BS Renewable Energy Engineering

2014-15 Assessment Report

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Contents

1 Introduction

1.1 Program Design and Goals

The Bachelor of Science in Renewable Energy Engineering (BS REE) 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 BS REE 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 program (BS RES) at its satellite campus in Portland, Oregon. The BS RES 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 BS RES degree was discontinued and replaced by the Bachelor of Science degree in Renewable Energy Engineering (BS REE). 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 BS RES 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.

We anticipate BS REE graduates will 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 BS REE degree, was the only suitable option for our students.

1.3 Industry Relationships

The BS REE 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 BS REE program. Representatives from corporations, government institutions and non-profit organizations comprise the IAC, giving the BS REE 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 BS REE 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

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[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. Table 1 shows the minimum outcomes assessed each year. The assessment cycle was changed during the 2014-15 assessment year from the previous assessment cycle, shown in Table 2. 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.

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		EE419, REE33X	
c) Design	EE355[W], REE412		
d) Teamwork	REE307[K],REE412[W], MECH318[W], ENGR465[K]		
e) Problem solving			REE337, EE419
f) Ethics		REE463, REE469	
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 MSREE faculty conducted formal assessment during the 2014-15 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 BS REE mapping process links specific tasks within BS REE 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 MSREE 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 at the following IAB meeting. If approved, these changes are implemented in the curriculum and submitted to the University Graduate Council (if catalog changes are required) for the following academic year.

3.3.3 2014-15 Targeted Direct Assessment Activities

The sections below describe the 2013-14 targeted assessment activities and detail the performance of students for each of the assessed outcomes. Unless otherwise noted, the tables report the percentage 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 (a): an ability to apply knowledge of mathematics, science, and engineering

This outcome was assessed in EE 321 - Electronics I, and EE 419 – Power Electronics.

Outcome (a): Wilsonville, EE 419, Winter 2015, Dr. Ahsan

This outcome was assessed in EE419 – Power Electronics in Winter 2014 by means of multiple lab projects. The projects consisted of designing, simulating, implementing, and analyzing power electronics circuit and devices (a semi-controlled, half-wave light dimmer circuit, buck converter and boost converter).

Students were provided with a series of design specifications and design constraints. Calculation of component values to meet the design specifications, as well as characterization of circuit performance requires the application of mathematical tools. The design, implementation, and integration of the different sub-circuits requires knowledge and application of science and engineering principles. Students were required to write a complete reports following the guidelines of the IEEE Transactions Journals (IEEE Transactions Publication-Ready Template and Instructions for Authors).

Fourteen BS REE students were assessed in Winter 2014 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 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, that is, over 80% of students were able to apply knowledge of mathematics, science, and engineering to the solution of an engineering problem.

Table 2 - Outcome (a): Wilsonville, EE 419, Winter 2015, Prof. Ahsan

Outcome (a): an ability to apply knowledge of mathematics, science, and engineering				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	%Students >= 2
1 - Mathematics	1	12	1	92.8%
2 – Science and Engineering	1	12	1	92.8%

Outcome (a): Wilsonville, EE 321, Fall 2014, Dr. Crespo

This outcome was assessed in EE321 - Electronics I in Fall 2014 by means of a project. The project consisted of designing, simulating, implementing, and experimentally testing an AC-to-DC power supply and linear regulator with current boosting to provide an adjustable regulated output voltage with short-circuit/overload protection. Students were provided with a series of design specifications and design constraints. Calculation of component values to meet the design specifications, as well as characterization of circuit performance requires the application of mathematical tools. The design, implementation, and integration of the different sub-circuits requires knowledge and application of science and engineering principles. Students were required to write a complete report following the guidelines of the IEEE Transactions Journals (IEEE Transactions Publication-Ready Template and Instructions for Authors).

Twelve BS REE students were assessed in Fall 2014 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 3 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 apply knowledge of mathematics, science, and engineering to the solution of an engineering problem.

Table 3 - Outcome (a): Wilsonville, EE 321, Fall 2014, Dr. Crespo

Outcome (a): an ability to apply knowledge of mathematics, science, and engineering				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	%Students >= 2
1 - Mathematics	1	11	7	94.7%
2 – Science and Engineering	1	11	7	94.7%

Outcome (a): Klamath Falls, EE419, Fall 2014, Prof. Zipay

This outcome was assessed in EE419 – Power Electronics in a Fall 2014 senior level course required for BSREE students and an elective for BSEE students by using two test questions on a final exam. The first test question #3 was used to assess knowledge of mathematics by using a switching transistor biasing problem. Students were assessed on solving mathematical equations to show transistor saturation during switching. The focus was on the math. The second test question #6 was used to assess knowledge of science (physics) and engineering (converter design) using the design of a basic inverter with a generic five transistor SW model (engineering) and EM coupling for the AC wave.

