BS Renewable Energy Engineering

2015-16 Assessment Report

Teshome Jiru

Electrical Engineering and Renewable Energy Department

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1 Introduction

1.1 Program Design and Goals

The Bachelor of Science in Renewable Energy Engineering (BSREE) program at Oregon Institute of Technology (Oregon Tech) has been designed to provide interdisciplinary education in mechanical, electrical, and chemical engineering topics as they apply to renewable energy. Students take coursework in communications, natural sciences, mathematics, and the humanities and social sciences to support their engineering coursework.

The BSREE program goal is to provide graduates for careers in areas of renewable energy engineering such as but not limited to: solar, solar thermal, wind power, wave power, geothermal energy, transportation, energy storage, hydroelectric and traditional energy fields such as power systems, smart grid, energy management, energy auditing, energy systems planning, energy economics, energy policy and development, carbon accounting and reduction, and controls and instrumentation. BSREE graduates will enter renewable energy engineering careers as design, site analysis, product, application, test, quality control, and sales engineers.

1.2 Program History

In 2005, the Oregon Institute of Technology (Oregon Tech) began offering its new Bachelor of Science degree in Renewable Energy Systems (BSRES) program at its satellite campus in Portland, Oregon. The BSRES degree was the first of its kind in North America, and it was created to prepare graduates for careers in various fields associated with renewable energy. These included, but were not limited to, energy management, energy auditing, energy systems planning, energy economics, energy policy and development, carbon accounting and reduction, and energy-related research, as stated in Oregon Tech's 2005-06 catalogue.

In 2008, however, the BSRES degree was discontinued and replaced by the Bachelor of Science degree in Renewable Energy Engineering (BSREE). Analysis of the market place and observed growth in career options across the renewable energy fields revealed significant opportunities for graduates with a solid energy engineering education. By design, the original BSRES program was built atop a firm engineering foundation, and the curriculum could generally be described as near engineering-level. But the title of the degree, Renewable Energy Systems, a dearth of 300-level mathematics coursework and the absence of several key engineering fundamentals courses prevented the degree from being considered a full engineering degree program, particularly one that could be accredited as by the Engineering Accreditation Commission of ABET, Inc. By stating engineering as a principle programmatic focus, the career potential for graduates expanded beyond those previously stated to also include engineering-related career paths such as electrochemical systems engineering, energy systems design engineering, building systems engineering and modeling, hydronics engineering, power electronics engineering, HVAC engineering, and power systems engineering.

BSREE graduates enter energy engineering careers as power engineers, PV/semiconductor processing engineers, facilities and energy managers, energy system integration engineers, HVAC and hydronics engineers, design and modeling engineers for net-zero energy buildings, LEED accredited professionals (AP), biofuels plant and operations engineers, energy systems control engineers, power electronics engineers, utility program managers, as well as renewable energy planners and policy makers. Graduates of the program will be able to pursue a wide range of career opportunities, not only within the emerging fields of renewable energy, but within more traditional areas of energy engineering as well. Without a mechanism for obtaining professional licensure, these graduates would either not be able to advance in their careers or they would not find employment in these

fields to begin with. Our survey of the renewable energy industry cluster in the Pacific Northwest convinced us that an engineering degree, the BSREE degree, was the only suitable option for our students.

1.3 Industry Relationships

The BSREE program has strong relationships with industry, particularly through its program-level Industry Advisory Council (IAC) and REE alumni. The IAC has been instrumental in the success of the BSREE program. Representatives from corporations, government institutions and non-profit organizations comprise the IAC, giving the BSREE a broad constituent audience. The IAC provides advice and counsel to the REE program with respect to the areas of curriculum content advisement, instructional resources review, career guidance and placement activities, program accreditation reviews, and professional development advisement and assistance. In addition, each advisory committee member serves as a vehicle for public relations information and potentially provides a point of contact for the development of specific opportunities with industries for students and faculty.

1.4 Program Locations

Among the advantages that make Oregon Tech an ideal institution for offering the BSREE program is the benefit of having campuses in two distinctive locations – one in urban Portland in proximity to the Pacific Northwest's energy industry cluster, and the second in rural Southern Oregon with exceptional natural energy resources. The Portland campus allows students to leverage their classroom experience within internships at the Northwest's world-class energy and power companies. The Klamath Falls campus has unique energy advantages and is already a leading geothermal research facility. In addition, the climate makes it ideally suited to applied research in the field of solar energy.

2 Program Mission, Educational Objectives and Outcomes

2.1 Program Mission

The mission of the Renewable Energy Engineering degree program is to prepare students for the challenges of designing, promoting and implementing renewable energy solutions within society's rapidly-changing energy-related industry cluster, particularly within Oregon and the Pacific Northwest. Graduates will have a fundamental understanding of energy engineering and a sense of social responsibility for the implementation of sustainable energy solutions. The department will be a leader in providing career ready engineering graduates for various renewable energy engineering fields. Faculty and students will engage in applied research in emerging technologies and provide professional services to their communities.

