Agendum
Oakland University
Board of Trustees Formal Session
June 28, 2024

MASTER OF SCIENCE IN ENERGY ENGINEERING
A Recommendation

1. **Division and Department:** Academic Affairs, School of Engineering and Computer Science, Department of Mechanical Engineering.

2. **Introduction:** The School of Engineering and Computer Science (SECS) is proposing a new Master of Science in Energy Engineering. The graduate program is aligned with the mission and vision of Oakland University as it will positively "impact Michigan and the world through education, research, scholarship, and creative activity". The program will also advance the mission of the SECS by: (1) providing a high-quality graduate engineering training program in the rapidly developing field of clean and sustainable energy; (2) supporting research activity in the scholarly area of energy and sustainability, which is one of the school's strategic pillars; and (3) providing service to Michigan's energy industry and workforce.

The objective of the M.S. Energy Engineering program is to prepare students for advanced-level energy engineering careers including in the sectors of power generation, energy distribution and storage, fuels, transportation, and energy use efficiency. The energy sector currently employs more than 7.8 million people throughout the United States, up 4 % over 2021 (outpacing overall job growth). Michigan saw the largest increase in energy jobs of any state (+35,500 new energy jobs), bringing the total number of energy jobs in the state now to almost 400,000. Most of this growth has come in areas experiencing rapid innovation, research, and development including renewable energies, battery technologies, and hybrid and electric vehicles. This trend is expected to continue as the United States has a goal to reach net-zero greenhouse gas emissions by 2050. Energy employers in Michigan currently report difficulty recruiting and hiring qualified personnel for over 50 % of their job openings related to energy. There is therefore a demand for new education programs to train highly qualified personnel.

3. **Previous Board Action:** None.

4. **Budget Implications:** The primary source of funding for the program will be graduate tuition. The program is expected to generate a net income for the university from its second year of operation. Tuition revenue is expected to reach a steady state with 15 new students per year in the fifth year of the program's operation. Salary expenses include a full-time faculty member and a graduate assistant. Operating expenses include library and marketing. The proforma budget is included as Attachment B.

5. Educational Implications: The proposed program aims to introduce three new courses within the Department of Mechanical Engineering and one new course within the Department of Electrical and Computer Engineering. These newly developed courses will (1) equip students from multidisciplinary backgrounds with fundamental theory from both mechanical and electrical energy systems, (2) provide a new capstone design and seminar course focused on energy and sustainability, and (3) provide students with additional depth area and elective choices.

6. Personnel Implications: To manage the delivery of the new program and new courses, and to strategically expand SECS expertise in the cluster area of Energy and Sustainability, one new tenure track faculty position is requested. This will provide personnel to cover the proposed courses and to expand curriculum in related depth areas. Additionally, annual hiring of one graduate assistant will be essential to support the new courses.

7. University Reviews/Approvals: The proposed program has been reviewed and approved by the School of Engineering and Computer Science Faculty Assembly, the Senate Budget Review Committee, the Senate Planning Review Committee, the Oakland University Senate and the Executive Vice President of Academic Affairs and Provost.

8. Recommendation:

WHEREAS, the Master of Science in Energy Engineering degree program is consistent with the objectives contained in Oakland University's Institutional Priorities; and

WHEREAS, the Master of Science in Energy Engineering degree program will build on the academic and research strengths in the Department of Mechanical Engineering and provide new educational and community engagement opportunities in the field of energy engineering; now, therefore, be it.

RESOLVED, that the Board of Trustees authorizes the School of Engineering and Computer Science to offer the Master of Science in Energy Engineering; and, be it further

RESOLVED, that the Executive Vice President for Academic Affairs and Provost will complete annual reviews of the Master of Science in Energy Engineering degree program to evaluate academic quality and fiscal viability to determine whether the program should continue.

9. Attachments:

A. Proposal for the Master of Science in Energy Engineering degree program.
B. Proforma budget for the Master of Science in Energy Engineering degree program.

Recommended on 6/19, 2024
to the Board for Approval by

Ora Hirsch Pescovitz, M.D.
President

Reviewed by

Joshua D. Merchant, Ph.D.
Chief of Staff and
Secretary to the Board of Trustees

Oakland University
Graduate Council

Title Page

Degree Program Title: Master of Science in Energy Engineering

Degree: Master of Science in Energy Engineering

Name of Degree Program Coordinator: Dr. Xia Wang and Dr. Jonathan Maisonneuve

Requested Implementation Term: Fall 2024

School or College Governance

Department of Mechanical Engineering

Date Submitted Date Approved

Graduate Committee on Instruction

Date Submitted Date Approved

Dean School or College

Date Submitted Date Approved

University Governance

Graduate Council

Date Submitted Date Approved

Senate

Date Submitted Date Approved

Board of Trustees

Date Submitted Date Approved

Presidents Council

Date Submitted Date Approved

One Page Abstract

The School of Engineering and Computer Science (SECS) is proposing a new Master of Science in Energy Engineering. The graduate program is aligned with the mission and vision of Oakland University as it will positively "impact Michigan and the world through education, research, scholarship, and creative activity". The program will also advance the mission of the SECS by: (1) providing a high-quality graduate engineering training program in the rapidly developing field of clean and sustainable energy; (2) supporting research activity in the scholarly area of energy and sustainability, which is one of the school's strategic pillars; and (3) providing service to Michigan's energy industry and workforce.

The objective of the M.S. Energy Engineering program is to prepare students for advanced-level energy engineering careers including in the sectors of power generation, energy distribution and storage, fuels, transportation, and energy use efficiency. The energy sector currently employs more than 7.8 million people throughout the United States, up 4 % over 2021 (outpacing overall jobs growth). Michigan saw the largest increase in energy jobs of any state (+35,500 new energy jobs), bringing the total number of energy jobs in the state now to almost 400,000. Most of this growth has come in areas experiencing rapid innovation, research, and development including renewable energies, battery technologies, and hybrid and electric vehicles. This trend is expected to continue as the United States has a goal to reach net-zero greenhouse gas emissions by 2050. Energy employers in Michigan currently report difficulty recruiting and hiring qualified personnel for over 50 % of their job openings related to energy. There is therefore a demand for new education programs to train highly qualified personnel.

