Renewable Energy Engineering
2012-13 Assessment Report

Department of Electrical Engineering and Renewable Energy

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Editing Faculty

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Contents

1 Introduction

1.1 Program Design and Goals

The Bachelor of Science in Renewable Energy Engineering (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 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 (BSRES) 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.

We anticipate 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 REE program. Twenty representatives from corporations, government institutions and non-profit organizations comprise the IAC, giving the BSREE a broad constituent audience. The IAC provides advice and counsel to the REE program with respect to the areas of curriculum content advisement, instructional resources review, career guidance and placement activities, program accreditation reviews, and professional development advisement and assistance. In addition, each advisory committee member serves as a vehicle for public relations information and potentially provides a point of contact for the development of specific opportunities with industries for students and faculty.

1.4 Program Locations

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

1.5 Enrollment

Enrollment in the program at both the Portland and Klamath Falls campuses has leveled off since the inception of the program. Fall 2012 headcount enrollment was 118 students at the Wilsonville campus (55 BSREE, 63 PREE) and 88 in Klamath Falls (38 BSREE, 50 PREE), for a total headcount of 206.

1.6 Graduates

Graduation rates have been climbing, as indicated in Table 1.

Table 1 – Renewable Energy Baccalaureate Degrees Awarded

Academic Year	Number of Graduates
2008-09	7[1]
2009-10	9
2010-11	29
2011-12	35
2012-13	67[2]

[1] Six graduates received the BSREE degree; one graduate received the BSRES degree.
[2] Number is approximate. Actual number to be obtained from Office of Institutional Research at a later date.

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 Student Outcomes

The BSREE student outcomes (SOs) include ABET's EAC a - k[3]. All of these are listed here:

(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

[3] 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.

(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[4]

(j) a knowledge of contemporary issues

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

[4] 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 Assessment of Student Outcomes

3.1 Introduction and Method

Table 2 shows the minimum outcomes assessed during each academic year. Assessment of the student outcomes will be conducted over a three year-cycle, following the pattern starting in 2010-11 (during the 2009-10 academic year, all outcomes were assessed in order to establish a baseline). In addition to program assessment, faculty members participate in assessment of Institutional Student Learning Outcomes (ISLOs).

3.2 Assessment Cycle

Table 2 – BSREE Outcome Assessment Cycle

		2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
(a)	Fundamentals	√	√		√		
(b)	Experimentation		√			√	
(c)	Design	√	√		√		
(d)	Teamwork	√	√		√		
(e)	Engineering Problems		√	√			√
(f)	Ethics		√			√	
(g)	Communication		√			√	
(h)	Impact of Solutions		√			√	
(i)	Life-long Learning		√	√	√*		√
(j)	Contemporary Issues		√	√			√
(k)	Engineering Tools		√	√			√
* indicates the outcome from the previous year has been selected to be reassessed							
as part of the continuous improvement process							

3.3 Assessment Activities & Evidence of Student Learning

3.3.1 Introduction

The BSREE faculty conducted formal assessment during the 2012-13 academic year using direct measures, such as comprehensive ABET Projects and ABET Assignments.[5] Additionally, the student outcomes were assessed using indirect measures, namely results from student evaluations based on methods developed by the IDEA Center[6] and senior exit surveys.

[5] ABET Projects and ABET Assignments refer to projects and assignments especially designed by Oregon Tech BSREE faculty to go beyond the assessment of course outcomes in order to assess more general program-level outcomes including the ABET a-through-k outcomes.

[6] The IDEA Center, www.theideacenter.org

3.3.2 Assessment of Program Educational Objectives

During the 2012-13 academic year, the Dean of the College of Engineering, Technology and Management pointed out that the Engineering Accreditation Commission does not require assessment of program educational objectives. Therefore, with the concurrence of the department chair, no PEOs are assessed. However, the Industry Advisory Council will continue to be polled on an annual basis regarding their approval of the PEOs.

3.3.3 Methods for Assessment of Student Outcomes

The BSREE conducts direct and indirect assessments. The direct assessment process using assignments specifically designed to measure ABET-style outcomes. The indirect assessment process derives assessment data from course evaluations and from senior exit surveys.

Direct Measure: ABET Assignments

This direct assessment process links specific tasks within engineering course assignments to ABET student outcomes and then on to program educational objectives in a systematic way based on ABET rubrics.[7] The student outcomes are evaluated as part of the course curriculum primarily by means of comprehensive ABET assignments specifically designed to measure program-level outcomes in addition to course-level outcomes. These assignments typically involve a project or lab requiring the student to apply math, science, and engineering principles learned in the course to solve a particular problem requiring the use of modern CAD tools and engineering equipment, working in teams, and writing a project report or giving an oral presentation. ABET assignments are designed to assess several fundamental student outcomes at once.

