Master of Science
Renewable Energy Engineering

2019-20 Assessment Report

Electrical Engineering and Renewable Energy Department

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Contents

1 Introduction

1.1 Program Design and Goals

The Master of Science in Renewable Energy Engineering (MSREE) program at Oregon Institute of Technology (Oregon Tech) has been designed to prepare graduates to be energy engineering professionals who have advanced knowledge and skills that enable them to assume a broad range of technical leadership roles.

The MSREE program goal is to provide graduates for careers in areas of renewable energy engineering including but not limited to solar photovoltaics (PV), solar thermal, wind power, wave power, geothermal energy, clean 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. MSREE graduates will enter renewable energy engineering careers as leaders in design, site analysis, product, application, test, quality control, and sales.

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. In 2008, the BSRES degree was discontinued and replaced by the Bachelor of Science degree in Renewable Energy Engineering (BSREE). Analysis of the marketplace and observed growth in career options across the renewable energy fields revealed significant opportunities for graduates with a solid energy engineering education. Building upon this strong foundation of renewable energy engineering education, the MSREE was launched in the Portland-Metro campus in 2012. In 2013, an accelerated, concurrent degree option was launched for exceptional undergraduate students in the BS Renewable Energy Engineering and BS Electrical Engineering programs. The MSREE concurrent degree was launched in Klamath Falls in 2016. Full time offering of the MSREE program was extended to the Klamath Falls campus for the first time in 2018.

We anticipate MSREE graduates will enter energy engineering careers as leaders in the fields of power engineering, PV/semiconductor processing engineering, facilities and energy management, energy system integration engineering, HVAC and hydronics engineering, design and modeling engineering for net-zero energy buildings, biofuels plant and operations engineering, energy systems control engineering, power electronics engineering, utility program management, as researchers and educators in renewable energy fields, as well as in the roles of LEED accredited professionals (AP) and 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. MSREE graduates with strong interests in research and academia will be well situated to pursue further advanced degrees at PhD granting institutions.

1.3 Industry Relationships

The REE programs have strong relationships with industry, particularly through the program-level Industry Advisory Council (IAC) and REE alumni. The IAC has been instrumental in the success of the REE program. Representatives from corporations, government institutions and non-profit organizations comprise the IAC, giving the BSREE and MSREE 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 MSREE program is the benefit of having a campus in urban Portland in proximity to the Pacific Northwest's energy industry cluster, and with close ties to Oregon Tech's campus in rural Southern Oregon, which exceptional natural energy resources and on-campus facilities generating renewable energy. The Portland campus allows students to leverage their classroom experience within internships at the Northwest's world-class energy and power companies. Graduate-level courses are also offered at the Klamath Falls campus. Online courses offer flexibility to concurrent degree and full time students in both campuses.

1.5 Enrollment and Graduates

The inaugural graduating class in Spring 2014 included just one student. Forty-seven students have graduated from the program as of Summer 2020 term.

2 Program Educational Objectives and Outcomes

2.1 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 Master of Science in Renewable Energy Engineering program are these:

- MSREE graduates will excel as leaders in the various fields of energy engineering.
- MSREE graduates will demonstrate an ability to apply advanced engineering methods to the solutions of complex energy-related engineering problems.
- MSREE graduates will demonstrate an ability to acquire emerging knowledge and remain current in the dynamic field of renewable energy.

2.2 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.

2.3 Program Outcomes

The MSREE program builds on the engineering knowledge students gained as undergraduates. The MSREE program outcomes are these:

(a) an ability to identify, formulate, and solve energy-related engineering problems.

(b) an ability to communicate effectively.

(c) an ability to independently acquire knowledge of contemporary technical, political, and economic issues related to energy.

3 Cycle of Assessment for Program Outcomes

3.1 Assessment Methodology

The assessment of the program outcomes was reviewed, and decision has been made to consider REE 599 Graduate Thesis/Project course to evaluate the program outcomes. The MSREE outcome assessment cycle was revised and year 2018-19 was used to assess all three outcomes using REE 599 Graduate Thesis/Project. This course involves the final work of students in the MSREE degree and provides a window into the three program outcomes. Starting in AY 2019-20, each outcome will be assessed each year, following the new MSREE outcome assessment cycle presented in Table 1.

Students taking REE 599 have to present a written thesis or project, and defend it in front of a committee composed by their advisor, a member of the department, and an external committee member. The three members of the committee read the written document prior to the defense. Department faculty who are members of the students committees but not their REE 599 advisors will be assigned with the assessment of outcomes. Assessment year 2018-19 has been used as a resetting point, considering all three outcomes, to continue with a regular 3-year cycle, as shown in Table .