Because of the interdisciplinary nature of this field, this program is being offered by the Department of Mechanical Engineering in close collaboration with the Department of Electrical and Computer Engineering, and the program consists of courses from both disciplines. This sets the program apart from others that are offered at local universities and will provide strategic and unique value to the program. The program consists of 32 credits hours including 4-8 credit hours of "Foundation", 12 credit hours of "Depth", 4-8 credit hours of "Capstone", and 4-12 credit hours of "Elective". To make this interdisciplinary program accessible to students from a wide variety of different undergraduate background, the "Foundation" includes 2 new courses that are designed to equip students with fundamental theory from both mechanical and electrical engineering. "Depth" courses allow students to specialize in an area of energy engineering including (i) Renewable Energy, (ii) Battery Technology, (iii) Vehicle Electrification, (iv) Energy Use Efficiency, or (v) Thermo-Fluid Science and Engineering. The "Capstone" courses provide students with opportunity for hands-on experience related to an applied industry or research project via either (i) Master's thesis research, (ii) a graduate engineering project, or (iii) a new capstone design and seminar course. "Elective" credits allow students to explore either broader complementary skillsets or additional depth and specialization, including from non-SECS courses in the broad area of sustainability.

Oakland University

Graduate Council

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The Proposal

I. Rationale

a. How the Program Will Help Promote the Role and Mission of the University

The Master of Science in Energy Engineering will help promote the role and mission of Oakland University, by positively "impacting Michigan and the world through education, research, scholarship and creative activity". The program also supports the university vision to "unlock the potential of individuals and leave a lasting impact on the world through the transformative power of education and research".

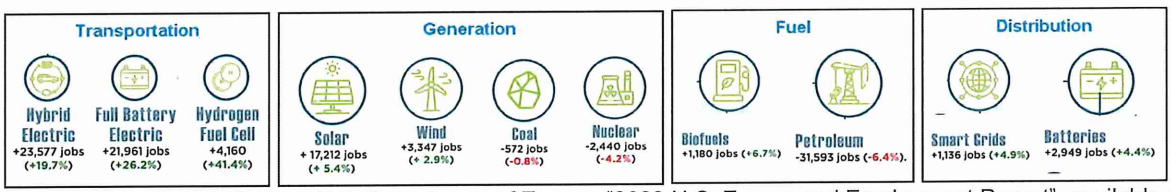
The new Master of Science in Energy Engineering also advances the mission of the School of Engineering and Computer Science in several ways:

- The new program provides a high-quality graduate engineering program that prepares graduates for careers in the rapidly developing field of clean and sustainable energy.
- The new program supports research activity in the scholarly area of energy and sustainability, where a cluster of faculty currently leads successful industry and nationally sponsored research programs. This activity will benefit students by creating additional opportunities to engage with research projects. And likewise, sponsored research at OU will benefit from an active pool of qualified graduate students from which to recruit.
- The new program provides service to both the engineering profession and public of the State of Michigan, including industry and energy utility companies that are advising the curriculum development.
- In addition, the new program will help to stabilize graduate enrollment.

b. Need for the Program

According to the "2022 U.S. Energy and Employment Report" published by the U.S. Department of Energy, the energy sector currently employs more than 7.8 million people throughout the U.S. This is an increase of 4 % over 2021, outpacing growth in the overall U.S. jobs market. Importantly, Michigan saw the largest increase in energy jobs of any state (+35,500 new energy jobs), bringing the total number of energy jobs in the state now to almost 400,000.

As highlighted below, most of this growth has come in areas experiencing rapid innovation, research, and development, including hybrid and electric vehicles (+19.7% and +26.2%), battery technology (+4.4%), hydrogen fuel cells (+41.4%), smart grids (+4.9%), solar energy (+5.4%), and biofuels (+6.7%). By contrast legacy fuels and energy systems saw job losses, including coal (-0.8 %) and petroleum (-6.4%). This trend is expected to continue as "the United States has a goal to reach net-zero greenhouse gas emissions by 2050. Net-zero emissions refers to achieving an overall balance between greenhouse gas emissions produced and greenhouse gas emissions prevented or taken out of the atmosphere."



Source: U.S. Department of Energy, "2022 U.S. Energy and Employment Report", available at: https://www.energy.gov/useer2022

Job growth in the energy engineering field will require new training and education program to develop highly qualified personnel. Importantly, energy employers in Michigan currently report difficulty recruiting and hiring qualified personnel for over 50 % of their job openings related to energy.

c. List the Goals and Objectives of the Program

Graduate students who complete the Master of Science in Energy Engineering will be able to:

- Goal 1: Understand the fundamental principles and theory of energy in both electrical and mechanical systems, and develop associated analytical skills.
- Goal 2: Understand advanced energy technologies including energy resources, power generation, power conversion, energy storage, and load management, and develop associated analytical skills.
- Goal 3: Gain hands-on real-world experience working with energy technologies via coursework and applied projects.
- Goal 4: Consider ethical and sustainability objectives that are related to energy engineering projects, and develop decision making tools for integrating these objectives into the design process.
- Goal 5: Connect to the energy engineering industry via seminars, sponsored projects, and internship opportunities.

The success of the program in achieving these goals will be ensured via the program assessment plan outlined in **Appendix G**.

d. Comparison to Other Similar Programs

Graduate programs focused on energy engineering have grown rapidly in the last several years, due to the growing popularity and importance of sustainable energy. A selection of different graduate degrees is provided below, including 2 Masters and 2 Graduate Certificates offered in Michigan. Because energy engineering is inherently interdisciplinary, these programs are housed in a number of different departments including mechanical, electrical, and chemical engineering, and they generally emphasize one of these disciplines. One of the distinguishing features of our MS in Energy Engineering program is that it gives students access to both our electrical engineering and mechanical engineering curriculum, and provides new foundational courses to help them succeed in both. This collaboration between mechanical and electrical engineering makes our program unique, and will offer something new and valuable to students and their employers.

Institution	Degree	College	Credits	Concentrations	Options
University of Michigan	M. Eng. Energy Systems and Sustainability Engineering	College of Engineering (Dept of Electrical and Computer Engineering)	30 credits (10 courses)	(1) Energy generation, distribution, and usage, (2) Transportation power, (3) Sustainable chemical conversion	Course-based Online / In-person / Hybrid

Wayne State University	M.S. Alternative Energy Technology	College of Engineering (Engineering Technology Division)	32 credits (8-9 courses)	-	Course-based / Thesis In-person
The University of Toledo	M.S. Energy Engineering	College of Engineering	30 credits (10 courses)		Online / In-person
Lawrence Tech	Certificate of Energy Engineering	College of Engineering (Dept of Mechanical, Robotics, and Industrial Engineering)	18 credits (6 courses)	-	-
Michigan Tech	Certificate in Engineering Sustainability and Resilience	College of Engineering (Department of Chemical Engineering)	9 credits (3 courses)		Online / In-person

II. Academic Unit

a. How the Goals of the Unit are Served by the Program

The new Master of Science in Energy Engineering advances the mission of the School of Engineering and Computer Science in several ways:

