BS Renewable Energy Engineering

2017-18 Assessment Report

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Contents

1 Introduction 3

1.1 Program Design and Goals 3

1.2 Program History 3

1.3 Industry Relationships 4

1.4 Program Locations 4

2 Program Mission, Educational Objectives and Outcomes 5

2.1 Program Mission 5

2.2 Program Educational Objectives 5

2.3 Relationship between Program Objectives and Institutional Objectives 5

2.4 Program Outcomes 5

3 Cycle of Assessment for Program Outcomes 6

3.1 Introduction and Methodology 6

3.2 Assessment Cycle 6

3.3 Summary of Assessment Activities & Evidence of Student Learning 6

3.3.1 Introduction 6

3.3.2 Methods for Assessment of Program Outcomes 7

3.3.3 2017-18 Targeted Direct Assessment Activities 8

3.3.4 Targeted Assessment for Outcome (a): an ability to apply knowledge of mathematics, science, and engineering 8

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. 9

3.3.6 Targeted Assessment of Outcome (d): an ability to function on multi-disciplinary teams14

3.3.7 Targeted Assessment of Outcome (e): An ability to identify, formulate, and solve engineering problems 13

3.3.8 Targeted Assessment of Outcome (i): a recognition of the need for, and an ability to engage in lifelong learning 15

3.3.9 Targeted Assessment of Outcome (j): a knowledge of contemporary issues 16

3.3.10 2017-18 Indirect Assessments 16

4 Changes Resulting from Assessment 22

4.1 Changes Resulting from the 2017-18 Assessment 28

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.

It is anticipated that BSREE 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 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 the Portland-metro area in proximity to the Pacific Northwest's energy industry cluster, and the second in rural Southern Oregon with exceptional natural energy resources. The Portland-metro 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*. 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

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

(j) a knowledge of contemporary issues

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

Starting with the 2018-19 academic year, assessment will be done using the new (1)-(7) student outcomes below

New ABET outcomes:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

3. an ability to communicate effectively with a range of audiences

4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

We will be assessing (1) - (7) from now on. Basically

(1) covers the old ABET outcomes (a) and (c)

(4) covers the old ABET outcomes (f), (h), and (j).

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 from the 2016-17 academic year, the assessment cycle begins in the Fall. In 2015-16 academic year, the assessment cycle started in the Spring. This change reflects a shift on an institutional level to begin data collection in the Fall term. In 2016-17 the Assessment Commission Executive Committee began recommending that programs begin data collection during Fall term, and generate the assessment report at the beginning of the next academic year.

3.2 Assessment Cycle

Table 1 – Old BSREE Outcome Assessment Cycle

Student Outcome	**2015-16**	**2016-17**	**2017-18**
a) Fundamentals			EE321, REE377 [K]
b) Experimentation	EE419, REE33X		
c) Design			EE355 [K], ENGR465
d) Teamwork			REE412
e) Problem solving		REE337, EE419	REE337 [W]
f) Ethics	REE463, REE469		
g) Communication		EE355, REE348	
h) Impact	REE412, REE346		
i) Independent learning		REE454, REE463	REE463
j) Contemporary Issues			REE412 [W], REE469 [K], REE407 [K], REE455 [W]
k) Engineering tools		ENGR355, REE455[W], REE413[K]	
K – assessed at Klamath Falls campus only, W – Assessed at Wilsonville campus only, if none is specified then it is applicable for both campuses.			

Table 2: New BSEE Outcome Assessment Cycle

Student Outcome	2018-19	2019-20	2020–21
(1) Principles			EE321, EE419
(2) Design			EE355, REE412
(3) Communication		EE355, REE348	
(4) Ethics	REE 463, REE346		
(5) Teams	REE337[k], REE412[w], REE469[w], ENGR465[k]		
(6) Experimentation		EE419, REE33X	
(7) Learning		REE463, ENGR267	
K – assessed at Klamath Falls campus only, W – Assessed at Wilsonville campus only, if none is specified then it is applicable for both campuses.			

