

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

**Program # 7**

**1. Name of the Planned Program**

Sustainable Energy

**V(B). Program Knowledge Area(s)**

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
123	Management and Sustainability of Forest Resources	20%		25%	
125	Agroforestry	20%		0%	
131	Alternative Uses of Land	20%		0%	
205	Plant Management Systems	40%		25%	
511	New and Improved Non-Food Products and Processes	0%		50%	
	<b>Total</b>	100%		100%	

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

1. Actual amount of FTE/SYs expended this Program

Year: 2011	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	2.0	0.0
Actual Paid Professional	0.6	0.0	2.1	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
15657	0	165020	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
18051	0	220193	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
106786	0	534000	0

**V(D). Planned Program (Activity)**

**1. Brief description of the Activity**

AFES researchers will concentrate primarily on yield potential of lignocellulosic crops as well as evaluate oilseed crops as bioenergy crops in Alaska. If successful, this research will lead to development of "best practices" management regimes and genetics of bioenergy crops. In the future, we intend to conduct research in remote locations in Alaska to determine the feasibility of various crops in small villages where people often have little experience in agriculture. For this purpose, we will concentrate on crops likely to be successful in these situations, especially woody crops, which will require little agricultural knowledge and simple technology.

AFES researchers are continuing to work on the utilization of low value biomass for fuels and chemicals, mostly through thermochemical means (gasification, pyrolysis, supercritical fluids). The chemical composition of alder, birch, hemlock, yellow cedar, Sitka spruce, red cedar, white spruce, and aspen will be evaluated for biofuel production via supercritical liquefaction. CES is working with communities on use of biomass products and with producers to develop value added forest products.

AFES researchers will seek to assimilate all existing information on the total forest and crop biomass available in Alaska into one database, determine the gaps in the database and the information needed to fill the gaps, and determine the biological, physical, and economic feasibility of using Alaska biomass as biofuels.

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

The target audiences include producers and consumers, communities, agriculture and forestry businesses, industry leaders, entrepreneurs, individuals and groups concerned about the quality of the Alaska environment, public resource agencies, public and private resource managers, other faculty and researchers, and undergraduate and graduate students. Our efforts will be directed toward environmentally and economically sustainable development and conservation of our natural resources that will benefit all citizens and help them adapt and become resilient as the climate changes. Advisors and the target audience include: Statewide Board of Advisors, Society of American Foresters, Alaska Farm Bureau, and the Alaska Northern Forest Cooperative. Specifically, this program will provide new information on soil properties and classification to the USDA natural Resource Conservation Service, the USDA Forest Service, the Alaska Department of Natural Resources, borough governments, and Alaska Native Corporations. Information on impact of fires on soil organic matter will assist the Department of Natural Resource's Division of Forestry and private land owners and managers.

**3. How was eXtension used?**

eXtension was not used in this program

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

**1. Standard output measures**

2011	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
<b>Actual</b>	166	20946	157	1100

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

**Patent Applications Submitted**

Year: 2011  
 Actual: 0

**Patents listed**

**3. Publications (Standard General Output Measure)**

**Number of Peer Reviewed Publications**

2011	Extension	Research	Total
Actual	2	5	7

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

**Output Target**

**Output #1**

**Output Measure**

- Workshops, demonstrations, short courses, classes, field days, and conferences organized and conducted.

Year	Actual
2011	15

**Output #2**

**Output Measure**

- Bioenergy crop varieties tested.

Year	Actual
2011	5

**Output #3**

**Output Measure**

- Bioenergy research projects conducted.

Year	Actual
2011	10

**Output #4**

**Output Measure**

- Bioenergy crop and technology publications.

<b>Year</b>	<b>Actual</b>
2011	7

**Output #5**

**Output Measure**

- Community, organizations, and one-on-one consultation concerning bio-based energy opportunities.

<b>Year</b>	<b>Actual</b>
2011	29

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

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

O. No.	OUTCOME NAME
1	Identify crops suitable for sustainable production of bio-based energy in Alaska.
2	Identify new value-added uses for by-product from bio-based energy crops and woody species.

## **Outcome #1**

### **1. Outcome Measures**

Identify crops suitable for sustainable production of bio-based energy in Alaska.

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

- 1862 Research

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

Change in Knowledge Outcome Measure

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

<b>Year</b>	<b>Actual</b>
2011	0

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

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

Sustainable energy work in CES and AFES endeavors to provide research, education and outreach for existing or potentially new small businesses in the wood product field. Research for alternatives to fossil fuels is urgent. Energy costs in most rural communities in Alaska are prohibitively expensive necessitating heart-wrenching choices between food and warmth. We are moving forward with research in biofuels and biomass with the goal to offset some of these high-energy costs.