2.2 Program Educational Objectives

Program educational objectives are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve. The Program Educational Objectives (PEOs) of Oregon Tech's Bachelor of Science in Renewable Energy Engineering program are:

- BSREE graduates will excel as professionals in the various fields of energy engineering.
- BSREE graduates will be known for their commitment to lifelong learning, social responsibility, and professional and ethical responsibilities in implementing sustainable engineering solutions.
- BSREE graduates will excel in critical thinking, problem solving and effective communication.

2.3 Relationship between Program Objectives and Institutional Objectives

These program educational objectives map to the Oregon Tech's institutional mission statement and core themes by offering statewide educational opportunity in an innovative and rigorous applied degree program in engineering oriented toward graduate success and an appreciation for the role of the engineer in public service.

2.4 Program Outcomes

The BS REE program outcomes include ABET's EAC *a* - *k*[1]. All of these are listed below:

(a) an ability to apply knowledge of mathematics, science, and engineering

(b) an ability to design and conduct experiments, as well as to analyze and interpret data

(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

(d) an ability to function on multi-disciplinary teams

(e) an ability to identify, formulate, and solve engineering problems

(f) an understanding of professional and ethical responsibility

(g) an ability to communicate effectively

(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

[1] Three additional student outcomes [(l) an ability to apply the fundamentals of energy conversion and applications, (m) an understanding of the obligations for implementing sustainable engineering solutions, and (n) an appreciation for the influence of energy in the history of modern societies] were deleted in 2012-13 based on the recommendation of experienced ABET evaluators (visiting Oregon Tech to evaluate the electrical engineering program for accreditation) with the Industry Advisory Council's concurrence.

(i) an ability to engage in independent learning and recognize the need for continual professional development[2]

(j) a knowledge of contemporary issues

(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

[2] During Convocation in Fall 2010, the EERE faculty agreed to change outcome (i). Previously, the faculty had adopted the outcome (i) developed by ABET: "a recognition of the need for, and an ability to engage in life-long learning".

3 Cycle of Assessment for Program Outcomes

3.1 Introduction and Methodology

Assessment of the program outcomes is conducted over a three year-cycle. The assessment cycle was changed during the 2014-15 assessment year. This change was implemented at an assessment coordination meeting on February 2, 2014. At this meeting, assessment coordinators representing each program within the Electrical Engineering and Renewable Energy (EERE) Department aligned their assessment cycles so that each program assesses similar outcomes on the same years. The intention for this change is to better organize the assessment process and produce more meaningful data for comparison between different programs in the EERE Department. Table 1 shows the minimum outcomes assessed in each cycle.

Effective the 2014-15 academic year, the assessment cycle begins in the Spring. In previous years, the assessment cycle started in the Fall. This change reflects a shift on an institutional level to begin data collection in the Spring term. In 2012-13 the Assessment Commission Executive Committee began recommending that programs begin data collection for the upcoming year during Spring term. This recommendation was based on the fact that many programs found the best courses to embed assessment often fell in Spring term, yet this made it difficult to gather the data, review the results and make recommendations for actions, and generate the assessment report by the end of the academic year.

3.2 Assessment Cycle

Table 1 - BSREE Outcome Assessment Cycle

Student Outcome	**2014-15**	**2015-16**	**2016-17**
a) Fundamentals	EE321[W], EE419		
b) Experimentation		EE223[W], EE419, REE331[K]	
c) Design	EE355[W], REE412		
d) Teamwork	REE307[K],REE412[W], MECH318[W], ENGR465[K]		
e) Problem solving			REE337, EE419
f) Ethics		EE355[W], REE412[W], REE463[K], REE469[K]	
g) Communication			EE355, REE348
h) Impact		REE412, REE346	
i) Independent learning			REE454, REE463
j) Contemporary Issues	REE412[K], REE469[W]		
k) Engineering tools			ENGR355, REE455[W], REE413[K]
[K] – assessed at Klamath Falls campus only , [W] – Assessed at Wilsonville campus only			

3.3 Summary of Assessment Activities & Evidence of Student Learning

3.3.1 Introduction

The BSREE faculty conducted formal assessment during the 2015-16 academic year using direct measures, such as designated assignments and evaluation of coursework normally assigned. Additionally, the student outcomes were assessed using indirect measures, primarily results from a graduate exit survey.

3.3.2 Methods for Assessment of Program Outcomes

At the beginning of the assessment cycle, an assessment plan is generated by the Assessment Coordinator in consultation with the faculty. This plan includes the outcomes to be assessed during that assessment cycle (according to Table 1), as well as the courses and terms where these outcomes will be assessed.

The BSREE mapping process links specific tasks within BSREE course projects and assignments to program outcomes and on to program educational objectives in a systematic way. The program outcomes are evaluated as part of the course curriculum primarily by means of assignments. These assignments typically involve a short project requiring the student to apply math, science, and engineering principles learned in the course to solve a particular problem requiring the use of modern engineering methodology and effectively communicating the results.