3.2 Assessment Cycle

Table 1. MSREE Outcome Assessment Cycle

	2018-19	2019-20	2020-21
(a) Problem Solving	REE 599	REE 599	
(b) Communication	REE 599		REE 599
(c) Independent/Contemporary	REE 599		

3.3 Curriculum Map

The MSREE curriculum map is shown in Table 2Table . The original assessment plan considered assessment of the program outcomes in different courses over a three-year cycle. However, faculty found out that the selected courses were not representative of the program outcomes and the methodology had to be revised. Long considerations during academic years 2016-17 and 2017-18 led to the decision that REE 599 Graduate Thesis/Project was the best course to evaluate the program outcomes.

Table 2. MSREE Curriculum Mapping

Course	Outcome A	Outcome B	Outcome C
Graduate Research Methods/ Innovation - Required			
REE 511 Research Methods I	-	-	-
REE 512 Research Methods II	-	-	-
REE 513 Research Methods III	-	-	-
Energy Engineering - Required			
REE 515 Energy Engineering I	-	-	-
REE 516 Energy Engineering II	-	-	-
REE 517 Energy Engineering III	-	-	-
Power Systems Engineering - Elective			

REE 529 Power Systems Analysis	-	-	-
REE 549 Power Systems Protection and Control	-	-	-
REE 569 Grid Integration of Renewables	-	-	-
Energy Efficient Building Systems – Elective			
REE 533 Heating, Ventil/AC	-	-	-
REE 553 Energy Systems Mange/Audt	-	-	-
REE 573 Energy Efficient Build design	-	-	-
Photovoltaic Systems and Processes - Elective			
REE 545 Applied Photvoltaics	-	-	-
REE 565 Semiconductor Process Engg	-	-	-
REE 525 Solid-State Physics/Photovoltaics	-	-	-
REE 5xx Elective			
REE 5xx Elective I	-	-	-
REE 5xx Elective II	-	-	-
REE 5xx Elective III	-	-	-
Graduate Thesis – Required			
REE 59X Graduate R&D/Project/Thesis	√	√	√
REE 59X Graduate R&D/Project/Thesis	√	√	√
REE 59X Graduate R&D/Project/Thesis	√	√	√

3.4 Summary of Assessment Activities & Evidence of Student Learning

3.4.1 Introduction

The MSREE faculty conducted formal assessment during the 2019-20 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.

3.4.2 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 program outcomes are evaluated as part of the course curriculum primarily by means of students' final theses or projects. These theses or projects 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.

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 graduate exit survey.

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

3.4.3 2019-2020 Targeted Direct Assessment Activities

The sections below describe the 2019-20 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. Outcomes (a), was assessed for academic year 2019-2020 by means of four theses or projects completed during the year by graduating students of the MSREE program under the course denoted REE 599. These students conducted their graduate research or thesis under three different advisors. Dr. H.J. Corsair advised two students. Drs. Slobodan Petrovic, Chitra Venugopal and Eklas Hossain advised one student each. The assessment work was performed by other faculty in the department and faculty from outside the university.

The minimum acceptable performance level for all outcomes is to have 80% or more 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.

3.4.3.1 Targeted Assessment for Outcome (a): an ability to identify, formulate, and solve energy-related engineering problems.

This outcome was assessed in REE 599 – Graduate Thesis or Project by means of an evaluation of a final graduate-level thesis or project. Students submitted a graduate thesis, which answered a research question or tested a hypothesis with an element of novelty, or a graduate project, which solved an advanced engineering design project with evidence of added value. Students submitted written documentation of their work, presented an oral defense, and made revisions and corrections based on feedback from both written and oral presentations of work.

Four MSREE students were assessed from 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, at least 80% of students were able to identify, formulate, and solve energy-related engineering problems.

Table 3. Targeted Assessment for Outcome (a) (N=4)

Outcome (a): an ability to identify, formulate, and solve energy-related engineering problems				
Performance Criteria	1-Developing	2-Accomplished	3-Exemplary	%Students >= 2
Identify problems		1	3	100
Formulate problems		1	3	100
Solve problems	1		3	75%

3.4.4 Summary of Indirect Assessment for 2019-20

In addition to direct assessment measures, the student outcomes are normally indirectly assessed through a graduate exit survey.

The survey asked students to indicate how well the MSREE program prepared them in each of the three specified outcomes. Figures 1 and 2 show the results of the indirect assessment of the MSREE student outcomes for the 2019-20 graduating class.

Four MSREE graduating students completed the survey, with 100% of respondents indicating that as a result of completing the MSREE program they feel prepared or highly prepared in each of the student outcomes. This suggests that graduates feel that they have attained the MSREE student outcomes. Both direct and indirect assessment indicate that the MSREE program is preparing students in the program's student outcomes.