An ABET multi-outcome rubric is used to perform direct assessment of these assignments. A systematic, rubric-based process is then used to quickly assess tasks within assignments and link them directly to a group of student outcomes. Evaluations of these outcomes are then gathered and accounted in outcome-specific tables, analyzed and then individually summarized. Summaries for all outcomes are then compiled into a comprehensive student outcome summary for each course. The outcome summary is then evaluated for relevance with respect to the program objectives. The summary of outcomes is formatted and organized such that it is suitable for inclusion in an ABET review document.

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 ABET-relevant ("a" through "k") 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 student outcome s.

By assessing multiple outcomes per assignment, the number of assessed assignments may be reduced and assignments become more relevant to the student outcome s, since the assignments are designed with the general student outcomes in mind. Additionally, incorporating multiple outcomes in a single assignment provides for a richer assignment, one that takes into account a wider range of engineering issues.

[7] "ABET rubrics" refer to rubrics especially designed by Oregon Tech BSREE faculty to assess ABET projects based on program-level outcomes.

Indirect Measure: KSU IDEA Evaluations

At Oregon Tech, course evaluations are conducted using the course evaluation form developed by the IDEA Center[8], an organization originating from Kansas State University. From collected student evaluation forms, an IDEA Center diagnostic report is generated and returned to the instructor.

Methods for this indirect assessment are detailed in Criteria 3 of the 2009-10 BSREE ABET Self-Study. The sections below describe the 2012-13 targeted indirect assessment activities based on the IDEA Center diagnostic reports.

Indirect Measure: Senior Exit Surveys

At Oregon Tech, senior exit surveys are conducted using the Qualtrics survey platform. The sections below describe the assessment performed using the senior exit surveys in 2012-13.

[8] The IDEA Center, www.theideacenter.org

3.3.4 2012-13 Targeted Direct Assessment Activities

The sections below describe the 2012-13 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.

The minimum acceptable performance level for all outcomes was to have 80% or above of the students performing at the accomplished or exemplary level for all performance criteria. The summary data presented in this section represent the percentages of students meeting course-specific criteria.

3.3.4.1 Targeted Assessment of Outcome (b)

An ability to design and conduct experiments, as well as to analyze and interpret data

Assessment b1: [EE 419, Fall 2012 – Klamath Falls]

This outcome was assessed using the final lab project assigned for student for the power electronics lab (EE 419). The students could select from a choice of topics including a linear power supply, a closed loop temperature controlled data acquisition system, and a project based on their interest.

Thirty-four students were assessed in fall 2012 using the performance criteria listed below. The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level in all performance criteria.

Table 3 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, except B3 (analyze and interpret data). Most students met or exceeded expectations, i.e., they demonstrated their abilities to design experiments to characterize systems or devices, as well as to conduct experiments in a laboratory setting using industry standard test equipment to collect data. However, 23% of students failed to correctly analyze and interpret their data. Therefore, the criterion B3 is showing a value slightly below the target level of 80%.

Table 3 Targeted Assessment for Outcome (b).

Performance Criteria	1 - Developing	2 - Accomplished	3 - Exemplary	% Students ≥ 2
(b) an ability to design and conduct experiments, as well as analyze and interpret data				
B1: Design an experiment	0%	60%	40%	100%
B2: Conduct an experiment	12%	24%	64%	88%
B3: Analyze, interpret data	23%	59%	18%	77%

Assessment b2: [MECH 318, Winter 2013 – Wilsonville]

This outcome was assessed using three laboratory experiments: Buoyancy and Stability, Bernoulli Principle, and Pump Testing. The students were divided into two groups and provided with laboratory manuals for each experiment. After conducting the experiments, each group 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.

Nine students were assessed in Winter 2013 using the performance criteria listed below. The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level in all performance criteria.

Table 4 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. Students met or exceeded expectations; they demonstrated their abilities to conduct experiments in a laboratory setting using industry standard test equipment, and to collect data and analyze and interpret results. Since students were not asked to design their own experiment, performance criterion B1 could not be properly assessed.

Table 4 Targeted Assessment for Outcome (b).

Performance Criteria	1 - Developing	2 - Accomplished	3 - Exemplary	% Students ≥ 2
(b) an ability to design and conduct experiments, as well as analyze and interpret data				
B1: Design an experiment	0%	0%	0%	N/A
B2: Conduct an experiment	0%	45%	55%	100%
B3: Analyze, interpret data	0%	45%	55%	100%

Assessment b3: [EE 419, Winter 2013 – Wilsonville]

This outcome was assessed using the final lab assignments and IEEE papers turned in, which focused on designing, modeling in LTSpice, building, and analyzing an actual boost converter. The students' ability to design and conduct experiments as well as to analyze and interpret data were observed by the instructor during the multiple lab hours, office hours, and was based on the final grades for the Lab 4 IEEE paper and term.

Nineteen students were assessed in Winter 2013 using the performance criteria listed below. The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level in all performance criteria.