The mapping process aims to systemize the assessment of engineering coursework, and to provide a mechanism that facilitates the design of engineering assignments that meet the relevant outcomes, particularly those that are more distant from traditional engineering coursework. Rather than considering how the outcomes match the assignment, the assignment is designed to map to the program outcomes.

A systematic, rubric-based process is then used to quickly assess the level of attainment of a given program outcome, based on a set of performance criteria. The work produced by each student is evaluated according to the different performance criteria, and assigned a level of 1-developing, 2-accomplished, or 3-exemplary. The results for each outcome are then summarized in a table, and reviewed by the faculty at the annual Closing-the-Loop meeting.

The acceptable performance level is to have at least 80% of the students obtain a level of accomplished or exemplary in each of the performance criteria for any given program outcome.

If any of the direct assessment methods indicates performance below the established level, that triggers the continuous improvement process, where all the direct and indirect assessment measures associated with that outcome are evaluated by the faculty, and based on the evidence, the faculty decides the adequate course of action. The possible courses of action are these:

- Collect more data (if there is insufficient data to reach a conclusion as to whether the outcome is being attained or not); this may be the appropriate course of action when assessment was conducted on a class with low enrollment, and it is recommendable to re-assess the outcome on the following year, even if it is out-of-cycle, in order to obtain more data.
- Make changes to the assessment methodology (if the faculty believe that missing the performance target on a specific outcome may be a result of the way the assessment is being conducted, and a more

proper assessment methodology may lead to more accurate numbers); for example, this could be the suggested course of action if an outcome was assessed in a lower-level course, and the faculty decide that the outcome should be assessed in a higher-level course before determining whether curriculum changes are truly needed.

- Implement changes to the curriculum (if the faculty conclude that a curriculum change is needed to improve attainment of a particular outcome). A curriculum change will be the course of action taken when the performance on a given outcome is below the target level, and the evidence indicates that there is sufficient data and an adequate assessment methodology already in place, and therefore there is no reason to question the results obtained.

If the faculty decide to take this last course of action and implement curriculum changes, the data from the direct assessments is analyzed and the faculty come up with a plan for continuous improvement, which specifies what changes will be implemented to the curriculum to improve outcome performance.

In addition to direct assessment measures, indirect assessment of the student outcomes is performed on an annual basis through a senior exit survey.

The results of the direct and indirect assessment, as well as the conclusions of the faculty discussion at the Closing-the-Loop meeting are included in the annual BSREE Assessment Report, which is reviewed by the Department Chair and the Director of Assessment for the university. The suggested changes to the curriculum are presented and discussed with all the department faculty at the annual Convocation meeting in Fall, as well as with the Industry Advisory Board (IAB) at the following IAB meeting. If approved, these changes are implemented in the curriculum and submitted to the Curriculum Planning Commission (if catalog changes are required) for the following academic year.

3.3.3 2015-16 Targeted Direct Assessment Activities

The sections below describe the 2015-16 targeted assessment activities and detail the performance of students for each of the assessed outcomes. Unless otherwise noted, the tables report the number of students performing at a developing level, accomplished level, and exemplary level for each performance criteria, as well as the percentage of students performing at an accomplished level or above.

3.3.4 Targeted Assessment for Outcome (b): an ability to design and conduct experiments, as well as to analyze and interpret data

This outcome was assessed in EE 419 – Power Electronics, REE331 – Fuel Cells, and EE223 – Circuit II

Outcome (b): Klamath Falls, EE 419, Fall 2015, Dr. Hossain

This outcome was assessed using the lab experiment assigned for student for the power electronics lab (EE 419). This course is required for REE students and is an upper division elective for EE students. The students were assigned series voltage regulator experimentation lab exercise. The objects of this experiment was to understand the design and operation of a series voltage regulator, measure the regulated DC output voltage with input voltage and test the regulator performance over various load current.

Ten students were assessed in Fall 2015 using the performance criteria listed below. The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level in all performance criteria.

Table 2 summarizes the results of this targeted assessment. The results indicate that the minimum acceptable performance level of 80% was met on all performance criteria for this program outcome. Most Students met or exceeded expectations, they demonstrated their abilities to conduct experiments in a laboratory setting using industry standard test equipment collect data and analyze and interpret results. As this is one of the laboratory experiments, the designing experiment and the improving a process from an experimental result are not application here.

Table 2 - Outcome (b): Klamath Falls, EE 419, Fall 2015, Dr. Hossain

(b) An ability to design and conduct experiments, as well as to analyze and interpret data				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	%Students >= 2
1- Conducting an experiment.	0	0	10	100%
2- Analyzing experimental data.	0	1	9	100%
3- Interpreting experimental data.	0	4	6	100%

Outcome (b): Klamath Falls, REE 331, Spring 2015, Dr. Shi

The outcome was assessed using the course project of REE331 Fuel Cells Lab taught in Spring 2015. The project was set up as a replacement of some lab experiments to test student's capability in designing and conducting experiments, as well as analyzing the data. Students teamed up by themselves and formed three groups. The topic chosen by the three groups were (1) Electrolysis of water: effect of electrodes surface area, (2) Electrolysis of water: effect of electrolyte, and (3) Electrolysis of water: effect of different electrode materials. The whole class of 8 students is divided into three groups with 2 groups of 3 students and 1 group of 2 students.