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

In three locations grass and woody species plots have been established: Fairbanks, Palmer and Delta Junction. Production of bio-oil was successfully completed and chemical analysis has been performed. Aspects of bio-oil quality (HHV, pH, GCMS and CHN) have been generated. The gasification work with alder has been completed, with this information serving as a baseline for a joint venture agreement with USDA ARS to introduce fish wastes to the alder. The quality of syngas was not sufficiently clean to maintain generator operations. The wood fired refrigerator was built as a class project for the mechanical engineering students of the University of Alaska Anchorage. The refrigerator was tested and evaluated for operations using gasification gas, and it performed very well for refrigeration but not as well for freezing.

#### **Results**

Grass species evaluated were smooth brome grass, hairgrass, wheatgrass, tufted hairgrass, slender wheatgrass, Siberian wildrye, and reed canarygrass. Woody species evaluated were *Salix alaxensis*, *Populus balsamifera*, *S. alaxensis*. Novel processing of native small diameter biomass by pyrolysis and gasification is helping guide the continuous development of second-generation technologies focused on undervalued wood resources in Alaska, with the broader impacts affecting the nation as a whole. This research is key to addressing fundamental questions with regards to uses of AK biomass in nontraditional value added products using small-

diameter trees. The study and demonstration of wood in refrigeration applications has significant importance for Alaska, as a high percentage of the rural population relies on subsistence fishing, hunting and gathering during the brief summer months.

#### 4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
125	Agroforestry
205	Plant Management Systems
511	New and Improved Non-Food Products and Processes

#### Outcome #2

##### 1. Outcome Measures

Identify new value-added uses for by-product from bio-based energy crops and woody species.

##### 2. Associated Institution Types

- 1862 Extension
- 1862 Research

##### 3a. Outcome Type:

Change in Knowledge Outcome Measure

##### 3b. Quantitative Outcome

Year	Actual
2011	4

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

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

Forest lands, in Alaska, are an abundant yet underutilized natural resource. Forest inventory data indicates the state has 24.9 million acres of forested land. Of these, 4.3 million are considered commercial forests capable of growing 20 cubic feet per acre per year. With the closing of the large pulp mills in the 80's and 90's, a rebuilding effort was initiated to transition the state to a more stable economic base within the forest products industry.

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

Upgrading Pyrolytic Bio-oil with zeolite catalysts: Production of bio-oil was successfully carried out. Wood-Plastic Composites from Low-value Alaskan Biomass and Blends of Recycled Thermoplastics: Rheological behavior of blended recycled polymers (polyethylene and polypropylene) and wood flour produced from fire-killed black spruce were examined to assist with determining WPC extrusion processing parameters. Thermal transitions of polymers and

thermal degradation of wood flour were evaluated. Using design of experiments (DOE) several WPC formulations (varying plastic blends) were extruded using 35mm twin-screw extruder. Physical and mechanical properties of WPCs of different formulations were evaluated and meet the current industry expectations (industry currently uses mixed pine wood flour).

### **Results**

Novel processing of native small-diameter biomass by pyrolysis and gasification is helping guide the continuous development of second-generation technologies focused on undervalued wood resources in Alaska, with the broader impacts affecting the nation as a whole. This research, in particular from small-diameter trees, is addressing fundamental questions with regards to uses of AK biomass in non-traditional value added products. Wood-Plastic Composites from Low-value Alaskan Biomass and Blends of Recycled Thermoplastics: Research has demonstrated the potential for utilizing low-value fire-killed black spruce wood flour for production of commercially viable wood-plastic composites in Alaska.

## **4. Associated Knowledge Areas**

<b>KA Code</b>	<b>Knowledge Area</b>
123	Management and Sustainability of Forest Resources
125	Agroforestry
131	Alternative Uses of Land
205	Plant Management Systems

## **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.)

### **Brief Explanation**

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

### **Evaluation Results**

Two main research projects are underway. The first is developing a database of the chemical composition of timber forest biomass and nontimber forest product species in representative locations across the State of Alaska, and the development of a biofuels agenda in first and second generation technology with a focus on space heating and raw chemical feedstock production. The second is evaluating Alaska grown lignocellulosic crops and oilseed crops as a source for biomass. Evaluation conducted at the basic and applied

research phase involves comparison of baseline data and testing of the pyrolysis unit.

**Key Items of Evaluation**