Table 5 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. Students met or exceeded expectations; they seemed to grasp the fundamentals of experimentation, did a good job with their converter designs, and did a decent job of analyzing and interpreting the data.

Table 5 Targeted Assessment for Outcome (b).

Performance Criteria	1 - Developing	2 - Accomplished	3 - Exemplary	% Students ≥ 2
(b) an ability to design and conduct experiments, as well as analyze and interpret data				
B1: Design an experiment	0%	0%	100%	100%
B2: Conduct an experiment	0%	0%	100%	100%
B3: Analyze, interpret data	11%	26%	63%	100%

3.3.4.2 Targeted Assessment of Outcome (f)

An understanding of professional and ethical responsibility

Assessment f1: [REE 346, Fall 2012 – Klamath Falls]

This outcome was assessed using a graded homework assignment involving a case study type assignment for a senior course in power electronics. This course is required for REE students and an upper division elective for EE students. In this assignment, students were given a hypothetical situation where they had the role of lead project engineer for a power converter company. In this situation your firm had just won a competitive bid to design and manufacture a quantity of AC to DC converters for a wind turbine farm. The situation included some possible ethical dilemmas such as a conflict of interest, errors in product test data and schedule issues. The students were asked to use the IEEE code of ethics and identify the ethical dilemmas in the situation and evaluate the issues. They were then asked to discuss how they (as lead engineer) would resolve these issues.

Twenty-one students were assessed in the Fall 2012 term using the performance criteria listed below. The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level in all performance criteria.

Table 6 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. Students met or exceeded expectations; they demonstrated their abilities to identify a professional code of ethics and analyze the ethical dimensions of an industrial type situation. Performance criterion F3 was not evaluated in this assignment. This assignment was also used for the Institutional Student Learning Outcome (ISLO) assessment for AY 2012/13.

Table 6 Targeted Assessment for Outcome (f).

Performance Criteria	1 - Developing	2 - Accomplished	3 - Exemplary	% Students ≥ 2
(f) An understanding of professional and ethical responsibility				
F1: Demonstrate a knowledge of a code of ethics	0%	33%	67%	100%
F2: Evaluate the ethical dimensions of a problem	10%	10%	80%	90%
F3: Demonstrate or recognize ethical practices	16%	0%	0%	N/A

Assessment f2: [REE463], Fall 2012 – Wilsonville]

This outcome was assessed using a graded homework assignment involving a case study type assignment for a senior course in energy systems instrumentation. Students were presented with the code of ethics from the National Society of Professional Engineers and asked to select and discuss three important provisions in the code, explain their importance, and give an example of application of the provision in a professional situation. Additionally, they were presented with a case study where eleven of my industry coworkers were killed in an explosion and asked to identify the ethical issues involved, discuss the roles of the individuals involved, describe possible alternative approaches to the ethical issues, and explain the benefits and risks of one alternative approach. Students were graded using a rubric.

Nineteen students were assessed in Fall 2012 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 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. Students met or exceeded expectations; they demonstrated their abilities to identify a professional code of ethics and analyze the ethical dimensions of an industrial type situation. This assignment was also used for the Institutional Student Learning Outcome (ISLO) assessment for AY 2012/13.

Table 7 Targeted Assessment for Outcome (f).

Performance Criteria	1 - Developing	2 - Accomplished	3 - Exemplary	% Students ≥ 2
(f) An understanding of professional and ethical responsibility				
F1: Demonstrate a knowledge of a code of ethics	0%	11%	89%	100%
F2: Evaluate the ethical dimensions of a problem	10%	10%	80%	90%
F3: Demonstrate or recognize ethical practices	10%	10%	80%	90%

3.3.4.3 Targeted Assessment of Outcome (g)

An ability to communicate effectively

Assessment g1: [REE 449, Winter 2013 – Klamath Falls]

The outcome was assessed using the senior projects in Winter 2013. Two rounds of status meeting presentations and the final version test plans were used to assess the students on their ability to communicate effectively. Senior projects are long term team work. The communication ability plays significant role in organizing the activities and moving the project forward. Totally five groups are assessed. One group was working on the conversion of an internal combustion engine car into a plug-in pure electric car. The second group was working on a solar powered sea water desalination system. The third group was working on the design and development of a mobile photovoltaic power generation system. The fourth group worked on the simulation of a renewable energy powered smart grid system. The fifth group designed a renewable energy micro-grid and implemented it with a model system. The presentations in which the team members take turns to present their progress were used to assess oral communication. The final version of the test plans was used to assess written communication and the ability to acquire and apply information from different sources.

Twelve students were assessed in Winter 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 8 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. Students met or exceeded expectations; they demonstrated their ability to communicate effectively in both oral and written ways. They especially demonstrate their outstanding ability in acquiring information about parts, services, standard, code, safety rules, etc.

Table 8 Targeted Assessment for Outcome (g).