Fifteen students from both the EE and the REE Programs were assessed in Fall 2014 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 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, that is, over 80% of students were able to apply principles of mathematics, science and engineering to solve problems on a final exam.

Table 4 - Outcome (a): Klamath Falls, EE419, Fall 2014, Prof. Zipay

Outcome (a): an ability to apply knowledge of mathematics, science, and engineering				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	%Students >= 2
1 - Math	0	0	10	100%
2 – Science and Engineering	1	5	4	90%

3.3.5 Targeted Assessment of Outcome (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.

This outcome was assessed in EE 355 – Control Systems Design, and REE 412 – Photovoltaic Systems.

Outcome (c): Wilsonville, EE 355, Fall 2014, Prof. Rytkonen

This outcome was assessed in EE 355 – Control Systems Design in Fall 2014 by means of a laboratory assignment. The project consisted of designing a computer model of a process using system identification techniques. Students were provided with a computer model used to generate output signals from input data. Students were expected to perform a basic system modeling exercise using a step response test, then use the information gathered from the basic model to improving the process model through an iterative process of analyzing and solving the system identification problem until satisfying model validation requirements. Once the design of the model was finalized and the simulations indicated the results were met, students were required to compare and contrast the model they developed with the model that created the output data from the input signal. Finally, the students were required to write a complete report.

Seven students were assessed in Fall 2014 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 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, that is, over 80% of students were able to design a model for the system provided using system identification techniques.

Table 5 - Outcome (c): Wilsonville, EE 355, Fall 2014, Prof. Rytkonen

Outcome (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.				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	%Students >= 2
1 – Recognize a need for an engineering solution	0	7	0	100%
2 - Develop a design strategy within realistic constraints	0	7	0	100%
3 - Evaluate relative value of a feasible solution	0	7	0	100%

Outcome (c): Wilsonville, REE 412, Winter 2015, Dr. Petrovic

This outcome was assessed in REE 412 – PV Systems in Winter 2015 by means of 9 exam questions related to the outcome. The questions were asking for design parameters related to sizing PV systems. Some questions required design sizing of complete system, while others required design sizing of some components of the PV system, such as batteries alone or charge controller.

All students in the class were assessed using the performance criteria listed in the table below. The levels of performance were established in the following way: for result of 6 or less out of 9 questions correct the performance was developing, for 7 correct questions it was accomplished and for 8 or more it was exemplary. The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level overall across performance criteria, i.e., design problems.

Table 6 summarizes the results of this targeted assessment. The results indicate that 81% of all students on all questions were accomplished or exemplary.

Table 6 - Outcome (c): Wilsonville, REE 412, Winter 2015, Dr. Petrovic

Outcome (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.				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	%Students >= 2
1 – Recognize a need for an engineering solution	4	7	10	81%
2 - Develop a design strategy within realistic constraints	4	7	10	81%
3 - Evaluate relative value of a feasible solution	4	7	10	81%

Outcome (c): Klamath Falls REE 412, Fall 2014, Dr. Shi

The outcome was assessed using the course projects of REE412 Photovoltaic Systems taught in Fall 2014. Project topics were offered for students to select to conduct research, design systems, collect data, analyze and interpret data. Students were allowed to choose their own topics to finish the projects. The projects are designed to test student's capability in designing 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. REE 412 course covers photovoltaic systems. Therefore the scope of the project for students to design, conduct experiments and analyze the data is confined in the area of photovoltaic related systems. This project was designed as a team based project. Students teamed up by themselves and formed 4 groups. One team chose topic "Solar Road Way Systems". One team chose topic "Portable Photovoltaic Systems". One team chose topic "Photovoltaic Learning Module". And the other team chose topic "Rainbow Youth Golf Education Project: Grid-Tied Solar System Design". The whole class of 12 students is divided into 4 groups with 5 in one group, 2 in one group, 1 in group, and 4 in other group. During the implementation process, 3 presentations were scheduled for students to present the progresses on their projects. And final reports with collected data and data analysis were collected to evaluate their performance and assess the outcome.