N. B. To collect the assessment data for 2018-19 ESLO Ethical Reasoning (Bachelor's Degree Programs only for REE) the course REE 454 has been selected for both campus.

3.3 Summary of Assessment Activities & Evidence of Student Learning

3.3.1 Introduction

The BSREE faculty conducted formal assessment during the 2017-18 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 Council (IAC) at the following IAC 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 2017-18 Targeted Direct Assessment Activities

The sections below describe the 2017-18 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 (a): an ability to apply knowledge of mathematics, science, and engineering

This outcome was assessed in EE 321 – Electronics I.

Outcome (a): Wilsonville, EE 321, Fall 2017, Dr. Aboy

This outcome was assessed in EE321 - Electronics I in Fall 2017 by means of a lab assignment. The lab assignment 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. Once the design was finalized (analyzed theoretically) and the simulations indicated the results were met, students were required to physically implement their designs and experimentally test them. Finally, the students were required to write a record and video demo showing their working design and write a brief (3 page) report documenting their design. The assignment involved the application of fundamentals (i.e., to apply knowledge of mathematics, science and engineering) in order to design the power supply.

Twelve students were assessed in Fall 2017 in the course EE321 Electronics I 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 mathematics, science and engineering fundamentals to design an adjustable power supply with a discrete regulator.

Table 2 - Outcome (a): Wilsonville, EE 321, Fall 2017, Dr. Aboy

Outcome (a): an ability to apply knowledge of mathematics, science, and engineering				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	%Students >= 2
1 - Math	2	10	0	83.3%
2 - Science	2	10	0	83.3%

3 - Engineering	1	11	0	91.67%

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 System Design, and ENGR465 - Senior Capstone Project

Outcome (c): Klamath Falls, EE 355, Spring 2018, Dr. Hossain

This outcome was assessed in EE355 - Control System Design in Spring 2018 by means of a project. The tasks consisted of control system design of different systems including induction motor drive, magnetic levitation system, solar tracking system, and vertical axis wind turbine. The students were required to have the theoretical knowledge to perform these tasks, carry out the necessary design, and present their works with necessary details.

Fourteen (14) students were assessed in Spring 2018 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 identify and perform the professional, ethical, and social responsibilities while carrying out their assigned tasks.

Table 3 - Outcome (c): Klamath Falls, EE 355, Spring 2018, Dr. Hossain

<table>
<tr><td colspan="5">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.</td></tr>
<tr><td>Performance Criteria</td><td>1-Developing</td><td>2-Accomplished</td><td>3-Exemplary</td><td>%Students >1</td></tr>
<tr><td>1 – Recognition of need (needs that motivate a design project)</td><td>0</td><td>4</td><td>10</td><td>100%</td></tr>
<tr><td>2 – Define the design problem (design objectives and functional requirements)</td><td>0</td><td>0</td><td>14</td><td>100%</td></tr>
<tr><td>3 - Develop a design strategy (design plan)</td><td>0</td><td>0</td><td>14</td><td>100%</td></tr>
<tr><td>4 - Gathers design information</td><td>0</td><td>6</td><td>8</td><td>100%</td></tr>
<tr><td>5 – Employs models in design decisions</td><td>0</td><td>0</td><td>14</td><td>100%</td></tr>
<tr><td>6 – Evaluates relative value of a feasible solution</td><td>0</td><td>7</td><td>7</td><td>100%</td></tr>
<tr><td>7 – Selects the best design</td><td>0</td><td>14</td><td>0</td><td>100%</td></tr>
<tr><td>8 – Communication and documentation</td><td>0</td><td>3</td><td>11</td><td>100%</td></tr>
</table>

