V(A). Planned Program (Summary)

Program # 1

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
133	Pollution Prevention and Mitigation			10%	
402	Engineering Systems and Equipment			35%	
511	New and Improved Non-Food Products and Processes			55%	
	Total			100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2012	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	3.0	0.0
Actual Paid Professional	0.0	0.0	6.4	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**
0	0	124941	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
0	0	867447	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
0	0	387389	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

In summary:
- Conduct Research Experiments
- Develop models and simulation tools
- Develop new culture strains and metabolic engineering tools
- Develop Products, Resources.
- Conduct surveys
- Conduct data analyses
- Conduct workshops
- Provide Training.
- Assessments.
- Partnering.

2. Brief description of the target audience

The target audiences for this research are :

public sector
private sector
economists
policy makers
agricultural biotechnology firms
farmers
bioenergy and biofuel producers
industrial manufacturers of hydrogen and fuel cells

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	0	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	0	5	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- OTHER SCHOLARLY EXCELLENCE: participation on professional boards and panels, as well as science panels, awards, etc.

Year	Actual
2012	0

Output #2

Output Measure

- IMPROVED BIOPRODUCT PRODUCTION SYSTEMS . . . Indicators: 1-Improved technologies and production systems for biofuel and bioenergy (solar energy capture, fermentation, sensors); 2-Improved feedstocks (microbial, algal, agricultural byproducts, invasive species, cellulosic)

Year	Actual
2012	0

Output #3

Output Measure

- TECHNOLOGY, MODELS AND ANALYSES THAT INFORM DECISION-MAKERS, INDUSTRY, AND PEERS REGARDING AGRICULTURAL PRODUCTION: Indicators: 1- theoretical and computation tools (both parametric and non-parametric); 2-determinants of innovation in agricultural biotechnology

Year	Actual
2012	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	K1...Improved knowledge about composition and conversion of feedstocks for biofuels, bioenergy, and co-products a) enhance use of existing varieties of algae, other micro-organisms, cellulosics, agricultural residues, and invasive species for bio-energy and coproducts b) new feedstock sources, extraction technologies, and co-products c) more acreages and tonnage of feedstocks used
2	K2 ... Improved engineering applications to advance production systems for bioenergy a) biomimetic models to create biobased generators to produce molecular H2 and O2 from water and light, with these generators incorporated into integrated H2 energy systems, providing generation, storage, and utilization of H2 in one unit. b) optimize the photobiological process to yield higher energy efficiencies. c) demonstrate that waste biomass, such animal wastes and organic component of urban wastewater, used as feedstock can not only yield biohydrogen, but that waste can be reduced.
3	K3 ... Models developed to look at biofuel and bioenergy productivity, technological processes, sustainability, and supply chain a) decision tools, economic and life cycle analyses, productivity analyses b) new technologies c) feedstock logistics d) resource inputs, outputs and quality e) land use change f) biodiversity
4	A1...Enhanced or improved bioeconomy a) number of new jobs b) increased revenue c) gallons of biofuels produced or consumed, gallons of fossil fuel displaced
5	A2-Implement sustainable biofuel supply chain a) acres or tons of feedstocks produced, numbers of farms involved in feedstock production b) number of technologies developed c) distributed conversion and processing

Outcome #1

1. Outcome Measures

K1...Improved knowledge about composition and conversion of feedstocks for biofuels, bioenergy, and co-products a) enhance use of existing varieties of algae, other micro-organisms, cellulosics, agricultural residues, and invasive species for bio-energy and coproducts b) new feedstock sources, extraction technologies, and co-products c) more acreages and tonnage of feedstocks used

2. Associated Institution Types

- 1862 Research

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)
Understanding better the role and physiology of nitrifying bacteria in the flow of nitrogen through the Nitrogen Cycle might result in significant reductions in energy required for nitrogen inputs into agriculture or for treatment of societal effluent. Understanding N transformation in unmanaged ecosystems, in wastewater treatment, and in soils amended with ammonia-based fertilizers, requires the thorough characterization of these organisms, singly, and while in the coupled two-step process.

What has been done
Constraints based models were built using a 2001 literature study as a framework. This study provided MFA and energetic models for hypothetical autotrophic nitrifiers with approximately 100 reactions and was done prior to the availability of published sequences for Nitrosomonas and Nitrobacter spp. The models will be updated to reflect current knowledge, with the final number of reactions being on the same order as the original models.

Results
To date, a metabolic reconstruction of N. europaea has been developed in this new effort. A reconstruction of N. hamburgensis is currently being developed using standard techniques. Both metabolic reconstruction models will be used to update the metabolic map provided by the 2001 .