Eight students were assessed using the performance criteria listed below. The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level in all performance criteria.

Table 3 summarizes the results of this targeted assessment. The results indicate that the performance level higher that 80% was met on the performance criteria for this program outcome, demonstrating that the students in the evaluated class have the ability to design, conduct experiment and analyze data.

Table 3 - Outcome (b): Klamath Falls, REE 331, Spring 2015, Dr. Shi

(b) An ability to design and conduct experiments, as well as to analyze and interpret data				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	% student >=2
1- Conducting an experiment.	0	0	8	100%
2- Analyzing experimental data	0	0	8	100%
3- Interpreting experimental data.	0	0	8	100%

Outcome (b): Wilsonville, EE 223, Winter 2016, Dr. Torres

This outcome was assessed in EE 223 – Circuits II in Winter 2016 by means of a laboratory assignment in which students designed and tested a second order circuit, which behavior was predicted using an excel spreadsheet prepared by them. Results were verified through simulation using SystemVision.com. The objective of this exercise to understand the output behavior of RCL circuits as a function of component values and circuit configuration, to design and conduct experimental steps necessary for circuit characterization, and to develop project planning skills.

Nine students were assessed in Winter 2016 using the performance criteria listed below. The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level in all performance criteria.

Table 4 summarizes the results of this targeted assessment. The results indicate that the minimum acceptable performance level of 80% was met on all performance criteria for this program outcome. Most students met or exceeded expectations, they demonstrated their abilities to conduct experiments in a laboratory setting using industry standard test equipment, collect data, analyze and interpret results.

Table 4 - Outcome (b): Wilsonville, EE EE223, Winter 2016, Dr. Torres

(b) An ability to design and conduct experiments, as well as to analyze and interpret data				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	%Students >= 2
Designing an experiment.	0	0	9	100%
Conducting an experiment.	0	0	9	100%
Analyzing experimental data.	0	0	9	100%
Interpreting experimental data.	0	0	9	100%

Outcome (b): Wilsonville, EE 419, Winter 2016, Dr. Ahsan

This outcome was assessed using the lab experiment assigned for student for the power electronics lab (EE 419). This course is required for REE students and is an upper division elective for EE students. The students were assigned to design a DC-DC Buck Converter using a pMOSFET. The objective was to design, simulate, build and analyze a buck converter and gain a better understanding of real-world functionality.

Twenty four students were assessed in Winter 2016 using the performance criteria listed below. The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level in all performance criteria.

Table 5 summarizes the results of this targeted assessment. The results indicate that the minimum acceptable performance level of 80% was met on all performance criteria for this program outcome. Most Students met or exceeded expectations, they demonstrated their abilities to conduct experiments in a laboratory setting using industry standard test equipment, collect data, analyze and interpret results.

Table 5 - Outcome (b): Wilsonville, EE 419, Winter 2016, Dr. Ahsan

(b) An ability to design and conduct experiments, as well as to analyze and interpret data				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	%Students >= 2
Conducting an experiment.	0	0	24	100%
Analyzing experimental data.	0	5	19	100%
Interpreting experimental data.	0	6	18	100%

3.3.5 Targeted Assessment of Outcome (f): an understanding of professional and ethical responsibility

This outcome was assessed in REE 463 – Energy Systems Instrumentation, REE 469 – Grid Integration of RE, EE 355 – Control Systems Design, and REE 412 – Photovoltaic Systems.

Outcome (f): Klamath Falls, REE 463, Spring 2015, Prof. Zipay

This outcome was assessed using a quiz with a single case study that presented some ethical situations and dilemmas in the REE 463 Instrumentation and Controls Class. The students had the role of Products Application Engineers at a company that designs, manufactures and sells data acquisition units. The problem centred around using low cost sensors to replace a current obsolete line with some ethical dilemmas presented. Students were asked to read the IEEE Ethics Code, Identify the violation(s) and describe how they would respond.

Eleven students were assessed in Spring of 2015 using the performance criteria listed below. The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level in all performance criteria.

Table 6 summarizes the results of this targeted assessment. The results indicate that the minimum acceptable performance level of 80% was met on all performance criteria for this program outcome. Students met or exceeded expectations; they demonstrated their abilities to identify a professional code of ethics and analyze the ethical dimensions of an industrial type situation.

Table 6 - Outcome (f): Klamath Falls, REE 463, Spring 2015, Prof. Zipay

(f) An understanding of professional and ethical responsibility (Fundamental Skills)				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	%Students >= 2
1- Demonstrate a knowledge of a code of professional ethics.	0	0	11	100%
2- Evaluate the ethical dimensions of an engineering situation.	0	5	6	100%
3- Demonstrate knowledge of professional behavior and conduct.	0	0	11	100%

Outcome (f): Klamath Falls, REE 469, Spring 2015, Prof. Zipay

This outcome was assessed using a quiz with a single case study that presented some ethical situations and dilemmas in the REE 469 Grid Integration of Renewable Energy Class. The students had the role of Quality Control Engineers at a company that designs, manufactures and sells wind turbine systems. The problem is about two models that do not meet marketed specification for power production, cut-off speed and cut-in speed. The QC engineer was asked to sign off and receive an extra salary stipend. Students were asked to read the IEEE Ethics Code, Identify the violation(s) and describe how they would respond.