Outcome (c): Klamath Falls, ENGR 465, Spring 2018, Dr. Shi

The outcome was assessed using the senior projects of ENGR465 Senior Capstone Project. 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. ENGR465 senior project covers any types of renewable energy. Therefore the scope of the project for students to design, conduct experiments and analyze the data is confined in the area of renewable energy related systems. This project was designed as a team based project. Students teamed up by themselves and formed 5 groups. One team chose topic "Utilization of solar desal apparatus to provide water to soilized sand for growing crops in arid climates". One team chose topic "Design, development, and implementation of a remote controlled lawn mower". One team chose topic "design, development and implementation of an active carbon capture system". One team chose topic "Design of a smart parking system". And the other team chose topic "Hybrid energy storage for renewable energy applications". The whole class of 14 students is divided into 5 groups with 5 in one group, 1 in one group, 3 in one group,4 in one group, and 1 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 total 14 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.

The table below 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 4 - Outcome (c): Klamath Falls, ENGR 465, Spring 2018, Dr. Shi

(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
C1: Recognize need for an engineering solution	0	0	100%	100%
C2: Develop a design strategy within realistic constraints	0	0	100%	100%
C3: Evaluate relative value of a feasible solution	0	0	100%	100%

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

This outcome was assessed in REE412 – PV System

Outcome (d): Klamath Falls, REE 412, Fall 2017, Dr. Terry

The outcome was assessed using the course project "Photovoltaic Array Design" of REE412 Photovoltaic Systems taught in Fall 2017. The projects are team based with 3 to 4 students per team. The objective of this project was to design a solar array to these specifications:

1. Select a site location on the planet.

2. Using publicly available resources (textbook, internet, other), determine the size of the system needed to power the site for the entire year for net-zero cost to the site owner.

3. Ensure the most recent NEC codes are followed with connection on the customer side of the meter. Design the entire system including: modules (type/brand and rating), inverter(s), wiring (including electrical design and sizing), breakers, junction boxes and combiners, racking/mounting system, etc.

4. Perform a cost analysis of the system to include return on investment (ROI).

The student groups were asked to give a final presentation to demonstrate their project and submit written report to conclude their project. Additionally, each student was required to complete a peer assessment on themselves along with each team member. Students demonstrated their ability to function on multi-disciplinary teams. Students with different background demonstrated their ability to collaborate with each other to work on the different parts of the design project. Students were assigned to teams by random draw which brought diversity to each team.

Eighteen senior students were assessed in term Fall 2017 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 5 summarizes the results of this targeted assessment. The results indicate that the minimum acceptable performance level exceeding 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 teams showed good team work skills with some individual outliers.

Table 5 - Outcome (d): Klamath Falls, REE 412, Fall 2017, Dr. Terry

Outcome (d): an ability to function on multi-disciplinary teams				
Performance Criteria	1-Developing	2-Accomplished	3- Exemplary	%Students >= 2
D1 – Team development	1	3	14	94.44%
D2 – Team participation	1	3	14	94.44%
D3 – Team communication (listening and feedback)	1	3	14	94.44%
D4 – Uses ideas in decision making	0	4	14	100.00%
D5 – Reaching a group consensus	0	4	14	100.00%
D6 – Manages a team effectively	3	1	14	83.33%

Outcome (d): Wilsonville, REE 412, Winter 2018, Dr. Petrovic

This outcome was assessed in REE 412 – PV Systems in Winter 2018 by means of a group project in teams of 3 or 4 students. The project involved creating manufacturing design proposals; and technical and business opportunities from the area of photovoltaic systems.

All fifteen students, in their teams, were assessed using the performance criteria listed in the table below. The levels of performance were established in the following way: for result of 90% or above was exemplary. The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level overall across criteria, i.e., such as team development, participation, consensus and managing teams effectively.

Table 6 summarizes the results of this targeted assessment. The results indicate that 100% of students exemplary.