- The new program provides a high-quality graduate engineering program that prepares graduates for careers in a rapidly developing field. In addition, the new program will help to stabilize SECS graduate enrollment.
- The new program supports research activity in the scholarly area of energy and sustainability, where a cluster of faculty currently leads successful industry and nationally sponsored research programs. This activity will benefit students by creating additional opportunities to engage with research projects. And likewise, sponsored research at OU will benefit from an active pool of qualified graduate students from which to recruit.
- The new program provides service to both the engineering profession and public of the State of Michigan, including industry and energy utility companies that are advising the curriculum development.

b. How Existing Staff Will Support the Proposed Program

The MS in Energy Engineering will be housed within the Department of Mechanical Engineering and supported by the Department of Electrical and Computer Engineering. One faculty will be appointed by the chair of the Department of Mechanical Engineering to serve as the program director. The program director will be responsible for administering the program and will be supported by the ME chair and administrative assistant. In addition, the program will be supported by both the ME Graduate Affairs Committee and the ECE Graduate Affairs Committee. As a testament to this inter-department collaboration and support, this curriculum proposal has been developed by an ad-hoc committee of 13 faculty from both the Department of Mechanical Engineering and the Department of Electrical and Computer Engineering.

c. Faculty Qualifications

Attached in **Appendix A**.

d. Current Resources and How Will the New Program Impact Existing Resources

Classroom and laboratory space:
With the exception of 4 newly created courses, the proposed program consists mostly of existing courses, therefore requirements for additional classroom and laboratory space are minimal. The 4 new courses will be distributed across the fall, winter, and summer semesters so that only 1-2 new classroom will be needed each semester for two lecture meetings per week.

Personnel:
To assist with delivering the new program and new courses, and to strategically expand SECS expertise in the cluster area of Energy and Sustainability, 1 new tenure track faculty position is required. This will provide personnel to cover the proposed courses and to expand curriculum in related depth areas. In addition, 1 new teaching assistant position is planned to support the new courses.

III. Program Plan

a. Admission Requirements

Admission to master's study is selective. All students are required to apply to be considered for admission into the program. Before an applicant's file can be reviewed for full program admission, all application documents must be received by the Oakland University Graduate School. Incomplete applications will not be sent to departments for admission review.

GPA required for regular admission to the program:
Applicants should have an undergraduate GPA of at least 3.0 on a 4.0 scale for regular admission. If the applicant's undergraduate GPA is between 2.7 and 3.0 on a 4.0 scale, admission with limited standing may be offered.

Any required degree, certificate or licensing:
Admission is open to students with a Bachelor of Science in engineering, physics, or mathematics. Other fields of science may be acceptable, but a student presenting such a degree is required to

complete MTH 1555, MTH 2554, and APM 2555 (or APM 2559 and MTH 2775). Additional details may be specified in the admission letter.

Preparatory undergraduate course requirements for admission to the program:
An entering student must have completed the following courses or their equivalents.

- MTH 1555 Calculus II
- MTH 2554 Multivariable Calculus
- APM 2555 Introduction to Differential Equations with Matrix Algebra (or APM 2559 and MTH 2775)

Academic term(s) and deadlines for applications for admission:
To be considered for graduate admission, applicants must submit all Graduate Application Requirements and additional department requirements by the published application deadlines:

- For fall semester: February 15 (early), April 15 (regular), and July 15 (late)
- For winter semester: October 1 (early) and November 15 (regular)
- For summer semester: March 1 (regular)

Specific admission requirements such as additional letters of recommendation, statement of objectives, personal interview, or special exams:
To be considered for graduate admission, applicants must submit all Graduate Application Requirements and additional department requirements, including the following.

- Official Transcripts: Official transcripts are required from all post-secondary educational institutions from which the applicant earned a degree (beginning with first baccalaureate) and all enrollment in graduate level course work beyond the bachelor's degree. International university transcripts must be evaluated by a professional credential evaluation service. Oakland University will only accept transcript evaluations completed by a NACES (National Association of Credential Evaluation service) member organization.
- Letters of Recommendation: Two letters of recommendation are required, with at least one from a faculty familiar with the candidate's academic performance.
- TOEFL/IETLS: Foreign applicants who do not have a degree from an English-speaking institution must provide scores for the Test of English as a Foreign Language (TOEFL) or the International English Language Testing System (IETLS).
- GRE: Applicants must submit official scores from the Graduate Record Examination (GRE) if they graduated from an institution not accredited by a regional accrediting agency of the USA. The department may choose to waive the GRE requirement if at least one of the following special circumstances is met: (1) Applicant's last degree is from a U.S. institution accredited by a regional accrediting agency. (2) Applicant's overall GPA from last degree is at least 3.0 on a 4.0 scale. (3) Applicant has worked in the USA for at least two years in the engineering profession. To request a waiver, applicants must submit a "Request to Waive GRE" form to the Graduate School as part of the application packet. The request for waiver is subject to the approval of the Graduate Admissions Committee.

b. Degree Requirements

To satisfy the requirements for the MS degree in Energy Engineering, all students admitted to the program are expected to complete a minimum of 32 credit hours of graduate coursework, with a cumulative grade point average of B or better. The program of study consists of foundation, depth, capstone, and elective courses. The program will require 4-8 credit hours of foundation courses, 12 credit hours of depth courses, 4-8 credit hours of capstone courses, and 4-12 credit hours of elective courses for a total of 32 credit hours.

c. Curriculum Overview

Courses, credit hours and course prerequisite requirements:
(also included in **Appendix B**)

To fulfill the requirements for the Master of Science in Energy Engineering, a student must complete 32 credits, as described below.

PREPARATORY COURSES – undergraduate courses				
Course	**Title**	**Credits**	**Prerequisites**	
MTH 1555	Calculus II	4	MTH 1554	
MTH 2554	Multivariable Calculus	4	MTH 1555	
APM 2555	Introduction to Differential Equations with Matrix Algebra (or APM 2559 and MTH 2775)	4	MTH 1555	

FOUNDATION COURSES					
Course	**Title**	**Credits**	**Prerequisites**	**New (x)**	**% Distance**
Complete 4-8 credits from the following:					
Students with a prior degree in Mechanical Engineering are not required to complete this course:					
ME 5505	Fundamentals of Thermal-Fluid Energy Systems	4		x	
Students with a prior degree in Electrical Engineering are not required to complete this course:					
ECE 5605	Introduction to Electrical Power Systems	4		x	

DEPTH COURSES					
Course	**Title**	**Credits**	**Prerequisites**	**New (x)**	**% Distance**
Students must declare one depth area and complete 12 credits from that area:					
Depth Area 1: Renewable Energy					
Required (at least 4 credits):					
ECE 5625	Microgrid Design and Operation	4			
ME 5530	Renewable Energy	4			