Performance Criteria	1 - Developing	2 - Accomplished	3 - Exemplary	% Students ≥ 2
(g) an ability to communicate effectively				
G1: Oral communication	0%	20%	80%	100%
G2: Written communication	0%	0%	100%	100%
G3: Acquisition and application of information sources	0%	20%	80%	100%

Assessment g2: [REE 412, Winter 2013 – Wilsonville]

This outcome was assessed using an individual project with report and oral presentation. The objective of the project was to design a stand-alone PV system for developing countries, write a report, and give a presentation. The project was expected to contain justification and social context for the application, solar resource evaluation, system layout and sizing, equipment specifications, selection of inverters, batteries, and days of backup. Furthermore, a detailed financial analysis was required including pricing of components, and assessment of the potential for growth. The students were encouraged to consider real implementation of their project and to consider applying for funding to grant making organizations. So, the assignment used to evaluate outcome (g) was envisioned not simply as a class exercise, but as preparation for the funding submission to a funding agency such as World Bank and was expected to include detailed deliverables, timeline, financial details, specifications, drawings, and references.

Eighteen students were assessed in Winter 2013 using the performance criteria listed below. The minimum acceptable performance level was to have above 80% of the students performing at the proficiency or high efficiency level in all performance criteria. The table below summarizes the results of this targeted assessment.

Table 9 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. All students demonstrated their abilities to effectively communicate their engineering solutions, specification, justification, and economic evaluation; to generate content, create amplification, bring credible sources, organize presentation, follow report structure, effectively use visuals, integrate them, and capture audience; and to use clear language, sustain attention, and generate interest.

Table 9 Targeted Assessment for Outcome (g).

Performance Criteria	1 - Developing	2 - Accomplished	3 - Exemplary	% Students ≥ 2
(g) an ability to communicate effectively				
G1: Oral communication	17%	27%	56%	83%
G2: Written communication	17%	22%	61%	83%
G3: Acquisition and application of information sources	11%	22%	67%	89%

3.3.4.4 Targeted Assessment of Outcome h

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

Assessment h1: [REE 451, Fall 2012 – Klamath Falls]

This outcome was assessed using a single question on a test taken by the students as part of the course requirements. This is a senior level course focused on geothermal energy systems. The course introduces basic geothermal energy systems and site assessment. It then focuses on direct use application systems. The course is the first course of a three term senior sequence in geothermal energy (the other courses are Geothermal Heat Pump Design and Geothermal Power Plant Design).

The test question asked students to discuss the economic, environmental and social impacts of replacing conventional HVAC systems with direct use geothermal HVAC systems in both residential and commercial applications. The issue of direct use retrofits was discussed in class for different types of conventional HVAC systems and students studied various case studies such as in town and the OIT campus system.

Ten students were assessed in Fall 2012 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 10 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. Students met or exceeded expectations; they demonstrated their abilities to identify the impacts of engineering solutions in environmental, social, economic or other contexts. Students discussed the economic impacts and issues involved in different types of conventional HVAC retrofits to an environmentally friendly geothermal HVAC system. They understood all the environmental aspects of direct use geothermal such as fluid reinjection and gas emission issues.

Table 10 Targeted Assessment for Outcome (h).

Performance Criteria	1 - Developing	2 - Accomplished	3 - Exemplary	% Students ≥ 2
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context				
H1: Identify impacts of engineering solutions	0%	10%	90%	100%
H2: Understand impacts in various contexts	0%	10%	90%	100%

Assessment h2: [REE 407 – Contemporary Power Systems, Spring2012 – Wilsonville]

This outcome was assessed using two assignments. The first assignment required each student to select and read a recent technical research paper or textbook chapter and provide a written summary of the material. The second assignment required each student to attend a technical conference or seminar related to the course, meet three people from industry and learn about their jobs, and provide a written summary of the material presented and the industry contacts they made.

Twenty-seven students were assessed in Spring 2012 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 11 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. Students met or exceeded expectations.

Table 11 Targeted Assessment for Outcome (h).

Performance Criteria	1 - Developing	2 - Accomplished	3 - Exemplary	% Students ≥ 2
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context				
H1: Identify impacts of engineering solutions	0%	10%	90%	100%
H2: Understand impacts in various contexts	0%	10%	90%	100%

3.3.4.5 Summary of Direct Measure Assessment for 2012-13

Strengths

The results indicated that REE are strong in the areas of knowledge and ability to apply math, science, engineering, and energy fundamentals while working in teams that are designing components or systems within constraints.

Weaknesses

There were no official weaknesses identified, though some areas within various outcomes where the percentage of students assessed were only slightly over the criteria set for demonstrating achievement.

Recommendations

In a couple of direct assessments, the assessment instrument chosen did not allow to assess all performance criteria for the particular student outcome. A general recommendation for the future is to select assessment instruments that allow to fully assess the particular outcome (i.e., all performance criteria) as much as possible.

