096	0	5452157	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

MAES. Research in this program area in 2013 showed results on several fronts. Research is providing a better understanding of the trade-offs and intersections of this opportunities of sustainable energy with agricultural productivity and environmental health. The promise of various crops for their use as biofuel is being tempered by a better understanding of the complexity of natural systems, and competition from various sources of energy. Biofuel production and use affects and is affected by climate change, air quality, water quality, biodiversity and many other environmental factors. Increasing understanding of these multiple factors is also providing convincing evidence that research has a significant role to play in helping to assure Minnesota's energy health and sustainability. Among the results and impacts of MAES supported research in sustainable energy in 2013:

- An analysis of federal expectations for achieving renewable fuel standards by 2022 revealed large implications for Minnesota agriculture. For example, the analysis showed the USDA projects Minnesota will produce 750,000 to 1 million acres of grasses in 2022, while the DOE and EPA project none. Evaluating external scenarios from federal agencies helps in developing realistic scenarios of bioenergy landscapes. Researchers used an input and risk assessment model to current bioenergy production data and tested the model in Southern Minnesota.
- A project on producing hydrogen from co-fermenting molasses with liquid swine manure in an anaerobic sequencing batch reactor confirmed the feasibility of producing biohydrogen from the two waste streams through fermentation.
- There is an urgent need to create ways to transform lignins produced in biorefineries into a range of useful materials, particularly versatile thermoplastics. MAES supported bioengineering researchers have made progress in identifying promising genes identified by comparing white and brown rot fungal secretomes in host organisms, and evaluating the resulting enzymes.
- Other research to increase the value of biomass through converting forest or crop residues into industrial products, has developed processes for thermal plasticization of wood waste into self-reinforced composites, without the need to add synthetic polymer binders.
- Biomass derived oils show promise as a renewable substitute for fossil fuels, if the quality of the oil could be improved. Researchers developed a lab device and processes that improved the heating value of biomass oils, reduced oxygen and nitrogen content, and removed pigments from the oils. Further work also showed that bio-oils could be renewable sources for making rigid polyurethane foams.
- As we reported here last year, progress on the use of biomass into acrylic technologies led to a patent application on a new technology entitled. "Pressure-Sensitive Adhesives having High Bio-Mass Content and Macromonomers for Preparing the Same." Researchers are now close to having a new patentable biomass technology for sealant and adhesive applications.
- Research on the use of byproducts from ethanol production for use in livestock feed has been

ongoing for several years, and these results reported in previous years. As a result of this research, poultry and swine producers have been using dried distiller's grains, a byproduct of corn processing for ethanol in their feed to lower feed costs. Nutrient studies have confirmed the feed additive's utility. However, a problem of manure foam fires at swine farms has raised the possibility that the foam could be related to the animals' diet. Researchers have found that the distillers grains contain high levels of fatty acids that pass through the pigs' digestive system and help form bubbles in the manure that causes the foam. Researchers have been collaborating with agricultural engineers at several universities to understand the effects of dietary components on manure foaming and biogas production and have learned that fiber type and size, as well as lipid composition of the manure appear to be significant risk factors.

- Perennial crops are being investigated as a bioindustrial feedstock because of their environmental and ecological benefits. Researchers have found that prairie cordgrass and a polyculture planting were the highest producing herbaceous crops in an alley cropping configuration. A management information system is being developed for storing and analyzing crop productivity in alley-cropping as well as monoculture biomass systems.
- We reported last year that researchers showed that ventilation fans in swine buildings cooled with a geothermal system reduced energy use compared to non-cooled rooms. They have now received funding to install and test the geothermal system at a commercial swine operation.

Extension. Sustainable Energy programming from U of M Extension is primarily carried out through the Clean Energy Resource Team (CERTs). CERTs is the clean energy program of the Regional Sustainable Development Partnerships. CERTs is a statewide partnership with a shared mission to connect individuals and their communities to the resources they need to identify and implement community-based clean energy projects.