Electives:					
ECE 5600	AC Motors Analysis and Design	4			
ECE 5640	Battery Management Systems	4			
ME 6530	Fuel Cell Science and Technology	4			
ME 6650	Advanced Battery Materials	4			
PHY 5730	Nuclear Physics	4	Recommended PHY 3720 and PHY 4720		
Depth Area 2: Vehicle Electrification					
Required (at least 4 credits):					
ECE 5630	Electric and Hybrid Drive Systems	4			
ME 5535	Introduction to Electric Drive Vehicle Engineering	4			
Electives:					
ECE 5600	AC Motors Analysis and Design	4			
ECE 5640	Battery Management Systems	4			
ME 5545	Fundamentals of Battery Systems for Hybrid and Electric Vehicles	4			
ME 6530	Fuel Cell Science and Technology	4			
Depth Area 3: Battery Technology					
ECE 5640	Battery Management Systems	4			
ME 5545	Fundamentals of Battery Systems for Hybrid and Electric Vehicles	4			
ME 6650	Advanced Battery Materials	4			
ME 6530	Fuel Cell Science and Technology	4			
Depth Area 4: Energy Use Efficiency					
ECE 5610	Energy Conservation Systems	4			
ECE 5620	Electrical Energy Systems	4			
ISE 5450	Fundamentals of Energy Management	4			
ME 5530	Renewable Energy	4			
ME 5570	Sustainable Design for the Built Environment	4		x	
Depth Area 5: Thermo-Fluid Science and Engineering					
ME 5510	Intermediate Fluid Mechanics	4			

ME 5515	Computational Fluid Dynamics	4			
ME 5520	Intermediate Heat Transfer	4			
ME 5540	Internal Combustion Engines I	4			
ME 6510	Convective Transport Phenomena	4			
ME 6520	Thermal Transport Phenomena	4			
ME 7510	Gas Dynamics	4			

CAPSTONE COURSES					
Course	**Title**	**Credits**	**Prerequisites**	**New (x)**	**% Distance**
Complete 4-8 credits from the following:					
ME 5590	Energy and Sustainability Engineering Seminar and Practice	4		x	
ECE 6996	Graduate Engineering Project	4			
ECE 6998	Master's Thesis Research	8			
ME 6996	Graduate Engineering Project	4			
ME 6998	Master's Thesis Research	8			

ELECTIVE COURSES					
Course	**Title**	**Credits**	**Prerequisites**	**New (x)**	**% Distance**
Complete 4-12 credits total from the follow list of Energy Electives (up to 12 credits) and / or Sustainability Electives (up to 4 credits):					
Energy Engineering Electives (up to 12 credits):					
	Any SECS graduate course listed in the above depth areas that was not taken to satisfy the depth requirements.	4			
ECE 5900	Special Topics (with approval)	4			
ISE 5487	Foundations of Systems Engineering	4			
ISE 5488	Advanced Systems Engineering	4			
ISE 5490	Industrial Sustainability	4		x	
ME 5900	Special Topics (with approval)	4			
Sustainability Electives (up to 4 credits):					

BIO 5380	Ecological Problem Solving	4			
CHM 5230	Chemical Separations	4			
CHM 5730	Fundamentals of Materials Chemistry	4			
CHM 5740	Polymer Science and Technology	4			
ECN 5010	Introduction to Economics	4			
ECN 6850	Economics of Industries	4	ECN 5210		
EHS 5440	Environmental Standards	4			
ENV 5800	Biogeochemical Cycling	4			
ENV 5850	Environmental Fate and Transport	4			
ENV 5870	Natural Resources Management	4			
PH 5350	Environmental Justice	4			
PHY 5220	Statistical Thermodynamics	4			
	Other 5000-level or greater non-SECS courses (with approval)	4			

Typical plan of study for students enrolled full-time in the program:
(also included in **Appendix C**)

Sample Student Schedule 1		
Thesis Option with Depth in Battery Technology (32 credits) (for sample student missing Mechanical Engineering background)		
Fall I ME 5505 Fundamentals of Thermal-Fluid Energy Systems (*Foundation*, 4 credits) ECE 5640 Battery Management Systems (*Depth*, 4 credits)	**Winter I** ME 5545 Fundamentals of Battery Systems for Hybrid and Electric Vehicles (*Depth*, 4 credits) ME 6650 Advanced Battery Materials (*Depth*, 4 credits)	**Summer I**
Fall II ECE 6998 Master's Thesis Research (*Capstone*, 4 credits) ME 6530 Fuel Cell Science and Technology (*Elective*, 4 credits)	**Winter II** ECE 6998 Master's Thesis Research (*Capstone*, 4 credits) PH 5350 Environmental Justice (*Elective*, 4 credits)	**Summer II**

Sample Student Schedule 2		
Coursework Option with Depth in Renewable Energy (32 credits) **(for sample student missing both Mechanical Engineering and Electrical Engineering background)**		
Fall I ME 5505 Fundamentals of Thermal-Fluid Energy Systems (*Foundation*, 4 credits) ECE 5605 Introduction to Electrical Power Systems (*Foundation*, 4 credits)	**Winter I** ME 5530 Renewable Energy (*Depth*, 4 credits) ECE 5625 Microgrid Design and Operation (*Depth*, 4 credits)	**Summer I**
Fall II ME 6530 Fuel Cell Science and Technology (*Elective*, 4 credits) ECE 5600 AC Motors Analysis and Design (*Depth*, 4 credits)	**Winter II** ME 5590 Energy and Sustainability Engineering Seminar and Practice (*Capstone*, 4 credits) ISE 5490 Industrial Sustainability (*Elective*, 4 credits)	**Summer II**

Course descriptions or syllabi for all new courses in the program:
(also included in **Appendix D**)

- ECE 5605: Introduction to Electrical Power Systems (4 credits)

This course introduces students to the fundamentals of electrical energy systems, including: Modeling and analysis of electric circuits; Transient and forced responses in RC, RL circuits; AC power, three-phase circuits, wye-delta transforms; Single- and Three-phase transformers, synchronous and induction machines; Per unit system and introduction to power generation, transmission and distribution; Per unit normalization, symmetrical faults. Computer-aided problem solving included.

- ME 5505: Fundamentals of Thermal-Fluid Energy Systems (4 credits)

Fundamentals of thermodynamics, heat transfer, and fluid mechanics, and applications to sustainable energy systems. First and second laws of thermodynamics, conservation of mass and momentum, inviscid and viscous flow, conduction, convection and radiation, and steady and lumped thermal capacitance analysis. Includes project.