3.3.4.6 Direct Measure Assessment Outcome-Specific Discussion

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

Assessment of this outcome showed attainment in the ability of students to deign and conduct experiments. The performance criterion related to the analysis and interpretation of data was met on all assessments, except EE419 in Klamath Falls, where it was slightly below the 80% target (only 77%). Since this is just below the threshold of attainment and it applied to a single assessment, no specific recommendations for changes were made. The only recommendation was to closely monitor this outcome in future assessments to determine whether a trend of low attainment in this performance criterion can be identified.

(f) An understanding of professional and ethical responsibility

Assessment of this outcome showed high levels of attainment. Most students demonstrated a good understanding of professional and ethical responsibility.

(g) An ability to communicate effectively

Assessment of this outcome showed overall success in the area of communication, including oral communication, written communication, and the ability to seek and apply appropriate sources of information. While the oral communication portion of the assessment was based on individual performance, the written communication and information gathering aspects were sometimes based on group reports. It is recommended that in the future individual assignments are used as opposed to group assignments, in order to get better definition in the level of attainment of all performance criteria.

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

Students showed high level of attainment in the identification and understanding of impacts of engineering solutions in different contexts (global, economic, environmental, societal). No recommendations are made regarding this outcome.

3.3.5 2012-13 IDEA Center Indirect Assessments

3.3.5.1 Methodology for Assessment of Student Outcomes using IDEA Center Course Evaluations

At Oregon Tech, course evaluations are conducted using the course evaluation form developed by the IDEA Center[9], an organization originating from Kansas State University in the 1960s. Using the course evaluation forms, an IDEA Center Diagnostic Report is generated and returned to the instructor. The report provides feedback from the students over a range of topics. Of interest to this indirect assessment are the Relevant Objectives of the course. These are listed in the table below.

The BSREE faculty uses these diagnostic reports as a means for collecting data for indirect assessment of student outcomes. Table 12 shows how the IDEA Center Relevant Objectives map (loosely) to the ABET-based a-through-k student outcomes. Note this mapping does not allow for assessment of all fourteen student outcomes; only outcomes (a), (d), (e), (g), (i) and (k) could be reasonably mapped to the IDEA Center Relevant Objectives.

Table 12 IDEA Center Mapping of Relevant Objectives to Student Outcomes

	IDEA Center Relevant Objectives	Related a-n Outcomes
21	Gaining factual knowledge	i
22	Learning fundamental principles, generalizations, or theories	e
23	Learning to *apply* course material	a, k
24	Developing specific skills, competencies and points of view needed by professionals	k
25	Acquiring skills in working with others as a team	d
26	Developing creative capcities (writing, etc.)	g
27	Gaining a broader understanding and appreciation of intellectual/cultural activity	none
28	Developing skills in expressing myself orally or in writing	g
29	Learning how to find and use resources for answering questions or solving problems	i
30	Developing a clearer understanding of, and commitment to, personal values	none
31	Learning to *analyze* and *crtiticaly evaluate* ideas, arguments and points of view	none
32	Aquiring an interest in learning more by asking my own questions and seeking answers	i

The IDEA Center Relevant Objectives are scored using a one-through-five numbering scheme, with the student asked to rate the amount of progress made on each objective. A score of one indicates no apparent progress, while a five indicates exceptional progress. For each course, faculty select which Relevant Objectives are pertinent to the course; typically, only three or four are indicated as Essential. For the purposes of assessing student outcomes, the faculty assumes an average score of 3.5 (between moderate and substantial progress) on Relevant Objectives as indicating success in meeting the related student outcomes.

[9] www.theideacenter.org

3.3.5.2 Student Outcome Mappings using IDEA Center Course Evaluations

The sections below describe the targeted indirect assessment activities based on the IDEA Center diagnostic reports. The assessment tables indicate which IDEA Center Relevant Objectives were deemed pertinent to the course, graded as "essential (E)," "important (I)," or "minor (M)." Based on the average score for each Relevant Objective, an indication is made determining whether the associated student outcomes were satisfied.

Mapping the IDEA Center Relevant Objectives to student outcomes is justified as follows:

Student Outcome (a), *an ability to apply knowledge of mathematics, science, and engineering*, maps to one Relevant Objective.

- (23), *learning to apply course materials*: Assuming the course material is math-, science- and/or engineering-based, students who identify with having made progress on learning to apply course material should have the ability to apply that material.

Student Outcome (d), *an ability to function on multi-disciplinary teams*, maps to one Relevant Objective.

- (25), *acquiring skills in working with others as a team*: Though not specific to *multi-disciplinary* teams, this Objective does ask students whether they have made progress in acquired the skills need to function on teams. Students who report having made progress are developing the ability to function on teams.

Student Outcome (e), *an ability to identify, formulate, and solve engineering problems*, maps to one Relevant Objective.