The first team designed a photovoltaic system beside highway to use road surface to collect sunlight and generate power. The team collect data and estimate the power generation on the selected portion of I-90 near Seattle, Washington. The second team designed a large scale portable photovoltaic system mounted on a trail for heavy duty truck and collect data to predict its performance. The third team design, implement a two axis tracking hybrid concentrating photovoltaic and solar thermal system based on CPC (Compound Parabolic Concentrator) concentrator. The group projects are evaluated for the following: design the systems; implement the systems; collect and analyze the data and conclude the results.

The total 12 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 7 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 7 - Outcome (c): Klamath Falls REE 412, Fall 2014, Dr. Shi

Outcome (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.				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	% student >2
1 - Recognize need for an engineering solution	0	2	10	100%
2 - Develop a design strategy within realistic constraints	0	0	12	100%
3 - Evaluate relative value of a feasible solution	0	4	8	100%

3.3.6 Targeted Assessment of Outcome (d): an ability to function on multi-disciplinary teams

This outcome was assessed in ENGR 465 –Senior Project, REE 307 - Energy Storage , MECH 318 – Fluid Mechanics, and REE 412 – Photovoltaic Systems.

Outcome (d): Wilsonville, MECH 318, Winter 2015, Dr. Jiru

This outcome was assessed in MECH 318 – Fluid Mechanics in Winter 2015 using three laboratory experiments: Buoyancy and Stability, Bernoulli Principle, and Pump Testing. The students were divided into five teams and provided with laboratory manuals for each experiment. After conducting the experiments, each team was required to write laboratory report for each experiment detailing the objectives of the experiment, materials and methods, analysis and interpretation of results, and conclusion and recommendation.

Twenty five students were assessed in Winter 2015 using the performance criteria listed below. Team participation, communication, management and delegation of responsibilities were observed by the instructor during lab experiments and when grading the team reports. 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. 88% of the students met or exceeded expectations; they demonstrated their abilities for participation, communication, management and delegation of responsibilities.

Table 8 - Outcome (d): Wilsonville, MECH 318, Winter 2015, Dr. Jiru

Outcome (d): an ability to function on multi-disciplinary teams				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	% Students >=2
1 - Team participation, communication	3	10	12	88%
2 - Management of team, delegation of responsibilities	3	10	12	88%

Outcome (d): Wilsonville, REE 412, Winter 2015, Dr. Petrovic

This outcome was assessed in REE 412 – PV Systems in Winter 2015 using a team project related to PV Systems. Twenty-one students were placed in 5 teams to work on the project. The project spanned through the whole term. The objectives of the team project were to identify, assess, design, and size a photovoltaic system for remote application. The project requirements were relatively simple, so the final outcome was a good indication of the effectiveness of the teamwork for both criteria.

The overall grade on the project was the only performance criteria and the results are presented in Table 9 below. The accomplished result was achieved with > 80% grade and exemplary with 90% or higher. Overall, 100% of the students showed accomplished or exemplary performance and the targets for this outcome were met.

Table 9 - Outcome (d): Wilsonville, REE 412, Winter 2015, Dr. Petrovic

Outcome (d): an ability to function on multi-disciplinary teams				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	% Students >=2
1 - Team participation, communication	0	8	13	100%
2 - Management of team, delegation of responsibilities	0	8	13	100%

Outcome (d): Klamath Falls, ENGR 465, Winter 2015, Dr. Shi

The outcome was assessed using the senior capstone projects of ENGR465 II Winter 2015. All senior projects are team based. The student teams are formed through two different ways. (1) Senior project topics are offered by course advisor or external sponsors for students to select. The advisor and external sponsors give presentations to introduce the background of the offered projects. Then students register for their selected projects. During this process, students may randomly register for some projects and the students who register for the same project form a team or students team up to register for a project. (2) Students team up and propose their own projects. In the senior project sequence of 2015-2015 Academic Year, 5 student teams are formed and work on 5 different projects, namely, "The Rainbow Golf Youth Education Project (Solar Photovoltaic Golf Court Irrigation System and Micro Power Grid Project)", "Biochar Supercapacitor", "An Automated Enzymatic Biodiesel Production Plant", "A Compound Parabolic Concentrator Hybrid Solar Thermal and Photovoltaic System", and "A Self-sustaining Water Purification System". The interdisciplinary teams are formed. The students from electrical engineering, renewable energy engineering, mechanical engineering and manufacture technology, teamed up to work on the interdisciplinary projects. The student groups were asked to give three presentations to demonstrate their project progresses and submit written report to conclude their project. Students are also required to prepare and attend the student senior project symposium as a team.