In 2013, the CERTs team conducted campaigns, programs, and events that supported clean energy goals. The teams partnered with others for the "Recycle Your Holidays" campaign to encourage use of LED holiday lights, through which 163,000 pounds of electrical cordage from holiday lights were collected and recycled. In September of 2013, CERTs completed a campaign to get energy and water-efficient pre-rinse spray valves, faucet aerators and shower heads operational in organizations and homes across Minnesota. CERTs hosted its biennial conference in February of 2013 where nearly 500 Minnesotans from residential, business, school, government and farm sectors came together to discuss and work on renewable energy and energy efficiency issues and projects. Of the 53 seed projects CERTs funded in 2012, 26 were completed in 2013. Of these, 11 implemented clean energy by incorporating renewable energy, energy efficiency or both. Six performed research and eight conducted education and outreach. Finally, CERTs funded over \$132,500 to 34 new seed grants to projects across the state. Work on these projects will be completed in 2014.

2. Brief description of the target audience

Extension programming through Clean Energy Resource Teams is delivered in seven regions spanning the entire state of Minnesota. CERTs empowers communities and their members to adopt energy conservation, energy efficiency and renewable energy technologies for their homes, businesses and local institutions. Types of communities that CERTs works with include, but are not limited to, businesses, civic organizations, economic developers, faith groups, farmers, local governments, residents and neighborhoods, schools, and utilities.

MAES target audiences include all of those, and also forest products industry, academic

researchers including bio-engineering and forestry researchers, and energy and land use economists. Also, agriculture and natural resources industry representatives, biotechnology company representatives, policymakers, state and federal agency representatives, private citizens, and new energy entrepreneurs.

3. How was eXtension used?

Although CERTS has not submitted materials to be shared on the eXtension portal, it has been a useful resource when trying to find examples of energy efforts from other Extension programs.

V(E). Planned Program (Outputs)

1. Standard output measures

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	26626	67393	2464	0

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

Patent Applications Submitted

Year: 2013
 Actual: 1

Patents listed

8,394,618--Lipase Containing Polymeric Coatings

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	1	29	30

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Workshops and consultation will provide unbiased information to the target audiences.

Year	Actual
2013	56

Output #2

Output Measure

- Number of stakeholders participating in programs on production, harvesting or storage systems that adopted BMPs for production, harvesting or storage systems.

Year	Actual
2013	0

Output #3

Output Measure

- Number of stakeholders participating in programs on production, harvesting or storage systems that adopted BMPs for production, harvesting or storage systems.

Year	Actual
2013	0

Output #4

Output Measure

- Dollar amount of seed grants awarded in 2012.

Year	Actual
2013	132500

Output #5

Output Measure

- Number of CERTs newsletter / list serve subscribers.

Year	Actual
2013	11020

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Research will provide information on new uses for ethanol byproducts.
2	Research will provide information on technologies for use of on-farm energy sources.
3	Research will provide better understanding of the economic impact and environmental trade-offs of renewable energy sources.
4	Number of new business systems created to provide new industry growth.
5	Measure of biofuels (gallon / acre).
6	Measure of BTUs/acre produced in energy production.
7	Number of new production or logistic practices developed.
8	Research will increase knowledge and understanding of the biofuels supply chain. (Measure: Numbe of new production/logistics practice developed)
9	Average percentage of participants of workshops and users of developed decision-making reports who report that they were able to make informed decisions about sustainable energy production and use.
10	Activities will contribute to quantifiable annual energy savings, either through energy efficiency and conservation efforts or by offsetting current energy sources through the use of renewable energy. (Target expressed is the total number of million BTUs saved as a result of CERTs activities this year.)
11	CERTs research will inform state efforts to achieve energy conservation and efficiency goals. (Target expressed as number of state projects with impact.)

Outcome #1

1. Outcome Measures

Research will provide information on new uses for ethanol byproducts.

Not Reporting on this Outcome Measure

Outcome #2

1. Outcome Measures

Research will provide information on technologies for use of on-farm energy sources.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Fertilizer accounts for roughly 14 percent of the carbon footprint of corn production. If fertilizer can be produced in a renewable way, it would be good for the environment, and good for farmers.