Nine students were assessed in Spring 2015 using the performance criteria listed below. The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level in all performance criteria.

Table 7 summarizes the results of this targeted assessment. The results indicate that the minimum acceptable performance level of 80% was met on all performance criteria for this program outcome. Students met or exceeded expectations; they demonstrated their abilities to identify a professional code of ethics and analyze the ethical dimensions of an industrial type situation. It should be noted that the one student with a score below two was due to not listed the actual ethics code violations.

Table 7 - Outcome (f): Klamath Falls, REE 469, Spring 2015, Prof. Zipay

(f) An understanding of professional and ethical responsibility (Fundamental Skills)				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	%Students >= 2
1- Demonstrate a knowledge of a code of professional ethics.	0	0	9	100%
2- Evaluate the ethical dimensions of an engineering situation.	1	4	4	89%
3- Demonstrate knowledge of professional behavior and conduct.	0	0	9	100%

Outcome (f): Wilsonville, EE 355, Fall 2015, Prof. Rytkonen

This outcome was assessed in EE 355 – Control Systems Design in Fall 2015 by means of a homework assignment. The assignment consisted of two parts: discussion of important provisions in the National Society of Professional Engineers Code of Ethics and analysis of a case study. Students were required to visit the NSPE website to learn about the Code of Ethics and the ethical dimensions of each of the canons. They then had to select three canons they felt were important and discuss them, providing examples for each. In the case study, they had to analyze the ethical dimensions and demonstrate or recognize ethical practices that could have prevented an explosion at a petroleum refinery. Students were provided with excerpts from the final investigative report by the Chemical Safety Board relevant to the course topic of control systems. Finally, the students were required to write a complete report.

Seven students were assessed in Fall 2015 using the performance criteria listed in the table below. The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level in all performance criteria.

Table 8 summarizes the results of this targeted assessment. The results indicate that the minimum acceptable performance level of 80% was met on all performance criteria for this program outcome, that is, over 80% of students were able to design a model for the system provided using system identification techniques.

Table 8 - Outcome (f): Wilsonville, EE 355, Fall 2015, Prof. Rytkonen

Outcome (f): an understanding of professional and ethical responsibility.				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	%Students >= 2
1 – Demonstrate knowledge of professional codes of conduct	1	1	5	86%
2 – Evaluate ethical dimensions of engineering practice	1	2	4	86%
3 – Demonstrate or recognize ethical practices	1	2	4	86%

Outcome (f): Wilsonville, REE412, Winter 2016, Dr. Petrovic

This outcome was assessed in REE 412 – PV Systems in Winter 2016 by means of 5 exam questions related to the outcome. The questions consisted of hypothetical case studies relevant to PV engineering. The students had to analyze the case studies, formulate the appropriate ethical question, identify possible courses of action and then propose and justify the conclusion. Students were required to prepare for these questions by visiting NSPE website to learn about the Code of Ethics and the ethical dimensions of the canons.

The student answers were evaluated for the ability to make informed ethical choices, ability to demonstrates knowledge of a professional code of ethics, evaluate the ethical dimensions of professional engineering and scientific practice, and demonstration of the understanding of norms of ethical practice

Twenty students in the class were assessed using the performance criteria listed in the table below. The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level in all performance criteria.

Table 9 summarizes the results of this targeted assessment. The results indicate that 70% of all students on all criteria were accomplished or exemplary.

Table 9 - Outcome (f): Wilsonville, REE 412, Winter 2016, Dr. Petrovic

Outcome (f): an understanding of professional and ethical responsibility.				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	%Students >= 2
1 – Demonstrate knowledge of professional codes of conduct	6	3	11	70%
2 – Evaluate ethical dimensions of engineering practice	6	3	11	70%
3 – Demonstrate or recognize ethical practices	6	3	11	70%

3.3.6 Targeted Assessment of Outcome (h): the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

This outcome was assessed in REE 346 –Biofuels and biomass, and REE 412 – Photovoltaic Systems.

Outcome (h): Klamath Falls, REE 346, Spring 2015, Dr. Shi

The outcome was assessed using three projects: "Bioreactor for Algae", "Growing of Algae", and "Extraction of Oil from Algae and Biodiesel Production". The students in this class organized into three teams to work on the three projects. The objective of these project was to design a bioreactor for growing Algae, investigate the optimized condition for growing Algae, and explore the technology to harvest Algae and make biodiesel from the Algae oil. Through the projects, the students are evaluated for the understanding of the impact of biomass and biofuels to fossil fuel depletion and environmental protection, as well as economy development and job creation. In addition, in order to evaluate the awareness of negative impact of biofuel industry to society, a specially designed question "Discuss the negative and positive impact of biofuel Ethanol made from corn in a global, economic, environmental and societal context" was added to the Midterm I test. The student answers were evaluated for the understanding of the impact of the engineering solution in a global, economic, environmental and societal context.