- (22), *learning fundamental principles, generalizations or theories*: This Objective only relates to the student's abilities to identify and formulate engineering problems, not to solve them. Identification and formulation of an engineering problem are dependent upon the student having learned fundamental principles and theories of engineering. Students who identify with having made progress towards learning these fundamentals are likely to have the ability to identify and formulate engineering problems.

Student Outcome (g), *an ability to communicate effectively*, maps to two Relevant Objectives.

- (26), *developing creative capacities*: Writing is explicitly identified by the IDEA Center as one of the 'creative capacities' applicable to this Objective. Whether technical writing qualifies as a 'creative' capacity is debatable, so the correlation between this Objective and student outcome (g) is weak. Nevertheless, students who identify with having made progress towards developing writing capacities, though not directly stated by the Objective, are gaining the ability to communicate effectively.
- (28), *developing skills in expressing myself orally or in writing*: Students who identify with having made progress towards developing oral presentation and/or writing skills are gaining the ability to communicate effectively.

Student Outcome (i), *a recognition of the need for, and an ability to engage in life-long learning*, maps to three Relevant Objectives.

- (21), *gaining factual knowledge*: Students who identify with having made progress towards gaining factual knowledge have noted their ability to engage in learning, though not necessarily 'life-long' learning.
- (29), *learning how to find and use resources for answering questions or solving problem*: Again, noting they've made progress towards learning how to learn (*find and use resources*), students are implying they have the ability to engage in learning, though again, not 'life-long' learning.
- (32), *acquiring an interest in learning more by asking my own questions and seeking answers*: Acquiring an interest in learning hints that, though does not demonstrate explicitly, the student has recognized the need for learning. Further, noting that learning is done by '*asking questions*' and '*seeking answers*', students are showing that they have made progress on gaining the ability to engage in learning.

The potential to employ an indirect assessment of student outcome (i) is notable, since effective assessment of this outcome has shown to be problematic using our ABET Assignment direct assessment method. Much of this difficulty has to do with assessing a student's understanding the need to engage in a "life-long" process (learning) using coursework that spans no more than ten weeks.

Student Outcome (k), *an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice*, was determined to map to two Relevant Objectives.

- (23), *learning to apply course materials*: Assuming that the course curriculum covers the techniques, skills and modern engineering tools necessary for engineering practice, students who note they've made progress towards learning to apply course material should have the ability to apply them in practice. This correlation between (k) and (23) should be used carefully, as many engineering courses present material that may not be considered 'techniques', 'skills' or 'modern engineering tools' necessary for engineering practice. For instance, the correlation may be appropriate for an engineering programming class that covers modern programming tools, but not for a theory-based course such as thermodynamics, which does not introduce tools used in every-day engineering practice.
- (24), *developing specific skills, competencies and points of view needed by professionals*: Students who identify with having made progress towards developing skills and competencies needed by professionals should have the ability to use those skills and competencies (or 'techniques' and 'modern engineering tools') in professional engineering practice.

3.3.5.2 Indirect Assessment of Student Outcomes using IDEA Center Course Evaluations

The following indirect assessments were conducted based on random selection of faculty evaluations from the two most experienced faculty.

IDEA Center Indirect Assessment: [EE 419, Fall 2012 – Klamath Falls]

Table 13 IDEA Center Indirect Assessment

No.	Relevant Objective	Related Outcome a-n	Import. Rating	Average	Outcome Met (>=3.5)
21	Gaining factual knowledge	i	I	4.4	Y
22	Learning fundamental principles, generalizations, or theories.	e	I	4.4	Y
23	Learning to apply course material	a, k	I	4.3	Y
24	Developing specific skills, competencies, and points of view needed by professionals.	k	M	4.2	Y
25	Acquiring skills in working with others as a team.	d	I	4.1	Y
26	Developing creative capacities (writing, design etc.).	g	M	3.8	Y
28	Developing skills in expressing myself orally or in writing.	g	M	3.9	Y
29	Learning how to find and use resources for answering questions or solving problems.	i	M	4.1	Y
32	Acquiring an interest in learning more by asking my own questions/seeking answers.	i	M	4.1	Y
	Total Students = 30/34				

For all IDEA Center Relevant Objectives rated as 'essential' or 'important,' (E/I) the average score rated above 3.5, the targeted score for determining whether the associated student outcomes were satisfied. The other relevant outcomes rated as minor (M) also were above the targeted average score of 3.5

This indirect assessment indicates students believe progress has been made on the following student outcomes assessed during this assessment cycle:

(g) an ability to communicate effectively

Students reported progress in both developing their communications abilities and developing skills in expressing themselves orally or in writing, even though the two Relevant Objectives that map to student outcome (g) were not deemed essential or important in this course.