What has been done

In the summer of 2013, the U of M's West Central Research and Outreach Center officially launched a process believed to be one-of-a-kind, which takes the energy from wind, converts it to hydrogen, and then to ammonia that can be used as fertilizer on surrounding farmlands. Making fertilizer from wind has been on the center's agenda since before 2005, when the first 1.65 megawatt wind turbine was installed at the center. Annually, the center will produce about 25 tons of fertilizer and sell it to farmers via local area co-ops. Researchers are using life-cycle analysis models to evaluate exactly how much fossil fuel can be saved by using the system.

Results

Members of the World Wildlife Fund, which is working with companies like General Mills and Coca-Cola that are responding to consumer demand for sustainable products, recently visited the

center. A growing field to market movement within agriculture and the food sector is working toward sustainability throughout the food chain. A plant like this could produce enough fertilizer for a group of farms or a small-town cooperative.

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment
601	Economics of Agricultural Production and Farm Management

Outcome #3

1. Outcome Measures

Research will provide better understanding of the economic impact and environmental trade-offs of renewable energy sources.

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Number of new business systems created to provide new industry growth.

Not Reporting on this Outcome Measure

Outcome #5

1. Outcome Measures

Measure of biofuels (gallon / acre).

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Measure of BTUs/acre produced in energy production.

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

Number of new production or logistic practices developed.

Not Reporting on this Outcome Measure

Outcome #8

1. Outcome Measures

Research will increase knowledge and understanding of the biofuels supply chain. (Measure: Numbe of new production/logistics practice developed)

Not Reporting on this Outcome Measure

Outcome #9

1. Outcome Measures

Average percentage of participants of workshops and users of developed decision-making reports who report that they were able to make informed decisions about sustainable energy production and use.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	72

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The Clean Energy Resource Teams help Minnesota communities advance clean energy projects by hosting educational forums, workshops and tours. These events aim to: 1) educate target audiences about specific topics; 2) provide venues for networking and sharing stories (both successes and failures); and, 3) provide opportunities for a hands-on look at clean energy technologies and projects.

What has been done

CERTs hosted or presented at 56 events in 2013, reaching farmers, small businesses, residents, local units of governments and utilities. Events included educational content about topics ranging from efficient lighting, to biomass energy, major mechanical upgrades, solar energy, and actions that Minnesotans can take to advance clean energy.

Results

Surveys evaluated the success of each CERTs event. Of the 56 events, three were intensely assessed to determine how attendee's knowledge changed as a result of the event. At the 2013 CERTs conference, 70 percent of survey respondents reported they left the conference with clean energy project ideas they would put to use. At the Utility Forum, 77 percent of respondents attending the six topic sessions at the forum felt they understood topics more after the event than before, or found topics to be "useful" or "very useful." Among farmers and utility representatives attending Poultry Field Day, each of the survey respondents reported they understood LED lighting for poultry applications more after the event than before.

4. Associated Knowledge Areas

KA Code	Knowledge Area
401	Structures, Facilities, and General Purpose Farm Supplies
605	Natural Resource and Environmental Economics

Outcome #10

1. Outcome Measures

Activities will contribute to quantifiable annual energy savings, either through energy efficiency and conservation efforts or by offsetting current energy sources through the use of renewable energy. (Target expressed is the total number of million BTUs saved as a result of CERTs activities this year.)

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	20415

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Minnesota's energy supply is not as clean efficient, reliable and affordable as it could be. Minnesotans spent \$16 billion and consumed a total of 1,852.2 trillion BTUs of energy (electricity, natural gas, petroleum products, coal and biomass) in 2010 to supply energy needs.

spreads across four main sectors: Transportation (26 percent total use covering planes, trains, buses, automobiles), residential (23 percent total use), commercial (19 percent total use) and industrial (32 percent total use).

What has been done

CERTs works with Minnesota communities to connect them to resources, research-based information, and networks that advance clean energy projects. The goal is to help Minnesota meet its energy efficiency and renewable energy goals, many of which were signed into law in 2007 as Minnesota's Next Generation Energy Act. The law requires Minnesota utilities to produce 25 percent of energy using renewable resources by the year 2025, and established a statewide energy conservation goal of 1.5 percent of annual retail electric and gas sales each year.