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation

402	Engineering Systems and Equipment
511	New and Improved Non-Food Products and Processes

Outcome #2

1. Outcome Measures

K2 ... Improved engineering applications to advance production systems for bioenergy a) biomimetic models to create biobased generators to produce molecular H2 and O2 from water and light, with these generators incorporated into integrated H2 energy systems, providing generation, storage, and utilization of H2 in one unit. b) optimize the photobiological process to yield higher energy efficiencies. c) demonstrate that waste biomass, such animal wastes and organic component of urban wastewater, used as feedstock can not only yield biohydrogen, but that waste can be reduced.

2. Associated Institution Types

- 1862 Research

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)
We are working to reduce the required external energy input for buildings through point source production of biological hydrogen from encapsulated cyanobacteria hung in sheets on building exteriors to capture sunlight energy.

What has been done
Microarray analyses were conducted to evaluate gene expression based on gel composition of cell encapsulating media. Chlorophyll fluorescence was used to explore the response of wild-type Synechocystis sp. PCC 6803 to short term (2 minute) exposure to, and 24-hour recovery from, common compounds present in biological encapsulation. Cultures of three photoantennae mutants were conditioned in nitrogen- and sulfur-starved media to assess glycogen accumulation, which is required for fermentative hydrogen production. We chose to examine photoantennae mutants because it is known that phototrophs with truncated photoantennae become saturated at higher light intensities compared to wild-type organisms. For a culture as a whole, they may use incident light more efficiently.

Results
Our results also showed that diffusion through the silica gels is adequate to support viable cells of Synechocystis sp. PCC 6803 for six weeks or more. The ultimate longevity of encapsulated

Synechocystis sp. PCC 6803 cells is not yet known. To our knowledge, this is the first investigation to demonstrate improved hydrogen production from a mutant. Furthermore, we have refined encapsulation protocols to improve encapsulation in gels derived from aqueous precursors, which we have shown to be advantageous for hydrogen production compared to alkoxide gels. We have confirmed our initial hypothesis that, done properly, encapsulation can significantly enhance hydrogen production.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
402	Engineering Systems and Equipment
511	New and Improved Non-Food Products and Processes

Outcome #3

1. Outcome Measures

K3 ... Models developed to look at biofuel and bioenergy productivity, technological processes, sustainability, and supply chain a) decision tools, economic and life cycle analyses, productivity analyses b) new technologies c) feedstock logistics d) resource inputs, outputs and quality e) land use change f) biodiversity

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

A1...Enhanced or improved bioeconomy a) number of new jobs b) increased revenue c) gallons of biofuels produced or consumed, gallons of fossil fuel displaced

Not Reporting on this Outcome Measure

Outcome #5

1. Outcome Measures

A2-Implement sustainable biofuel supply chain a) acres or tons of feedstocks produced, numbers of farms involved in feedstock production b) number of technologies developed c) distributed conversion and processing

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Energy and water are two critical issues that have to be addressed for sustainable development of the world. In addition, food vs. fuel issues, intensive use of agricultural inputs and uncertain long term ecosystem effects of first generation biofuels have led to research in second and third generation biofuels such as cellulosic ethanol and algal biofuels. To be economically viable there is a need for bioprocess technologies that are efficient and environmentally benign. Development of technologies within a sustainability framework necessitates systemic approach for utilization of renewable bioresources.

What has been done
To achieve a sustainable biobased economy, it is important to study different technologies at multiple scales. Hence, we employ a combination of experimental and theoretical approaches using control theory, systems biology, process modeling and life cycle analysis techniques to conduct molecular, cellular, industrial scale and systems level analyses. To communicate our research, we developed the website (http://stl.bee.oregonstate.edu/index.htm) for the Sustainable Technologies Laboratory. The website includes information about vision, current projects, publications, learning resources, links to course websites and members of laboratory.

Results
A patented Dynamic Controller technology resulted in direct savings of $130,000 in savings per year for a pilot 40 mgpy commercial trial without affecting the process performance. Initial investment to modify existing plants to use the current technology was under $15,000. After the successful trial, the technology licensor, World Wide Bioenergy, partnered with Trident Technologies, a control systems company that develops control systems for commercial dry grind corn ethanol plants. The software developed by Dr. Ganti Murthy was integrated into a commercial package and installed in a 40 mgpy ethanol plant in Iowa. The technology transfer was complete as the licensee and their technology partner installed the dynamic controller and tested successfully in the plant.

4. Associated Knowledge Areas

KA Code	Knowledge Area
402	Engineering Systems and Equipment
511	New and Improved Non-Food Products and Processes

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

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Formative evaluations are still underway, but we expect that the nexus of water and energy will form the focus of this program area.

Key Items of Evaluation

the interplay of bioenergy and water
life cycle analysis