Four senior students were assessed in term Fall 2013 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 demonstrated their abilities to function on multi-disciplinary teams. It is observed that student team work was improved significantly through senior capstone project.

Table 10 - Outcome (d): Klamath Falls, ENGR 465, Winter 2015, Dr. Shi

Outcome (d): an ability to function on multi-disciplinary teams				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	% student >=2
1 - Team participation, communication	0	1	3	100%
2 - Management of team, delegation of responsibilities	0	1	3	100%

Outcome (d): Klamath Falls, REE 307, Winter 2015, Dr. Shi

The outcome was assessed using the course project "Solar Energy Airship" and "Net Zero Home" of REE307 Energy Storage taught in Winter 2015. The projects are team based. The objective of these project are to design solar collection, storage and utilization systems. The students in this class organized 2 teams to work on 2 projects. One team with 4 students worked on designing a solar energy airship which is launched to collect, and store solar energy in sky, and transport to various destinations for use. One team designed a unique wall structure to collect and store energy for building heating, cooling and power generation. The student groups were asked to give three presentations to demonstrate their project progresses and submit written report to conclude their project. Students demonstrated their ability to function on multi-disciplinary teams. Students with different background demonstrated their ability to collaborate each other to work on the different parts of the projects. In this assessment, one of the student team is formed by registering to the assigned project, the other team is formed by selecting their own project and teaming up their own team.

Six senior students were assessed in term Winter 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 demonstrated their abilities to function on multi-disciplinary teams. The two teams showed outstanding team work skills and worked out fabulous projects.

Table 11 - Outcome (d): Klamath Falls, REE 307, Winter 2015, Dr. Shi

Outcome (d): an ability to function on multi-disciplinary teams				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	% student >=2
1 - Team participation, communication	0	0	6	100%
2 - Management of team, delegation of responsibilities	0	0	6	100%

3.3.7 Targeted Assessment of Outcome (j): A knowledge of contemporary issues

This outcome was assessed in REE 412 - Photovoltaic Systems, and REE 469 - Grid Integration of Renewables.

Outcome (j): Wilsonville, REE 469, Spring 2014, Prof. Rytkonen

This outcome was assessed in REE 469 – Grid Integration of Renewables in Spring 2014 by means of a written paper. The assignment consisted of reading and reviewing two professional journal papers (with a publication date later than 2012) or a technical book/publication chapter (with a publication date of later than 2010) in order to familiarize themselves with contemporary issues associated with integrating renewable resources into the power grid. Finally, the students were required to write a two-page summary (one page per reviewed paper or two pages per book chapter) following the guidelines of the IEEE Transactions Journals (IEEE Transactions Publication-Ready Template and Instructions for Authors). This shows student's ability to think critically about the contemporary issues studied and to condense digested information.

Thirteen students were assessed in Spring 2014 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 12 summarizes the results of this targeted assessment. The results indicate that the minimum acceptable performance level of 80% was met on all three performance criteria for this program outcome, that is, over 80% of students were able to demonstrate knowledge of contemporary issues.

Table 12 - Outcome (j): Wilsonville, REE 469, Spring 2014, Prof. Rytkonen

Outcome (j): A knowledge of contemporary issues				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	%Students >= 2
1 - Demonstrate knowledge of contemporary issues	0	9	4	100%
2 - Recognize the temporal nature of contemporary issues	0	9	4	100%
3 - Recognize the historical context of contemporary issues	0	13	0	100%

Outcome (j): Klamath Falls, REE 412, Fall 2014, Dr. Shi

The outcome was assessed using the course projects of REE412 Photovoltaic Systems taught in Fall 2014. Project topics were offered for students to select to conduct research, design systems, collect data, analyze and interpret data. Students were allowed to choose their own topics to finish the projects. The projects are designed to test student's knowledge of contemporary issues, particularly utilizing renewable energy to address the environmental issues. REE 412 course covers photovoltaic systems. Therefore the scope of the project for students to design, implement systems and analyze the data is confined in the area of photovoltaic related systems. This project was designed as a team based project. Students teamed up by themselves and formed 4 groups. One team chose topic "Solar Road Way Systems". One team chose topic "Portable Photovoltaic Systems". One team chose topic "Photovoltaic Learning Module". And the other team chose topic "Rainbow Youth Golf Education Project: Grid-Tied Solar System Design". The whole class of 12 students is divided into 4 groups with 5 in one group, 2 in one group, 1 in group, and 4 in other group. During the implementation process, 3 presentations were scheduled for students to present the progresses on their projects. And final reports with collected data and data analysis were collected to evaluate their performance and assess the outcome.