IDEA Center Indirect Assessment: [REE 463, Winter 2012 – Wilsonville]

Table 14 IDEA Center Indirect Assessment

No.	Relevant Objective	Related Outcome a-n	Import. Rating	Average	Std. Dev.	Outcome Met (>3.5)
21	Gaining factual knowledge	i	I	4.5	0.6	Y
22	Learning fundamental principles, generalizations, or theories.	e	I	4.3	0.7	Y
23	Learning to apply course material	a, k	E	4.1	1.0	Y
24	Developing specific skills, competencies, and points of view needed by professionals.	k	E	4.3	0.9	Y
25	Acquiring skills in working with others as a team.	d	M	4.2	0.9	Y
26	Developing creative capacities (writing, design etc.).	g	M	3.7	1.2	Y
28	Developing skills in expressing myself orally or in writing.	g	M	3.8	1.1	Y
29	Learning how to find and use resources for answering questions or solving problems.	i	M	4.3	0.8	Y
32	Acquiring an interest in learning more by asking my own questions/seeking answers.	i	M	4.0	1.2	Y
	Total Students = 15/19					

For all IDEA Center Relevant Objectives rated as "essential" or "important," the average score rated above 3.5, the targeted score for determining whether the associated student outcomes were satisfied.

This indirect assessment indicates students believe progress has been made on the following student outcomes assessed during this assessment cycle:

(g) an ability to communicate effectively

Students reported progress in both developing their communications abilities and developing skills in expressing themselves orally or in writing, even though the two Relevant Objectives that map to student outcome (g) were not deemed essential or important in this course.

3.3.5.3 Summary of IDEA Center Indirect Measure Assessment for 2012-13

Strengths

For all IDEA Center Relevant Objectives rated as "essential" or "important," the average score rated above 3.5, the targeted score for determining whether the associated student outcomes were satisfied.

Weaknesses

No weaknesses were noted.

Recommendations

Faculty need to reach consensus in the way the IDEA Center Relevant Objectives are rated Essential, Important, or Minor/No Importance for courses. Differences in ratings assigned by individual faculty members can affect the efficacy of the IDEA Center indirect measure assessments. It is recommended that the faculty develop more standardization for this method of assessment.

3.3.6 2012-13 Senior Exit Survey Indirect Assessments

3.3.6.1 Methodology for Assessment of Student Outcomes using Senior Exit Surveys

At Oregon Tech, graduating seniors are asked to complete an exit survey delivered online via the Qualtrics survey tool. One of the questions in the survey asks students to determine, for each student outcome, whether they think they are "inadequately prepared," "prepared," or "highly prepared" to meet that outcome. A result of "inadequately prepared" is scored as a 1, a result of "prepared" is scored as a 2, and a result of "highly prepared" is scored as a 3.

The minimum acceptable performance level is 80% of students believing that they are "prepared" or "highly prepared" for each assessed student outcome.

3.3.6.2 Indirect Assessment of Student Outcomes using Senior Exit Surveys

Twenty-six REE students responded to the senior exit survey question on student outcomes. Table 15 shows the results for the AY 2012-13 assessed student outcomes. Table 16 provides additional detailed statistics for the assessed outcomes. Both tables were obtained from the Qualtrics survey tool. The minimum acceptable performance level of 80% at the level of "prepared" or "highly prepared" was achieved for each outcome.[10]

Table 15 Student Exit Survey Indirect Assessment

Student Outcome	1 - Inadequately prepared	2 - Prepared	3 - Highly prepared	% Students ≥ 2
b. an ability to design and conduct experiments, as well as to analyze and interpret data	11.54%	30.77%	57.69%	88%
f. an understanding of professional and ethical responsibility	0.00%	61.54%	38.46%	100%
g. an ability to communicate effectively	0.00%	61.54%	38.46%	100%
h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context	7.69%	34.62%	57.69%	92%

Table 16 Student Exit Survey Detailed Statistics

Statistic	b.	f.	g.	h.
Min Value	1	2	2	1
Max Value	3	3	3	3
Mean	2.46	2.38	2.38	2.50
Variance	0.50	0.25	0.25	0.42
Standard Deviation	0.71	0.50	0.50	0.65
Total Responses	26	26	26	26

[10] An alternative means of achieving the minimum acceptable performance level would be a mean of 1.8, which is equivalent to 80% of respondents at the level of "prepared" or "highly prepared."

3.3.6.3 Summary of Senior Exit Survey Indirect Measure Assessment for 2012-13

Strengths

All 26 respondents to the senior exit survey believe they are either prepared or highly prepared for outcomes (f) and (g). Only three respondents believe that they are inadequately prepared with regard to outcome (b), and only two respondents believe they are inadequately prepared with regard to outcome (h).

Weaknesses

No weaknesses were noted, but there is a concern among the faculty regarding the design of experiments portion of outcome (b).

Recommendations

It is recommended that design of experiments be introduced within the first two years of the curriculum and assessed in the final two years.