Results

CERTs quantifies the total BTUs of energy saved annually through its campaigns, technical assistance, utility support and seed grants. The total is 20.4 billion BTUs in annual energy savings. Among these efforts, 4.6 billion BTUs were saved by upgrading to LED holiday lighting during the recycling campaign. Seed Grant Programs saved 1.6 billion BTUs by funding local energy efficiency and renewable energy projects. Twelve poultry producers are saving 1.2 billion BTUs of energy by retrofitting barns with LED lighting. CERTs assistance to utilities' conservation programming resulted in 2.6 billion BTUs of energy savings. A program offering a discount price for spray valves, faucet aerators and shower heads in commercial and institutional settings saved 8.5 billion BTUs.

4. Associated Knowledge Areas

KA Code	Knowledge Area
401	Structures, Facilities, and General Purpose Farm Supplies
402	Engineering Systems and Equipment
501	New and Improved Food Processing Technologies
511	New and Improved Non-Food Products and Processes
605	Natural Resource and Environmental Economics

Outcome #11

1. Outcome Measures

CERTs research will inform state efforts to achieve energy conservation and efficiency goals. (Target expressed as number of state projects with impact.)

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2013	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The Minnesota Department of Commerce, Division of Energy Resources Staff is committed to increasing energy literacy throughout the state of Minnesota. Raising awareness of energy efficiency best practices and energy source options increases the likelihood that Minnesotans will adopt those practices and options. Adoption helps the state meet its energy efficiency goal of saving 1.5 percent of annual retail electric and gas sales each year and its renewable energy goal of producing 25 percent the year 2025.

What has been done

The Minnesota State Fair -- "The Great Minnesota Get Together" -- welcomes over 1.7 million people each year. The Minnesota Department of Commerce staff makes a point to have a big presence at the state fair in order to increase energy literacy in Minnesota. Exhibits on home heating, windows, lighting and more educate Minnesotans on the energy issues of their homes.

Results

CERTs assisted the Minnesota Department of Commerce staff as they prepared for lighting displays at the fair. CERTs used behavior change science to influence the layout of, as well as the information included in the lighting display. CERTs also gained an understanding of issues around choosing energy efficient lighting through the development of the CERTs Right Light Guide. From this research, CERTs developed a set of Frequently Asked Questions around efficient household lighting. Lastly, CERTs provided training to the Minnesota Department of Commerce staff on effective communication strategies (again, applying behavior change science concepts). The Right Light Guide, Lighting FAQs and the communication strategies served as invaluable references for staff to use while talking to the public at the state fair.

4. Associated Knowledge Areas

KA Code	Knowledge Area
401	Structures, Facilities, and General Purpose Farm Supplies
402	Engineering Systems and Equipment
605	Natural Resource and Environmental Economics

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Other (New swine facility problem use required new research)

Brief Explanation

MAES has been working for several years on the use of dried distillers' grains, a

byproduct of ethanol production, as an additive in animal feed. This research has provided ethanol producers with a use for this byproduct and lowering feed costs for animal producers. Several nutrition studies have proven its effectiveness as a feed additive. However, the new phenomenon of pig manure pit explosions has led to the need to redirect that research towards determining if distillers' grains could be implicated. As a result, we are not reporting under the outcome: "Research will provide new uses for ethanol." The results of this new research is summarized under "Activities."

V(I). Planned Program (Evaluation Studies)

Evaluation Results

As noted earlier, the overriding charge of CERTs is to help Minnesota meet its energy efficiency and renewable energy goals by connecting communities with the resources they need to identify and implement energy efficiency and renewable energy projects. The metrics of effectiveness employed by the CERTs team considers the efficacy of the educational outreach, as well as the efficacy of programs to meet energy efficiency and renewable goals. Surveys and observations examine whether program participants take action to change their energy sources or decrease their energy use. Using information about the effectiveness of such campaigns, the team has established a way to quantify the annual energy savings in BTUs.

Campaigns, educational programming, technical assistance, utility support and seed grants have resulted in actions that have saved 20.4 billion BTUs annually."

Key Items of Evaluation

Campaigns, educational programming, technical assistance, utility support and seed grants have resulted in actions that have saved 20.4 billion BTUs annually."