- ME 4570 / 5570: Sustainable Design for the Built Environment (4 credits)

The analysis and design of sustainable buildings including envelope analysis, climate control and comfort level, energy efficiency and air quality. Emphasis on alternative energy technology integration towards a net-zero goal. Baseload and peak power generation and mitigation strategies for a sustainable power grid campus-wide. Includes design project(s).

- ME 4590 / 5590: Energy and Sustainability Engineering Seminar and Practice (4 credits)

Theory and practice of developing sustainable engineering solutions for a variety of energy, environment, and other applications. Review of best practices including sustainability metrics and life-cycle assessment. Analysis of energy resources, water resources, food production, and social issues related to sustainability. Includes seminar and design project.

d. Academic Progress – Probation – Dismissal

Provide criteria by which a student is evaluated on academic progress:
To be in good academic standing, a graduate student must make satisfactory progress toward fulfilling degree requirements, including maintaining a minimum semester and overall GPA of 3.0. All grades received as a graduate student are used in computing the GPA except that, if a course has been repeated, the most recent grade is used in the calculation of the GPA.

The minimum satisfactory grade for graduate work is B. Credit for completion of a course in the Master of Science in Energy Engineering will be given for grades of B- or above but no more than two grades may be B-. Graduate credit will not be awarded for grades below B-. To repeat a course, a student must have the permission of the graduate committee of the school.

Explain the steps that lead to probation and dismissal from the program:
A graduate student is placed on academic probation if the student's overall GPA drops below 3.0, or if the student receives more than one grade below B, including the original grade(s) of any repeated course(s). A graduate student receiving a grade less than B while on probation is subject to dismissal. A graduate student receiving more than two grades below B is subject to dismissal whether or not the student was put on probation previously. If a student's GPA is less than 3.0 after having attempted 16 credits, the student will be recommended for dismissal from the program.

e. Academic direction and oversight for the program

The MS in Energy Engineering program will be administered by the Department of Mechanical Engineering. One program director will be responsible for administering the program and they will be supported by the ME department chair and administrative assistant and by the ME Graduate Affairs Committee.

f. Interdisciplinary Programs

Academic home:
The MS in Energy Engineering will be housed within the Department of Mechanical Engineering.

Participating academic units:
The MS in Energy Engineering will be supported by the Department of Electrical and Computer Engineering from the School of Engineering and Computer Science.

Process for recommending and proposing program changes:
The program director will be appointed by the chair of the Department of Mechanical Engineering. The program director will consult with the Mechanical Engineering Graduate Affairs Committee and the Electrical and Computer Engineering Graduate Affairs Committee to consider possible changes to the program and propose related motions. Proposed changes must be approved by both the Department of Mechanical Engineering and the Department of Electrical and Computer Engineering.

Statement of support from the Deans and department chairs with responsibility for providing courses and faculty for the program:
Included in **Appendix H**

g. Accreditation

Not applicable

h. Prepare a Brief Description of the Program

The MS in Energy Engineering consists of 32 credits hours including 4-8 credit hours of "Foundation", 12 credit hours of "Depth", 4-8 credit hours of "Capstone", and 4-12 credit hours of "Elective".

The program is unique in that it provides access to both mechanical engineering and electrical engineering curriculum to provide students with a wholistic and multi-disciplinary training related to advanced energy systems. To make this interdisciplinary program accessible to students from a wide variety of different undergraduate background, the "Foundation" includes 2 new courses that are designed to equip students with fundamental theory from both mechanical and electrical engineering including thermodynamics, heat and mass transfer, circuit theory, electric machines, power electronics, and controls.

"Depth" courses allow students to specialize in an area of energy engineering including (i) Renewable Energy, (ii) Battery Technology, (iii) Vehicle Electrification, (iv) Energy Use Efficiency, or (v) Thermo-Fluid Science and Engineering. Depth areas are structured such that credits can be also counted towards completion of certificates in the selected depth area, which will be developed in the near future.

The "Capstone" courses provide students with opportunity for hands-on experience related to an applied industry or research project via either (i) Master's thesis research, (ii) a graduate engineering project, or (iii) a new capstone design and seminar course.

"Elective" credits allow students to explore either broader complementary skillsets or additional depth and specialization. Depending on how students have satisfied the "Foundation" and "Capstone" components of the curriculum, it may be possible to select electives so as to complete an additional depth area. Students also have the option to select up to 4-credits from outside of the SECS which may be related to the broader topic of sustainability.

i. Source of Students

- Graduates from OU undergraduate engineering programs including BSE Mechanical Engineering, BSE Electrical Engineering, BS Bioengineering, BS Engineering Chemistry, BS Engineering Physics, and others
- Graduates from other OU STEM programs including physics, math, chemistry and others
- Graduates from other higher education institutions in Michigan and around the country and world
- Mid-career professionals in government and industry that wish to advance or specialize in the energy sector

j. Recruitment Plan

The MS in Energy Engineering program will be promoted via a variety of efforts. A new brochure and webpage will be distributed to our network of industry, alumni, and other SECS contacts. Information will be posted to the SECS social media accounts. The program director will make visits

to strategic industry partners to introduce the new program. Recruiting efforts will be coordinated with the Graduate School, including participation in the Graduate School sponsored open house events.

A special effort will be made to attract minorities and women to the program and prepare them to succeed within the MS in Energy Engineering program and beyond. This will include promotion via the university chapters of national organizations such as IEEE Women in Engineering, the Society of Women Engineers, the National Society of Black Engineers, the Society of Hispanic Professional Engineers, and the American Indian Science and Engineering Society. For many years, the Department of Mechanical Engineering has been highly engaged and supportive of several student organizations. For example, our faculty and students have served the Society of Women Engineers (SWE) local and university chapters in many capacities, and this will continue. The faculty advisor to the OU SWE chapter is a mechanical engineering faculty member (Prof. Laila Guessous) and the past two SWE chapter presidents have been ME students. The Mechanical Engineering and ECE departments also have experience with recruiting a diverse pool of students for NSF-funded Research Experience for Undergraduates (REU) programs. In addition, we envision that the proposed new course "ME 5590 Energy and Sustainability Engineering Seminar and Practice" will provide opportunities to engage with a variety of student clubs, such as for example on co-hosting seminar events. This would have the dual benefit of supporting these clubs, while also attracting students from diverse backgrounds to the program.

k. Planned Program Enrollment

We expect that enrollment in the first year of the program will be 10 students and will increase from there to reach a steady-state enrollment of 30 students by the fourth year. For reference, enrollment in the MS in Mechanical Engineering program is currently about 60 students (was close to 100 students pre-pandemic). On average, we anticipate enrolled students will take 16 credit hours per calendar year.

l. Advising Students

Upon admission, students will be assigned to a faculty advisor from either the Department of Mechanical Engineering or the Department of Electrical and Computer Engineering. The advisor will monitor Plan of Study and scheduling. Efforts will be made to assign advisors from the student's selected depth area so as to provide additional opportunity for mentoring.

m. Retention Plan

Student retention will be ensured (1) by delivering excellent educational value and high-quality instruction, and (2) by fostering a dynamic and supportive environment for students to connect with peers, faculty, and industry. Retention activities will include:

- Faculty mentoring and advising as outlined above in the "Advising Students" section.
- Regular seminars that will be coordinated via the new "Energy and Sustainability Engineering Seminar and Practice". Seminars will include experts from industry and academia across a broad range of topics, as well as peer-to-peer speakers. Seminars will be required for students enrolled in the course but also open to public and encouraged for students throughout their enrollment in the program. This will help to create community and connections.
- Participation of selected students on the curriculum advisory committee to receive feedback and recommendations.