The survey includes the following questions:

- **Q MREE 1 - Program Student Learning Outcomes for Renewable Energy Engineering M.S. Please rate your proficiency in the following areas.**

(High Proficiency/Proficiency / Some Proficiency / Limited Proficiency)

(1.a) An ability to identify formulate, and solve energy-related engineering problems
(1.b) An ability to communicate effectively
(1.c) An ability to independently acquire knowledge of contemporary technical, political, and economical issues related to energy

- **Q MREE 2 - Program Student Learning Outcomes for Renewable Energy Engineering M.S. How much has your experience at Oregon Tech contributed to your knowledge, skills, and personal development in these areas?**

(Very much / Quite a bit / Some / Very little)

(2.a) An ability to identify formulate, and solve energy-related engineering problems
(2.b) An ability to communicate effectively
(2.c) An ability to independently acquire knowledge of contemporary technical, political, and economical issues related to energy

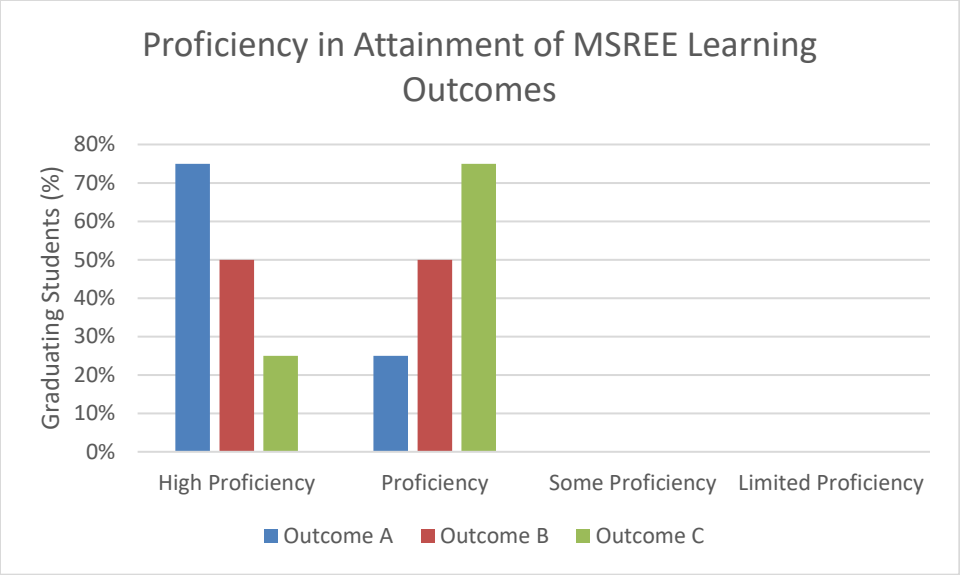

Fig1. Results of Indirect Assessment exit survey report for AY 2019-20 (N=4)

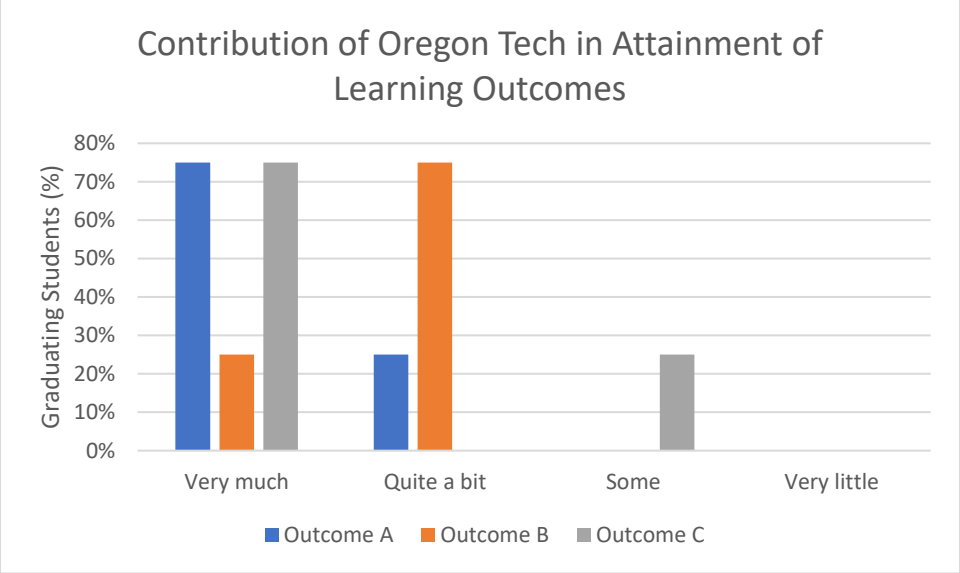

Fig2. Results of Indirect Assessment exit survey report for AY 2019-20 (N=4)

4 Changes Resulting from Assessment

4.1 Changes Resulting from the 2019-20 Assessment

This section describes the changes resulting from the assessment activities carried out during the academic year 2019-2020.