Six students were assessed in term Spring 2015 using the performance criteria listed below. The minimum acceptable performance level was to have 80% of the students performing at the accomplished or exemplary level in all performance criteria.

Table 10 summarizes the results of this targeted assessment. The results indicate that the minimum acceptable performance level of 80% was met on all performance criteria for this program outcome. Students met or exceeded expectations; they showed their understanding to the impact of engineering solutions in a global, economic, environmental and societal context.

Table 10 - Outcome (h): Klamath Falls, REE 346, Spring 2015, Dr. Shi

(h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context.				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	% student >=2
1- Identifying impacts of an engineering solution	0	1	5	100%
2- Understand impacts in Various Context (groups of people, National boundaries, Economic and environmental)	0	0	6	100%

Outcome (h): Klamath Falls, REE 412, Fall 2015, Dr. Shi

The outcome was assessed using four projects: "Photovoltaic Cars", "Design of Solar Thermal System and Photovoltaic System for Residential House", "Design and Implementation of a Photovoltaic System for a Weather Station", and "Design and Implementation of a Photovoltaic System for a Quadcopter Drone". The students in this class were organized into four teams to work on the four projects. The student groups were asked to give three presentations to demonstrate their project progresses and submit written report to conclude their project. Through the projects, the students are evaluated for the understanding of the impact of solar energy utilization to fossil fuel depletion and environmental protection, as well as economy development and job creation. In addition, in order to evaluate the awareness of negative impact of photovoltaic industry to environment and society, a specially designed question "Discuss the negative and positive impact of photovoltaic industry in a global, economic, environmental and societal context" was added to the Midterm II test of REE412. The student answers were evaluated for the understanding of the impact of the engineering solution in a global, economic, environmental and societal context.

Eleven students were assessed in term Fall 2015 using the performance criteria listed below. The minimum acceptable performance level was to have 80% of the students performing at the accomplished or exemplary level in all performance criteria.

Table 11 summarizes the results of this targeted assessment. The results indicate that the minimum acceptable performance level of 80% was met on all performance criteria for this program outcome. Students met or exceeded expectations; they showed their understanding to the impact of engineering solutions in a global, economic, environmental and societal context.

Table 11 - Outcome (h): Wilsonville, REE 412, Fall 2015, Dr. Shi

(h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context.				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	% student >=2
1- Identifying impacts of an engineering solution	0	9	2	100%
2- Understand impacts in Various Context (groups of people, National boundaries, Economic and environmental)	0	0	11	100%

Outcome (h): Wilsonville, REE 346, Spring 2015, Dr. Torres

This outcome was assessed in REE 346 – Biofuels and Biomass in Spring 2015 by means of an assignment in which students were required to identify a case study of a company associated with the use of biofuels, and write a one-page essay defining the topic, identifying the reach of the engineering solution, explaining its geographical, socioeconomic impact. Students had to present their selected case to the rest of the class during a round table discussion.

Six students were assessed based on the written essay, their oral presentation, and the answers provided to the questions asked by the rest of the class. The minimum acceptable performance level was to have 80% of the students performing at the accomplished or exemplary level in all performance criteria.

Table 12 summarizes the results of this targeted assessment. The results indicate that 100% of all students performed at a level considered as "accomplished" or "exemplary".

Table 12 - Outcome (h): Wilsonville, REE 346, Spring 2015, Dr. Torres

(h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context.				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	% student >=2
1- Identifying impacts of an engineering solution	0	0	6	100%
2- Understand societal impacts (groups of people)	0	0	6	100%
3- Understanding global impacts (National boundaries, Economic and environmental)	0	4	2	100%

Outcome (h): Wilsonville, REE 412, Winter 2016, Dr. Petrovic

This outcome was assessed in REE 412 – PV Systems in Winter 2016 by means of a homework assignment related to the outcome. The main assignment goal was to design two PV systems for developing countries. One of the requirements was to discuss the impact of the PV systems on global, economic, environmental and societal issues in the country or region where the systems are installed.

Some of the skills that engineering students need to have is to be able to evaluate the impact of their solutions in a global/societal context. The outcome of this assessment will be used determine if additional course elements need to be incorporated into required and elective engineering courses to help students master those skills. The expectation is that engineers need to have a solid understanding of the impact that their products will have locally, as well as globally, so that they can make a sound evaluation of the pros and cons.

Twenty students were assessed based on their individual projects, which incorporated the analysis of impact of their PV Systems design in developing countries. The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level in all performance criteria.

Table 13 summarizes the results of this targeted assessment. The results indicate that 85% of all students on all questions were accomplished or exemplary.