- Promotion of internship and job opportunities which will be supported by the industry advisory committee.
- Applied and hands-on team projects via the new "Energy and Sustainability Engineering Seminar and Practice". This will help students to engage in their program, work with their peers, and connect with industry sponsors.
- Support for student organizations including chapters of IEEE, ASME, Engineers for a Sustainable World, the Society of Women Engineers, the National Society of Black Engineers, the Society of Hispanic Professional Engineers, the American Indian Science and Engineering Society, and others.

n. Provide List of Businesses That Would Likely Employ Graduates of the Program

- Electric utilities: DTE Energy, Consumers Energy
- Energy: Shell
- Industry: Tesla, Stellantis, GM, Ford
- Green building: Peter Baso & Associates, John E. Greene
- Federal agencies: Department of Energy, Department of Transportation, NASA
- Research: National Laboratories, GTI Energy

IV. Off Campus or Distance Delivered Programs

Not applicable.

V. Needs and Costs of the Program

a. New Resources Needed for the Program

- 1 × Tenure Track Assistant Professor: A new faculty position is requested in the area of energy and sustainability with a joint appointment between the Department of ME and the Department of ECE. This will provide personnel to cover the proposed courses and to expand curriculum in new depth areas. Of note, a faculty position was previously approved by the Provost Office as part of the cluster hire in water and sustainability (entitled: H2OU). This requested faculty position is closely connected to the previously approved cluster.

- 1 × Teaching Assistant: TA will provide classroom and grading support for the two new foundational courses: "Fundamentals of Mechanical Energy Systems" and "Introduction to Electrical Energy Systems".

b. Source of New Resources

Costs will be covered by tuition revenue from this program (included in Appendix E) and by other related curriculum proposals that are being submitted in connection with this one, which include also a Minor in Sustainability Engineering, and plans for future certificates related to renewable energy, battery technology, and thermal-fluid science.

c. 5-Year Budget and Revenue from Program

Attached in **Appendix E**.

d. Library Assessment Report

Attached in **Appendix F.**

e. Classroom, Laboratory, Space Needs

Not applicable. Existing resources will be used.

f. Equipment Needs

Not applicable. Existing resources will be used.

VI. Program Assessment Plan

Attached in **Appendix G.**

VII. Appendices

a. Abbreviated Faculty Vitae
b. Degree Requirements
c. Typical Student Plan of Study – Full-Time Schedule
d. Detailed New Course Descriptions or Syllabi
e. Proforma Budget
f. Library Budget Report
g. Graduate Assessment Plan
h. Support Letters
i. Survey Data

Oakland University
Graduate Council

REQUESTED Effective Term/Year Fall 2024
Proposed Title of the Graduate Degree program Master of Science in Energy Engineering
Department Mechanical Engineering
School/College School of Engineering and Computer Science
The delivery method for the Graduate Degree program is **x face to face (100%)** ☐ **fully online (100%)** ☐ **primarily online (75%)**

I, Dean Chamra certify that the Master of Science in Energy Engineering has been reviewed by the appropriate school/college and department committees and that implementation of the proposed degree program is recommended.

Dean of College/School (signature) | 10/03/2023 Date | Louay Chamra Dean of College/School (print)

DECISION OF GRADUATE COUNCIL | Date

Oakland University
GRADUATE COUNCIL
Policy updated 2016-17

NEW DEGREE PROGRAM –GUIDELINES AND PROCEDURES

The Senior Vice President for Academic Affairs and Provost encourages proposals for new degree programs since continuing program development is vital to the university. This process may take up to two years – timing of the proposal submission is crucial. The timeline presented in this document is a **general guide** for new program development.

However, to meet this timeline it is crucial to have a well-reasoned and documented proposal. It is the purpose of these guidelines to help academic units develop good proposals and to elucidate the approval process.

The new degree proposal is a detailed description of the new program as outlined below. While writing the proposal, it is important to remember that it is the principal document used in the approval process for the program. Therefore, it must be written so that it is suitable and sufficient for two different audiences: 1) various faculty and administrative bodies within the university, and 2) a consultant, usually an expert in the field.

Any questions regarding the preparation of the proposal should be referred to the Graduate School.

THE PROPOSAL

Cover Memo

All proposals must be accompanied with a **signed cover memo** from the Dean stating that the proposal has received the appropriate school/college and department/school approvals, and that implementation of the proposal is recommended. **All proposals should be submitted in a word document to gradcouncil@oakland.edu**

Title Page

Abstract
One-page summary of the proposal

Table of Contents

The Table of Contents should show all headings and subheadings in these Guidelines and Procedures, along with page numbers in the Proposal where the information is found. If some information is better located in another location, e.g., an additional appendix or supplemental binder, be sure to record according to this outline where the information is located.