The first team designed a photovoltaic system beside highway to use road surface to collect sunlight and generate power. The team collected data and estimated the power generation on the selected portion of I-90 near Seattle, Washington. The second team designed a large scale portable photovoltaic system mounted on a trail for heavy duty truck and collect data to predict its performance. The third team design, implement a two axis tracking hybrid concentrating photovoltaic and solar thermal system based on CPC (Compound Parabolic Concentrator) concentrator. The group projects are evaluated for the following: awareness of environmental issues; photovoltaic system design to address the issues; collect and analyze the data and conclude the results.

A total of 13 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 13 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 13 - Outcome (j): Klamath Falls, REE 412, Fall 2014, Dr. Shi

Outcome (j): A knowledge of contemporary issues				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	%Students >= 2
1 - Demonstrate knowledge of contemporary issues	0	0	12	100%
2 - Recognize the temporal nature of contemporary issues	0	0	12	100%
3 - Recognize the historical context of contemporary issues	0	0	12	100%

3.3.8 2014-15 Indirect Assessments

In addition to direct assessment measures, the student outcomes (a) through (k) were indirectly assessed through a senior exit survey. 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 Table 15 show the results of the indirect assessment of the BSREE student outcomes for the 2014-2015 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.)

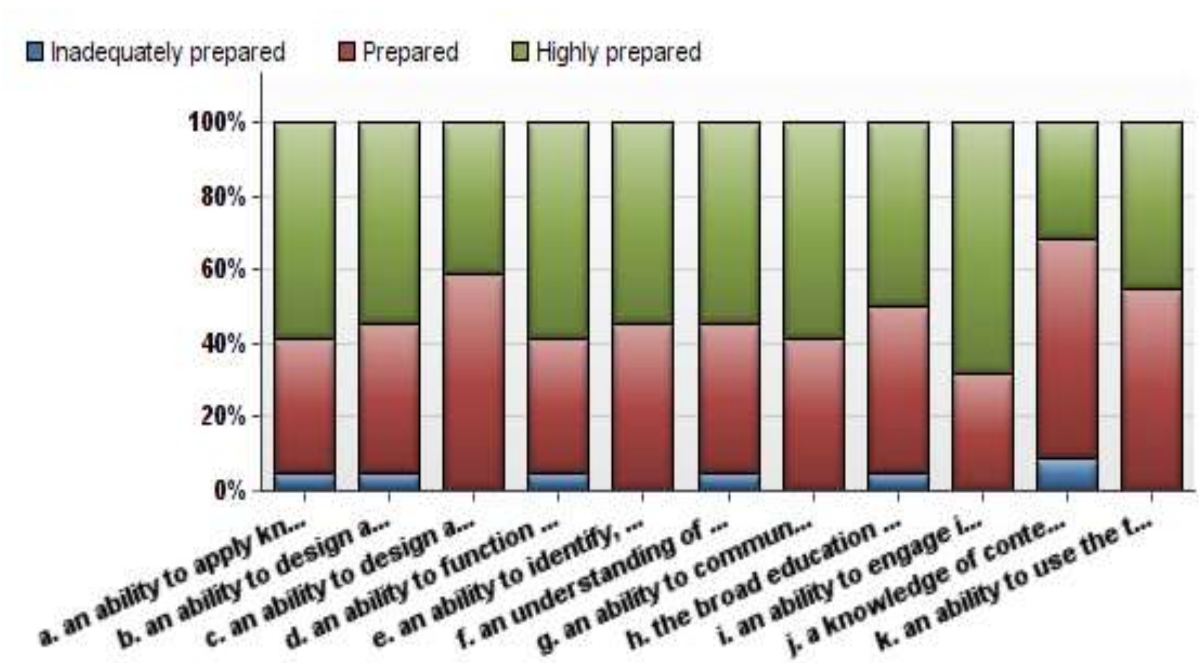

Figure 1 - Graph of results of the indirect assessment for the BSREE Student Outcomes as reported in the Senior Exit Survey (2014-15)