Tables 4 shows the summary of 2019-20 and 2018 – 19 direct assessment results of outcome (a). The results show the improvement in attainment of outcomes above the target of 80% is achieved in a.1 and a.2. The attainment of outcome a.3 is decreased below 80%. The results shown in the table are assessed at a level of 2-Accomplished or above in outcome (a) for the current year and compared with the previous year. The rubric for this outcome is included in Appendix.

Table 4: Assessment for Outcome (a) for AY 2019-20 and AY2018-19

Performance Criteria	AY 2019-20 (N=4) %of students ≥2	AY 2018-19 (N=4) %student ≥2
a.1-Identify Problems	100%	100%
a.2-Formulate Problems	100%	50%
a.3-Solve Problems	75%	100%

4.2 Changes to Assessment Methodology

This section describes changes to the assessment methodology that were proposed in the 2019-2020 assessment cycle for implementation in the 2020-21 assessment cycle.

The MSREE faculty met to review the assessment results and determine the need for changes in the assessment method. Faculty proposed no changes to assessment methodology for the AY2020-21.

Also, faculty discussed about the Coursework-only and Graduate Research and Development (ENGR 596) options. In the course work only option, the student completes an additional approved REE graduate specialization sequence (9 credits) in lieu of a graduate thesis/project/R&D. Students should get prior approval for the sequence from their academic advisor or MSREE Program Director.

The Graduate Research and Development (ENGR 596) option involves conducting research and/or developing a project in a chosen topic. The scope of the research or project must meet the standards for graduate work, like the graduate thesis and graduate project options. In the case of students following the accelerated BS/MSREE path who have not completed an undergraduate capstone project, the scope of the project must also meet the requirements for the undergraduate capstone project. However, the requirements of review for this option are lower. Under this option, an oral defense before a faculty committee is not required. The work is graded exclusively by the faculty advisor supervising the work, who will also determine the particular deliverables appropriate to the nature of the work performed by the student (e.g., project report, oral presentation, live demonstration, etc.). Faculty decided to include these options in the AY2021-22 assessment cycle.

5 Review of Assessment Results and Closing the Loop

This section describes changes to the assessment activities carried out during AY2019-20 and addresses the concerns relating to the attainment of student outcomes from both direct and indirect assessments. The objective set for all programs in the EERE department is to have atleast 80% of the students perform at the level of accomplished or exemplary in all performance criteria of the assessed outcomes. Table 4 shows direct assessment results for outcomes (a), (b) and (c). The attainment of outcome (c) is below the target level of 80% for the AY2019-20. The indirect assessment shown in fig.2 shows attainment of outcome (c) is below the target of 80%. Though the results shown in this report is based on small class size (N=4), faculty raised concerns about it and will continue to perform assessment activities to achieve all of these outcomes successfully.

6 Appendix MSREE Program Rubrics

6.1 Rubric for Assessment of Outcome (a): An ability to identify, formulate and solve energy-related engineering problems

OUTCOME A RUBRIC – AN ABILITY TO IDENTIFY, FORMULATE,

AND SOLVE TECHNICAL PROBLEMS

COURSE:_____ STUDENT NAME:_____ GRADE_____

Students must demonstrate the following Program Outcome A). An ability to identify, formulate and solve technical problems,				
CRITERIA	1-DEVELOPING	2-ACCOMPLISHED	3-EXEMPLARY	SCORE
A.1-IDENTIFIES TECHNICAL PROBLEMS	Classifies information to develop possible solutions (comp). Distinguishes what is known/unknown for a problem (comp).	Identifies where an improvement can be made for a problem solution (analyze). Develops possible alternative solutions to a given solution. (app.).	Assembles new solution information from various solutions (syn). Assesses effectiveness of problem solutions (Eval).	
A.2-FORMULATES PROBLEMS.	Describes problem to be solved (know). Visualize a problem with diagrams (comp). Specifies problem scope (comp.). States a problem in words (app.).	Specifies problem and appropriate models (appl.). Determines the limits of a problem (app.). Analyzes problem variable limits for a basic model (anal.).	Builds variables, resources and limits into a problem statement (syn). Assess problem statement with regard to objectivity, relevance and validity (eval.).	
A.3-IMPLEMENT A SOLUTION	Describe implementation process and documentation (know.). Describe several documentation methods and it's relationship to problem (comp.).	Applies manage/team skills to implement solution (app.). Communicates (oral/written) recommended solutions (app.). Reviews/critiques documentation by others to problem at hand (anal.).	Apprises effectiveness of techniques to problem at hand (anal.). Uses management/team solutions to implement final solution (syn.). Evaluate recommendations/solutions with respect to impact factors (eval.).	