Table 6 - Outcome (d): Wilsonville, REE 412, Winter 2018, Dr. Petrovic

Performance Criteria	1 - Developing	2 - Accomplished	3 - Exemplary
D1 Participation in teams	0	0	15
D2 Communication within teams	0	0	15
D3 Consensus in teams and managing effectively	0	0	15

3.3.7 Targeted Assessment of Outcome (e): An ability to identify, formulate, and solve engineering problems.

This outcome was assessed in REE 337 - Materials for RE Applications

Outcome (e): Klamath Falls, REE 337, Winter 2018, Dr. Shi

This outcome was assessed using the final examination of the course. 8 problems are modified to test the 8 criterias, as well as the course contents. Each individual student is assessed based on their answers of the test questions.

9 students were assessed in Winter 2018 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.

The table below 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 student outcome.

Table 7 - Outcome (e): Klamath Falls, REE 337, Winter 2018, Dr. Shi

(e) An ability to identify, formulate, and solve engineering problems.				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	% student >2
E1: Identifies technical problems	0	0	100%	100%
E2: Identifies problem statement and parameters.	11.11%	0	88.89%	88.89%
E3: Collects data resources and information for a problem	0	31.25%	68.75%	100%
E4: Modeling the problem	0	11.11%	88.89%	100%
E5: Designing an experiment (outcome b)	11.11%	11.11%	77.78%	88.89%
E6: Develop Solutions from a model or experiment	11.11%	0	88.89%	88.89%
E7: Interpreting results from experiments or models	11.11%	0	88.89%	88.89%
E8: Implement a solution	11.11%	44.44%	44.44%	88.89%

3.3.8 Targeted Assessment of Outcome (i): a recognition of the need for, and an ability to engage in lifelong learning.

This outcome was assessed in REE 463 - Energy Systems Instrumentation

Outcome (i): Klamath Falls, REE 463, Spring 2018, Dr. Hossain

This outcome was assessed in REE463 - Energy Systems Instrumentation in Spring 2018 by means of lab work. The tasks consisted of curve fitting, simulation and hardware implementation of Wheatstone bridge, and analyzing system behavior through step and impulse response. The students were required to have the theoretical knowledge to perform these tasks, carry out the necessary simulation, hardware implementation, and measurement, and present their works with necessary details.

Eleven (11) students were assessed in Spring 2018 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 identify and perform the professional, ethical, and social responsibilities while carrying out their assigned tasks

Table 8 - Outcome (i): Klamath Falls, REE 463, Spring 2018, Dr. Hossain

Outcome (i): a recognition of the need for, and an ability to engage in lifelong learning.				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	%Students >1
1 - Demonstrates an awareness of what needs to be learned	0	0	11	100%
2 - Identifying, gathering and analyzing information.	1	6	4	90.91%

Outcome (i): Wilsonville, REE 463, Winter 2018, Dr. Melendy

ABET Outcome (i) was assessed by means of a laboratory assignment in which students conducted a comprehensive, multidisciplinary experiment. The objective of this experiment was to have the students recognize the need for sensors, actuators, and electronic circuitry in measuring equipment and instrumentation engineering. An equally important objective was to have students recognize the need for Newtonian mechanics and the mechanical properties of materials in the development of electronic instrumentation for energy-related systems.

Eleven (11) REE majors were assessed using the performance criteria (Table 1). The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level in all performance criteria. The results indicate that the minimum acceptable performance level of 80% was met on the performance criteria for this program outcome.

The majority of the students met or exceeded expectations, they demonstrated their abilities to interface sensors and actuators with various metal test specimens, how sensors and actuators interface with various electronic circuitry to form different types of energy systems instruments, how the different forms of measurements are interrelated with sensors, actuators, and recording instrumentation, and how experimental research is conducted using instruments and components that the researcher designs and builds.