Table 13 - Outcome (h): Wilsonville, REE 412, Winter 2016, Dr. Petrovic

(h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context.				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	% student >=2
4- Identifying impacts of an engineering solution	3	10	7	85%
5- Understand societal impacts (groups of people)	3	10	7	85%
6- Understanding global impacts (National boundaries, Economic and environmental)	3	10	7	85%

3.3.7 2014-15 Indirect Assessments

In addition to direct assessment measures, the student outcomes (a) through (k) were indirectly assessed through a senior exit survey conducted every year in the Spring term. The 2014-15 data collected in Spring 2015 was used in the last assessment report, which covers the period from Spring 2014 to Winter 2015. The indirect assessment data used in the 2014-15 report was not collected during the assessment cycle. In order to avoid this inconsistency, in this and the subsequent annual assessment reports, we will use indirect assessment data collected during spring term in the respective assessment cycle. To this end, the 2014-15 academic year senior exit survey, conducted in Spring 2015, will be used again in this assessment report, which covers the terms from Spring 2015 to Winter 2016.

Question 16 in the survey asked students "Below are the ABET student outcomes for the BS REE program. Please indicate how well the BS REE program prepared you in each of the following areas". Figures 1 and 2 show the results of the indirect assessment of the BSREE student outcomes for the 2014-15 graduating class. Twenty two BS REE graduating seniors completed the survey, with over 90% of the respondents indicating that as a result of completing the BS REE program they feel prepared or highly prepared in each of the student outcomes. These results suggest that the BSREE graduating students feel they have attained the BSREE student outcomes, and agree with the direct assessment results (namely, that at least 80% of the students perform at the level of accomplished or exemplary in all performance criteria of the assessed outcomes.)

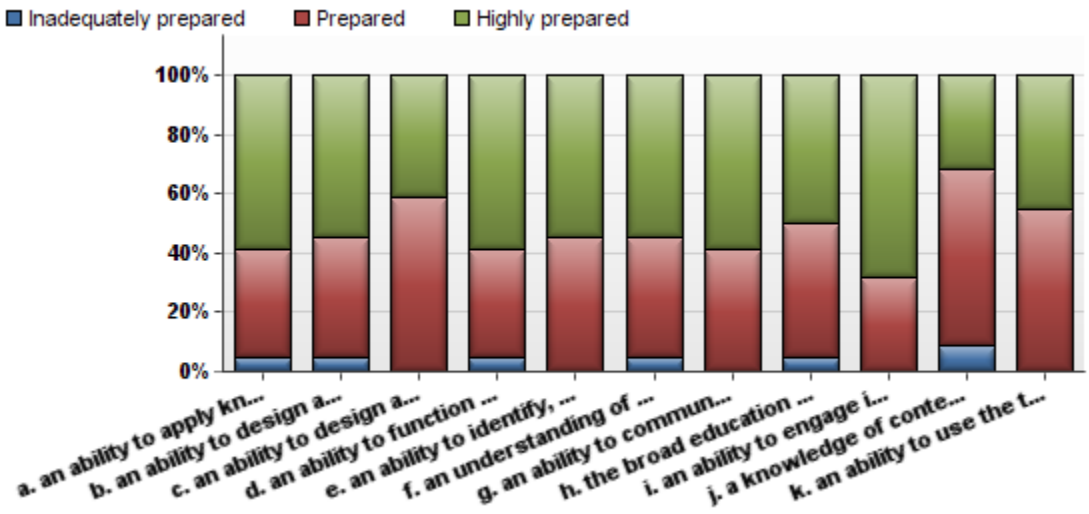

Figure 1 - Graph of results of the indirect assessment for the BSREE Student Outcomes as reported in the Senior Exit Survey (2014-15)

Outcome	1-Inadequately prepared	2-Prepared	3-Highly prepared	% Student >= 2
a. an ability to apply knowledge of mathematics, science, and engineering	1	8	13	96%
b. an ability to design and conduct experiments, as well as to analyze and interpret data	1	9	12	96%
c. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	0	13	9	100%
d. an ability to function on multi-disciplinary teams	1	8	13	96%
e. an ability to identify, formulate, and solve engineering problems	0	10	12	100%
f. an understanding of professional and ethical responsibility	1	9	12	96%
g. an ability to communicate effectively	0	9	13	100%
h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context	1	10	11	96%
i. an ability to engage in independent learning and recognize the need for continual professional development	0	7	15	100%
j. a knowledge of contemporary issues	2	13	7	91%
k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	0	12	10	100%

Figure 2 - Results of the indirect assessment for the BSREE Student Outcomes as reported in the Senior Exit Survey (2014-15)

4 Changes Resulting from Assessment

This section describes the changes resulting from the assessment activities carried out during the year 2015-16. It includes any changes that have been implemented based on assessment in previous assessment cycles, from this or last year, as well as considerations for the next assessment cycle.

The BSREE faculty met on June 9, 2016 to review the assessment results and determine whether any changes are needed to the BSREE curriculum or assessment methodology based on the results presented in this document. The objective set by the BSREE faculty was to have at least 80% of the students perform at the level of accomplished or exemplary in all performance criteria of the assessed outcomes. Table 14 provides a summary of the 2015-16 assessment results for the outcomes which were directly assessed.