Outcome	Inadequately prepared	Prepared	Highly prepared
a. an ability to apply knowledge of mathematics, science, and engineering	1	8	13
b. an ability to design and conduct experiments, as well as to analyze and interpret data	1	9	12
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
d. an ability to function on multi-disciplinary teams	1	8	13
e. an ability to identify, formulate, and solve engineering problems	0	10	12
f. an understanding of professional and ethical responsibility	1	9	12
g. an ability to communicate effectively	0	9	13
h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context	1	10	11
i. an ability to engage in independent learning and recognize the need for continual professional development	0	7	15
j. a knowledge of contemporary issues	2	13	7
k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	0	12	10

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 2014-15. 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 BS REE faculty met on May 27, 2015 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 2014-15 assessment results for the outcomes which were directly assessed.

Table 14 - Summary of BSREE direct assessment for 2014-15

	Total Students	Students >= 2	% Students >=2
a- Fundamentals (Prof. Zipay)			
1- Mathematics	10	10	100%
2- Science ad Engineering	10	10	90.0%
a- Fundamentals (Prof. Ahsan)			
1- Mathematics	14	13	92.8%
2- Science and Engineering	14	13	92.8%
a- Fundamentals (Dr. Crespo)			
1- Mathematics	19	18	94.7%
2- Science and Engineering	19	18	94.7%
c - Design (Prof. Rytkonen)			
1- Engineering Solution	7	7	100%
2- Develop	7	7	100%
3- Evaluate	7	7	100%
c - Design (Dr. Shi)			
1- Engineering Solution	12	12	100%
2- Develop	12	12	100%
3- Evaluate	12	12	100%
c - Design (Dr. Petrovic)			
1- Engineering Solution	21	17	81.0%
2- Develop	21	17	81.0%
3- Evaluate	21	17	81.0%
d- Teamwork (Dr. Shi)			
1- Participation	4	4	100%
2- Management	4	4	100%
d- Teamwork (Dr. Shi)			
1- Participation	6	6	100%
2- Management	6	6	100%
d- Teamwork (Dr. Jiru)			
1- Participation	25	22	88.0%
2- Management	25	22	88.0%
d- Teamwork (Dr. Petrovic)			
1- Participation	21	21	100%
2- Management	21	21	100%
j- Contemporary Issues (Dr. Shi)			
1- Demonstrate Knowledge	12	12	100%
2- Recognize Temporal Nature	12	12	100%
3- Recognize Historical Context	12	12	100%
j- Contemporary Issues (Prof. Rytkonen)			
1- Demonstrate Knowledge	13	13	100%
2- Recognize Temporal Nature	13	13	100%
3- Recognize Historical Context	13	13	100%

4.1 Changes Resulting from the 2014-15 Assessment

The results of the 2014-15 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 May 2015 with respect to these results. These areas include:

- **Outcome a (Fundamentals):**
  - **Results:** The results show that the threshold of attainment of this outcome was exceeded in all performance criteria. These results are consistent with those obtained the last time this outcome was assessed in the 2011-12 assessment cycle.
  - **Recommendation:** The faculty identified no problem with this outcome, and therefore recommended no changes at this time.
- **Outcome c (Design):**
  - **Results:** The results show that the threshold of attainment of this outcome was exceeded in all performance criteria. These results are consistent with those obtained the last time this outcome was assessed in the 2011-12 assessment cycle.
  - **Recommendation:** The faculty identified no problem with this outcome, and therefore recommended no changes at this time.
- **Outcome d (Teamwork):**
  - **Results:** The results show that the threshold of attainment of this outcome was exceeded in all performance criteria. These results are consistent with those obtained the last time this outcome was assessed in the 2011-12 assessment cycle.
  - **Recommendation:** The faculty identified no problem with this outcome, and therefore recommended no changes at this time.
- **Outcome j (Contemporary Issues):**
  - **Results:** The results show that the threshold of attainment of this outcome was exceeded in all performance criteria. These results are consistent with those obtained the last time this outcome was assessed in the 2010-11 assessment cycle.
  - **Recommendation:** The faculty identified no problem with this outcome, and therefore recommended no changes at this time.

4.2 Changes to Assessment Methodology

Based on the discussion at the 2015 BSREE Closing the Loop meeting, the BS REE faculty have no major recommendations with regards to improving the assessment methodology.