Table 9 - Outcome (i): Wilsonville, REE 463, Winter 2018, Dr. Melendy

Outcome (i): a recognition of the need for, and an ability to engage in lifelong learning.				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	%Students >= 1
Demonstrates and awareness of what needs to be learned.	1	3	7	90.91%
Identifying, gathering, and analyzing information.	1	4	6	90.91%

3.3.9 Targeted Assessment of Outcome (j): a knowledge of contemporary issues.

This outcome was assessed in REE 469 - Grid Integration of Renewables, REE407 Solar Power System III, REE 455 - Energy-Efficient Building Design

Outcome (j): Klamath Falls, REE 469, Spring 2018, Dr. Hossain

This outcome was assessed in REE469 - Grid Integration of Renewables in Spring 2018 by means of a homework. The homework consisted of questions related to the current practice and trends of power systems. It tested the amount of knowledge the student had on distributed power generation, power distribution, storage, and microgrid.

Eleven (11) students were assessed in Spring 2018 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 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, that is, over 80% of students were able to identify and perform the professional, ethical, and social responsibilities while carrying out their assigned tasks.

Table 10 - Outcome (j): Klamath Falls, REE 469, Spring 2018, Dr. Hossain

Outcome (j): a knowledge of contemporary issues.				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	%Students >1
1 - Knowledge of contemporary issues (socio-econ. issues for us/world)	0	0	11	100%
2 - Knowledge of contemporary issues (political issues at national/state/local levels)	0	0	11	100%
3 - Knowledge of contemporary issues (environmental context)	0	2	9	100%

Outcome (j): Klamath Falls , REE 407, Spring 2018, Dr. Shi

The outcome was assessed using the course projects of REE407 Solar Power System III taught in Spring 2018. 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 407 course covers photovoltaics. 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 3 groups. One team chose topic "3D Printer Design and Fabrication". One team chose topic "Integrated Circuit

Solar Cell Fabrication". And the other team chose topic "Solar Powered Electric Vehical Charging station with Fuzzy Logic Controller". The whole class of 8 students is divided into 3 groups with 2 in 1 groups, 3 in 2 groups. 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 total 8 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.

The table 11 below 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 11 - Outcome (j): Klamath Falls, REE 407, Spring 2018, Dr. Shi

Outcome (j) a knowledge of contemporary issues				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	% student >2
J1: Knowledge of contemporary issues (socio-econ. Issues for US/world)	0%	0%	100%	100%
J2: Knowledge of contemporary issues (Political issues at national/state/local levels)	0%	0%	100%	100%
J3: Knowledge of contemporary issues (Environmental context)	0%	0%	100%	100%

Outcome (j): Wilsonville, REE455, Spring 2018, Dr. Jiru

This outcome was assessed in REE 455 - Energy-Efficient Building Design in spring 2018 using project reports and oral presentations. Each student were assigned an oral presentation topic and were required to give a 30-minute oral presentation. The topics cover contemporary building energy-efficiency technologies that reduce energy consumption and improve environmental quality.

Eight students were assessed in spring 2018 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 below 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. 80% of the students met or exceeded expectations; they demonstrated knowledge of contemporary issues.

Outcome (j) a knowledge of contemporary issues				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	%Students >= 2
Environmental context	1	5	2	87.5%

3.3.10 2017-18 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. Question BREE 1 in the survey asked students "Program Student Learning Outcomes for Renewable Energy Engineering B.S. Please rate your proficiency in the following areas."

Figure 1 and Table 12 show the results of the indirect assessment of the BSREE student outcomes for the 2017-18 graduating class. Fifteen BS REE graduating seniors completed the survey, with over 93% of the respondents indicating that as a result of completing the BS REE program they feel proficient or highly proficient 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.)