Table 14 - Summary of BSREE direct assessment for 2015-16

	Total Students	Students >= 2	% Students >=2
b- Experimentation (Klamath Falls, EE 419, Fall 2015, Dr. Hossain)			
1- Conducting an experiment	10	10	100%
2- Analyzing experimental data	10	10	100%
3- Interpreting experimental data	10	10	100%
b- Experimentation (Klamath Falls, REE 331, Spring 2015, Dr. Shi)			
1- Conducting an experiment	8	8	100%
2- Analyzing experimental data	8	8	100%
3- Interpreting experimental data	8	8	100%
b- Experimentation (Wilsonville, EE 223, Winter 2016, Dr. Torres)			
1- Designing an experiment	9	9	100%
2- Conducting an experiment	9	9	100%
3- Analyzing experimental data	9	9	100%
4- Interpreting experimental data	9	9	100%
b- Experimentation (Wilsonville, EE 419, Winter 2016, Dr. Ahsan)			
1- Conducting an experiment	24	24	100%
2- Analyzing experimental data	24	24	100%
3- Interpreting experimental data	24	24	100%
f - Ethics (Klamath Falls, REE 463, Spring 2015, Prof. Zipay)			
1- Code of professional ethics	11	11	100%
2- Ethical dimensions	11	11	100%
3- Professional behavior and conduct	11	11	100%
f - Ethics (Klamath Falls, REE 469, Spring 2015, Prof. Zipay)			
1- Code of professional ethics	9	9	100%
2- Ethical dimensions	9	8	89%
3- Professional behavior and conduct	9	9	100%
f - Ethics (Wilsonville, EE 355, Fall 2015, Prof. Rytkonen)			
1- Code of professional ethics	7	6	86%
2- Ethical dimensions	7	6	86%
3- Professional behavior and conduct.	7	6	86%

f - Ethics (Wilsonville, REE 412, Winter 2016, Dr. Petrovic)			
1- Code of professional ethics	20	14	70%
2- Ethical dimensions	20	14	70%
3- Professional behavior and conduct.	20	14	70%
h- Impact (Klamath Falls, REE 346, Spring 2015, Dr. Shi)			
1- Impacts of an engineering solution	6	6	100%
2- Impacts in various context	6	6	100%
h- Impact (Klamath Falls, REE 412, Fall 2015, Dr. Shi)			
1- Impacts of an engineering solution	11	11	100%
2- Impacts in various context	11	11	100%
h- Impact (Wilsonville, REE 346, Spring 2015, Dr. Torres)			
1- Impacts of an engineering solution	6	6	100%
2- Societal impact	6	6	100%
3- Global impact	6	6	100%
h- Impact (Wilsonville, REE 412, Winter 2016, Dr. Petrovic)			
1- Impacts of an engineering solution	20	17	85%
2- Societal impact	20	17	85%
3- Global impact	20	17	85%

4.1 Changes Resulting from the 2015-16 Assessment

The results of the 2015-16 Assessment indicate that the minimum acceptable performance level of 80% was met on all performance criteria for all assessed outcomes. Areas of improvement to the curriculum were discussed during the Closing the Loop Meeting in June 2016 with respect to these results. These areas include:

- **Outcome b (Experimentation):**
  - **Results:** The results show that the threshold of attainment of this outcome was exceeded in all performance criteria.
  - **Recommendation:** The faculty identified no problem with this outcome, and therefore recommended no changes at this time.
- **Outcome f (Ethics):**
  - **Results:** The results show that the threshold of attainment of this outcome was not met on all performance criteria when it was assessed in REE 412 in Wilsonville. The assessment results for this course indicate that for all performance criteria only 70% of students were accomplished or exemplary. This outcome was also assessed in REE 463 (Klamath Falls), REE 469 (Klamath Falls), and EE 355 (Wilsonville). In these three courses, the results indicate that the minimum acceptable performance level of 80% was met on all performance criteria. The average of the results of the targeted assessment in the four courses greater than 80% on all performance criteria, indicating on average the minimum acceptable performance level was met. This is consistent with the indirect assessment result where 96% of the graduating students felt prepared or highly prepared in this outcome as a result of completing the program.

- **Recommendation:** The BSREE faculty discussed ways to improve the assessment of this outcome during the Closing-the-Loop meeting. The discussion emphasized the subjectivity involved in assessing this criteria and the use of performance criteria for assessing an outcome. The following recommendations were made for improving assessment outcomes.

    (1) The number of courses assessed for outcome f should be at least four and the same case study should be used in both campuses.
    (2) In order to improve consistency, the same rubric should be used in both campuses for assessing an outcome, starting the next assessment cycle.

    The BSREE faculty will further discuss the implementation of the above recommendations during the Fall 2016 convocation meeting.

- **Outcome h (Impact):**
    - **Results:** The results show that the threshold of attainment of this outcome was exceeded in all performance criteria.
    - **Recommendation:** The faculty identified no problem with this outcome, and therefore recommended no changes at this time.