4 Changes Resulting from Assessment

4.1 Changes to 2012-13 Assessment Methods Resulting from the 2011-12 Assessment

The assessments conducted during the 2011-12 academic year revealed the following areas of recommended improvement (shown in italics). The 2012-13 actions taken are shown following each recommendation.

1. *The FE exam has been dropped as an assessment tool due to inconclusiveness of data regarding REE students since they select "Other" as a major, and enrollee and graduates from other majors may also select "Other."*

   The FE exam was not, and will not be used in the future, as an indirect assessment method for the REE students.

2. *Due to completing only one of the three assigned direct assessments for outcome (l), reassess outcome (l) in 2012-13 at the Klamath Falls campus.*

   Per the recommendations of an ABET-EAC assessment team and with concurrence from the REE Industry Advisory Council, student outcomes (l), (m), and (n) were dropped, therefore, there was no need to reassess outcome (l) at the Klamath Falls campus this year.

3. *Revisit IDEA Center indirect mapping with faculty and provide training on how to use the mapping consistently as a faculty. Develop other indirect assessment methods for outcomes not mapped, such as use of student exit surveys.*

   No faculty training on use of the IDEA Center indirect assessment mapping occurred. A training session will be scheduled for AY 2013/14. Student exit survey results were used as a second means of indirect assessment.

4. *Require faculty complete assigned assessments by linking them to faculty annual performance evaluations.*

   This recommendation was made to the department chair.

5. *Update mapping between SOs and the BSREE curriculum to reflect curriculum change*

   The mapping between the student outcomes and the curriculum was updated.

4.2 Recommended Changes to Methods Resulting from the 2012-13 Assessment

The assessments conducted during the 2012-13 academic year revealed the following areas needing improvement to the assessment method:

1. *Due to completing only one of the assigned direct assessments for outcome (h), reassess outcome (h) in 2013-14 at the Wilsonville campus.*

2. *Revisit IDEA Center indirect mapping with faculty and provide training on how to use the mapping consistently as a faculty.*

3. *Change the scale of achievement from 1-Developing, 2- Accomplished, 3-Exemplary, to a 1-Limited or No Proficiency, 2-Some Proficiency, 3-Proficiency, 4-High Proficiency scale for direct assessments using assignments in order to coordinate the program method with the institutional method in order to make an easier .*

4. *Discuss criterion F3 with the faculty. Some faculty believe that this criterion should be deleted or amended.*

4.3 Recommended Changes to Curriculum Resulting from the 2012-13 Assessment

1. *Though not identified by the direct assessments, there is a concern among the faculty regarding the design of experiments portion of student outcome (b) as identified by the indirect assessment using the senior exit surveys. Design of experiments should be introduced early in the curriculum (i.e., within the first two years) and be assessed in the final two years. No formal instruction is currently provided in any program course regarding design of experiments.*

Appendix A - Mapping Between Student Outcomes and the BSREE Curriculum

Table 17 - Mapping between BSREE engineering courses and the Student Outcomes. Check marks indicate the faculty has identified the outcome as assessable in a particular class.

	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)
CHE 260	√	√		√	√		√			√	
ECO 357	√					√	√	√	√	√	
EE 221	√	√		√	√		√				√
EE 223	√	√		√	√		√				√
EE 225	√	√		√	√		√				√
EE 321	√	√	√	√	√		√		√		√
EE 343	√			√	√	√	√	√	√	√	
EE 419	√	√	√	√	√		√	√			√
EE 456	√	√	√	√	√	√	√				√
ENGR 211	√				√		√				√
ENGR 266	√	√			√						√
ENGR 355	√				√		√				√
ENGR 465	√	√	√	√	√	√	√	√	√	√	√
ENV 427	√					√	√		√	√	
HIST 356							√				
MECH 318	√	√		√	√		√				√
MECH 323	√				√						√
MECH 433	√	√		√	√		√			√	√
REE 201	√					√	√	√		√	
REE 243	√	√		√	√		√		√	√	√
REE 253	√	√	√	√	√		√				√
REE 331	√	√	√	√	√		√	√	√	√	√
REE 333	√	√	√	√	√	√	√	√	√	√	√
REE 335	√	√	√	√	√	√	√	√	√	√	√
REE 337	√				√					√	√
REE 344	√			√	√	√	√	√		√	√
REE 345	√				√	√		√		√	√
REE 346	√	√	√	√	√		√	√		√	√
REE 347	√				√	√		√		√	√
REE 348	√		√		√	√	√	√		√	√
REE 412	√		√		√	√	√	√		√	√
REE 413	√		√		√		√				√
REE 439	√	√	√	√	√		√				√
REE 451	√		√		√						√
REE 453	√		√		√				√	√	√
REE 454	√		√		√	√			√	√	√
REE 455	√	√	√	√	√	√	√			√	√
REE 463	√	√	√	√	√	√	√		√		√