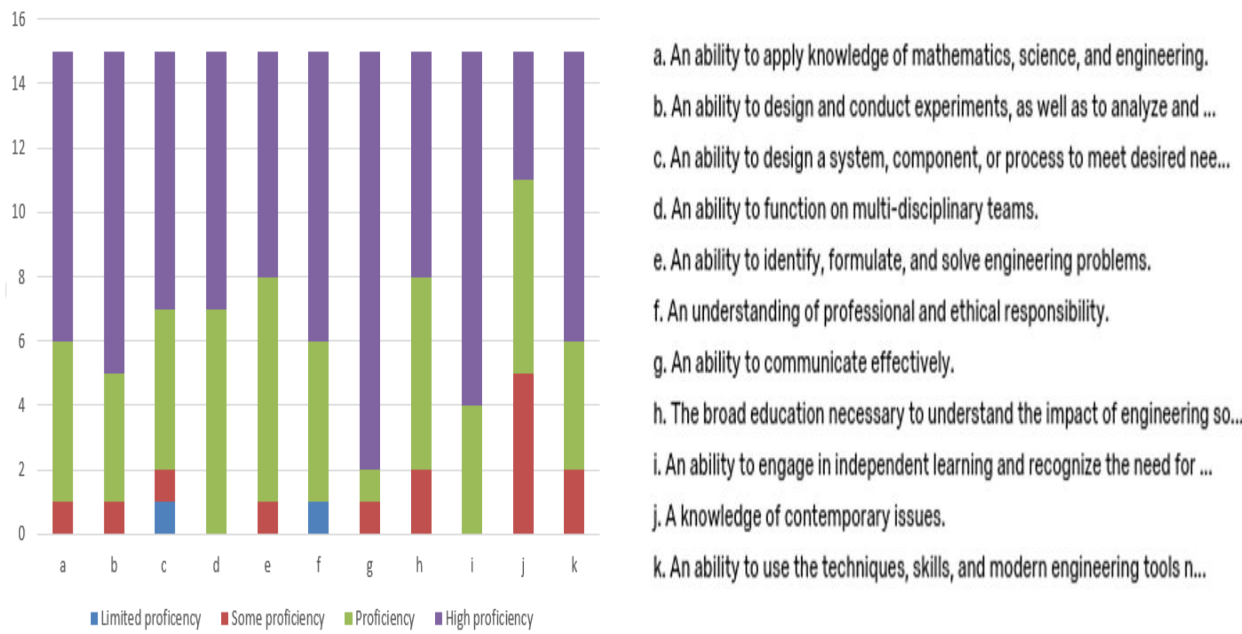

Figure 1 - Graph of results of the indirect assessment for the BSREE Student Outcomes as reported in the Senior Exit Survey (2017-18)

The previous Senior Exit Survey questions have been changed to the following questions which will be effected from 2018-19 sessions for BSREE programs

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

3. an ability to communicate effectively with a range of audiences

4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Table 12 - Results of the indirect assessment for the BSREE Student Outcomes as reported in the Senior Exit Survey (2017-18)

Outcome	1-Limited proficiency	2-Some proficiency	3-proficiency	4-High proficiency	% Student >= 3
a. an ability to apply knowledge of mathematics, science, and engineering	0	1	5	9	93.3%
b. an ability to design and conduct experiments, as well as to analyze and interpret data	0	1	4	10	93.3%
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	1	1	5	8	86.67%
d. an ability to function on multi-disciplinary teams	0	0	7	8	100%
e. an ability to identify, formulate, and solve engineering problems	0	1	7	7	93.3%
f. an understanding of professional and ethical responsibility	1	0	5	9	93.3%
g. an ability to communicate effectively	0	1	1	13	93.3%
h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context	0	2	6	7	86.67%
i. an ability to engage in independent learning and recognize the need for continual professional development	0	0	4	11	100%
j. a knowledge of contemporary issues	0	5	6	4	66.67%
k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	0	2	4	9	86.67%

4 Changes Resulting from Assessment

This section describes the changes resulting from the assessment activities carried out during the year 2017-18. 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 November 15, 2018 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 13 provides a summary of the 2017-18 assessment results for the outcomes which were directly assessed.