Body of Proposal
Cover Memo

SBRC Proforma Template

Master of Science in Energy Engineering

FY2024

Most Likely Scenario

		Year 1	Year 2	Year 3	Year 4	Year 5
Est. New Students to Program		10	10	12	15	15
1st Year Cohort Revenue		$ 139,440	$ 139,440	$ 167,328	$ 209,160	$ 209,160
2nd Year Cohort Revenue		$ -	$ 139,440	$ 139,440	$ 167,328	$ 209,160
3rd Year Cohort Revenue		$ -	$ -	$ -	$ -	$ -
4th Year Cohort Revenue		$ -	$ -	$ -	$ -	$ -
Gross Tuition Revenue		$ 139,440	$ 278,880	$ 306,768	$ 376,488	$ 418,320
Less: Avg Financial Aid (30%)		$ -	$ -	$ -	$ -	$ -
Net Tuition Revenue		**$ 139,440**	**$ 278,880**	**$ 306,768**	**$ 376,488**	**$ 418,320**
Expenses						
Salaries						
Faculty Salaries	6101	$ 100,000	$ 102,500	$ 105,063	$ 107,689	$ 110,381
Visiting Faculty	6101					
Administrative Professionals	6201					
Clerical Technical	6211					
Administrative IC	6221					
Faculty Inload/Replacement Costs	6301	$ 20,000	$ 20,500			
Faculty Overload	6301					
Part-Time Faculty	6301					
Graduate Assistant	6311	$ 17,334	$ 17,334	$ 17,334	$ 17,334	$ 17,334
Casual/Temp	6401					
Out of Classification	6401					
Student Labor	6501					
Total Salary Expense		**$ 137,334**	**$ 140,334**	**$ 122,397**	**$ 125,023**	**$ 127,715**
Fringe Benefits	6701	$ 44,800	$ 45,920	$ 45,387	$ 46,522	$ 47,685
Total Compensation		**$ 182,134**	**$ 186,254**	**$ 167,784**	**$ 171,545**	**$ 175,400**
Operating Expenses						
Supplies and Services	7101					
Graduate Tuition	7101	$ 14,028	$ 14,028	$ 14,028	$ 14,028	$ 14,028
E-Learning Support	7102					
Travel	7201					
Equipment	7501					
Maintenance	7110					
Recruitment and advertising	7101	$ 20,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000
Library	7401	$ 7,450	$ 6,850	$ 7,535	$ 8,289	$ 9,118
Total Operating Expenses		$ 41,478	$ 25,878	$ 26,563	$ 27,317	$ 28,146
Total Expenses		**$ 223,612**	**$ 212,132**	**$ 194,347**	**$ 198,862**	**$ 203,546**
Net Income (Loss)		**$ (84,172)**	**$ 66,748**	**$ 112,421**	**$ 177,626**	**$ 214,774**

[1]The tuition calculations do not account for any attrition of students.

SBRC Proforma Template

Master of Science in Energy Engineering

FY2024

Best-Case Scenario

		Year 1	Year 2	Year 3	Year 4	Year 5
Est. New Students to Program		12	12	16	20	20
1st Year Cohort Revenue		$ 167,328	$ 167,328	$ 223,104	$ 278,880	$ 278,880
2nd Year Cohort Revenue		$ -	$ 167,328	$ 167,328	$ 223,104	$ 278,880
3rd Year Cohort Revenue		$ -	$ -	$ -	$ -	$ -
4th Year Cohort Revenue		$ -	$ -	$ -	$ -	$ -
Gross Tuition Revenue		$ 167,328	$ 334,656	$ 390,432	$ 501,984	$ 557,760
Less: Avg Financial Aid (30%)		$ -	$ -	$ -	$ -	$ -
Net Tuition Revenue		**$ 167,328**	**$ 334,656**	**$ 390,432**	**$ 501,984**	**$ 557,760**
Expenses						
Salaries						
Faculty Salaries	6101	$ 100,000	$ 102,500	$ 105,063	$ 107,689	$ 110,381
Visiting Faculty	6101					
Administrative Professionals	6201					
Clerical Technical	6211					
Administrative IC	6221					
Faculty Inload/Replacement Costs	6301	$ 20,000	$ 20,500			
Faculty Overload	6301					
Part-Time Faculty	6301					
Graduate Assistant	6311	$ 17,334	$ 17,334	$ 17,334	$ 17,334	$ 17,334
Casual/Temp	6401					
Out of Classification	6401					
Student Labor	6501					
Total Salary Expense		**$ 137,334**	**$ 140,334**	**$ 122,397**	**$ 125,023**	**$ 127,715**
Fringe Benefits	6701	$ 44,800	$ 45,920	$ 45,387	$ 46,522	$ 47,685
Total Compensation		**$ 182,134**	**$ 186,254**	**$ 167,784**	**$ 171,545**	**$ 175,400**
Operating Expenses						
Supplies and Services	7101					
Graduate Tuition	7101	$ 14,028	$ 14,028	$ 14,028	$ 14,028	$ 14,028
E-Learning Support	7102					
Travel	7201					
Equipment	7501					
Maintenance	7110					
Recruitment and advertising	7101	$ 20,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000
Library	7401	$ 7,450	$ 6,850	$ 7,535	$ 8,289	$ 9,118
Total Operating Expenses		$ 41,478	$ 25,878	$ 26,563	$ 27,317	$ 28,146
Total Expenses		**$ 223,612**	**$ 212,132**	**$ 194,347**	**$ 198,862**	**$ 203,546**
Net Income (Loss)		**$ (56,284)**	**$ 122,524**	**$ 196,085**	**$ 303,122**	**$ 354,214**

[1]The tuition calculations do not account for any attrition of students.

SBRC Proforma Template

Master of Science in Energy Engineering

FY2024

Worst-Case Scenario

		Year 1	Year 2	Year 3	Year 4	Year 5
Est. New Students to Program		8	8	9	10	10
1st Year Cohort Revenue		$ 111,552	$ 111,552	$ 125,496	$ 139,440	$ 139,440
2nd Year Cohort Revenue		$ -	$ 111,552	$ 111,552	$ 125,496	$ 139,440
3rd Year Cohort Revenue		$ -	$ -	$ -	$ -	$ -
4th Year Cohort Revenue		$ -	$ -	$ -	$ -	$ -
Gross Tuition Revenue		$ 111,552	$ 223,104	$ 237,048	$ 264,936	$ 278,880
Less: Avg Financial Aid (30%)		$ -	$ -	$ -	$ -	$ -
Net Tuition Revenue		**$ 111,552**	**$ 223,104**	**$ 237,048**	**$ 264,936**	**$ 278,880**
Expenses						
Salaries						
Faculty Salaries	6101	$ 100,000	$ 102,500	$ 105,063	$ 107,689	$ 110,381
Visiting Faculty	6101					
Administrative Professionals	6201					
Clerical Technical	6211					
Administrative IC	6221					
Faculty Inload/Replacement Costs	6301	$ 20,000	$ 20,500			
Faculty Overload	6301					
Part-Time Faculty	6301					
Graduate Assistant	6311	$ 17,334	$ 17,334	$ 17,334	$ 17,334	$ 17,334
Casual/Temp	6401					
Out of Classification	6401					
Student Labor	6501					
Total Salary Expense		**$ 137,334**	**$ 140,334**	**$ 122,397**	**$ 125,023**	**$ 127,715**
Fringe Benefits	6701	$ 44,800	$ 45,920	$ 45,387	$ 46,522	$ 47,685
Total Compensation		**$ 182,134**	**$ 186,254**	**$ 167,784**	**$ 171,545**	**$ 175,400**
Operating Expenses						
Supplies and Services	7101					
Graduate Tuition	7101	$ 14,028	$ 14,028	$ 14,028	$ 14,028	$ 14,028
E-Learning Support	7102					
Travel	7201					
Equipment	7501					
Maintenance	7110					
Recruitment and advertising	7101	$ 20,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000
Library	7401	$ 7,450	$ 6,850	$ 7,535	$ 8,289	$ 9,118
Total Operating Expenses		$ 41,478	$ 25,878	$ 26,563	$ 27,317	$ 28,146
Total Expenses		**$ 223,612**	**$ 212,132**	**$ 194,347**	**$ 198,862**	**$ 203,546**
Net Income (Loss)		**$ (112,060)**	**$ 10,972**	**$ 42,701**	**$ 66,074**	**$ 75,334**

[1]The tuition calculations do not account for any attrition of students.