Table 13 - Summary of BSREE direct assessment for 2017-18

	Total Students	Students >= 2	% Students >=2
(a): fundamentals (Wilsonville, EE 321, Fall 2017, Dr. Aboy)			
1- Math	12	10	83.3%
2- Science	12	10	83.3%
3- Engineering	12	11	91.67%
(c): design (Klamath Falls, EE 355, Spring 2018, Dr. Hossain)			
1- Recognition of need (needs that motivate a design project)	14	14	100%
2- Define the design problem (design objectives and functional requirements)	14	14	100%
3- Develop a design strategy (design plan)	14	14	100%
4- Gathers design information	14	14	100%
5- Employs models in design decisions	14	14	100%
6- Evaluates relative value of a feasible solution	14	14	100%
7- Selects the best design	14	14	100%
8- Communication and documentation	14	14	100%
(c): design (Klamath Falls, ENGR 465, Spring 2018, Dr. Shi)			
1- Recognize need for an engineering solution	14	14	100%
2- Develop a design strategy within realistic constraints	14	14	100%
3- Evaluate relative value of a feasible solution	14	14	100%
(d): teamwork (Klamath Falls, REE 412, Fall 2017, Dr. Terry)			
1- Team development	18	17	94.4%
2- Team participation	18	17	94.4%
3- Team communication	18	17	94.4%

(listening and feedback) 4- Uses ideas in decision making 5- Reaching a group consensus 6- Manages a team effectively	 18 18 18	 18 18 15	 100% 100% 83.3%
(d): teamwork (Wilsonville, REE 412, Winter 2018, Dr. Petrovic)			
1- Participation in teams 2- Communication within teams 3- Consensus in teams and managing effectively	15 15 15	15 15 15	100% 100% 100%
(e): problem solving (Klamath Falls, REE 337, Winter 2018, Dr. Shi)			
1- Identifies technical problems 2- Identifies problem statement and parameters. 3- Collects data resources and information for a problem 4- Modeling the problem 5- Designing an experiment (outcome b) 6- Develop Solutions from a model or experiment 7- Interpreting results from experiments or models 8- Implement a solution	9 9 9 9 9 9 9 9	9 8 9 9 8 8 8 8	100% 88.89% 100% 100% 88.89% 88.89% 88.89% 88.89%
(i): independent learning (Klamath Falls, REE 463, Spring 2018, Dr. Hossain)			
1- Demonstrates an awareness of what needs to be learned 2- Identifying, gathering and analyzing information.	11 11	11 10	100% 90.91%
(i): independent learning (Wilsonville, REE 463, Winter 2018, Dr. Melendy)			
1- Demonstrates an awareness of what needs to be learned 2- Identifying, gathering and analyzing information	11 11	10 10	90.91% 90.91%
(j): contemporary issue (Klamath Falls, REE 469, Spring 2018, Dr. Hossain)			
1- 1 - Knowledge of contemporary issues (socio-econ. issues for us/world) 2- Knowledge of contemporary issues (political issues at national/state/local levels)	11 11	11 11	100% 100%

3- Knowledge of contemporary issues (environmental context)	11	11	100%
(j): contemporary issue (Klamath Falls, REE 407, Spring 2018, Dr. Shi)			
1- J1: Knowledge of contemporary issues (socio-econ. Issues for US/world) 2- Knowledge of contemporary issues (Political issues at national/state/local levels) 3- Knowledge of contemporary issues (Environmental context)	8 8 8	8 8 8	100% 100% 100%

4.1 Changes Resulting from the 2017-18 Assessment

The results of the 2017-18 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 November 15, 2018 with respect to these results. These areas include:

- **Outcome (e): fundamental**
  - **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 (c): design**
  - **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 (d): teamwork**
  - **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 (e): problem solving**
  - **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 (i): independent learning**
    - **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 (j): contemporary issue**
    - **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.