M.S. Energy Engineering

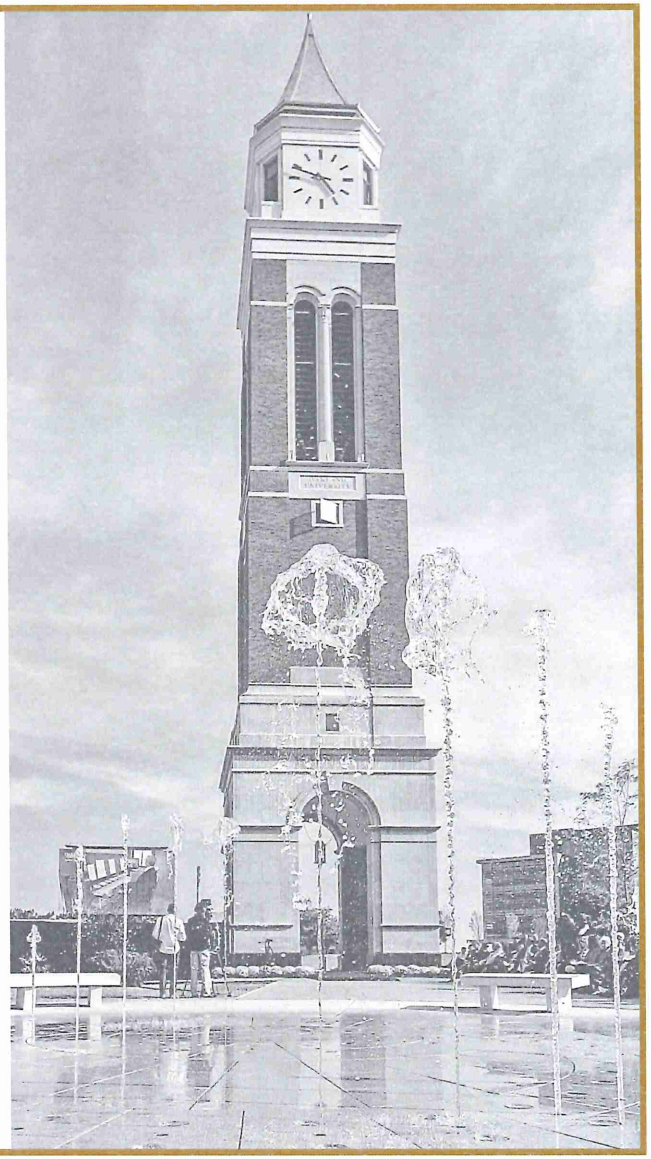
Board of Trustees

M.S. Energy Engineering

Department of Mechanical Engineering,
School of Engineering and Computer Science

presented by:
Prof. Laila Guessous

OAKLAND UNIVERSITY



Summary of Need / Market Analysis

- Provide evidence of need or workforce demand
  - Energy sector employs > 7.8 million throughout the United States and almost 400,000 in Michigan. Growth since 2021 has outpaced overall jobs growth.
  - Most growth has come in areas experiencing rapid innovation including renewable energies, battery technologies, and hybrid and electric vehicles.
  - Trend is expected to continue as the US has goal to reach net-zero greenhouse gas emissions by 2050.
  - Energy employers in Michigan report difficulty recruiting and hiring qualified personnel for > 50 % of their job openings related to energy.

Summary of Need / Market Analysis

- Goals and objectives
  - The goal of the M.S. Energy Engineering program is to prepare students for advanced-level energy engineering careers in the sectors of power generation, energy distribution and storage, fuels, transportation, and energy use efficiency.

- Businesses that would likely employ graduates of the program
  - Electric utilities: DTE Energy, Consumers Energy
  - Industry: Shell, Tesla, Stellantis, GM, Ford
  - Federal agencies: DOE, DOT, NASA
  - Research: National Laboratories, GTI Energy

State & National Comparisons

Institution	Degree	College	Credits
University of Michigan	M. Eng. Energy Systems and Sustainability Engineering	College of Engineering (Dept of Electrical and Computer Engineering)	30 credits (10 courses)
Wayne State University	M.S. Alternative Energy Technology	College of Engineering (Engineering Technology Division)	32 credits (8-9 courses)
The University of Toledo	M.S. Energy Engineering	College of Engineering	30 credits (10 courses)

- Our unique multidisciplinary program offers access to both our electrical engineering and mechanical engineering curriculum, and provides new foundational courses to help students succeed in both.

Lawrence Tech	Certificate of Energy Engineering	College of Engineering (Dept of Mechanical, Robotics, and Industrial Engineering)	18 credits (6 courses)
Michigan Tech	Certificate in Engineering Sustainability and Resilience	College of Engineering (Department of Chemical Engineering)	9 credits (3 courses)

Curriculum Overview

- Degree requirements
  - Complete a minimum of 32 credit hours of graduate coursework, with a cumulative grade point average of B or better.
  - Includes 4-8 credits of foundation courses,
  - 12 credits of depth courses,
  - 4-8 credits of capstone courses, and
  - 4-12 credits of electives.

- Intended program length: 2 years (16 credits per year)

Curriculum Overview

Sample Student Schedule 1		
Thesis Option with Depth in Battery Technology (32 credits) **(for sample student missing Mechanical Engineering background)**		
Fall I ME 5505 Fundamentals of Thermal-Fluid Energy Systems (*Foundation*, 4 credits) ECE 5640 Battery Management Systems (*Depth*, 4 credits)	**Winter I** ME 5545 Fundamentals of Battery Systems for Hybrid and Electric Vehicles (*Depth*, 4 credits) ME 6650 Advanced Battery Materials (*Depth*, 4 credits)	**Summer I**
Fall II ECE 6998 Master's Thesis Research (*Capstone*, 4 credits) ME 6530 Fuel Cell Science and Technology (*Elective*, 4 credits)	**Winter II** ECE 6998 Master's Thesis Research (*Capstone*, 4 credits) PH 5350 Environmental Justice (*Elective*, 4 credits)	**Summer II**

Curriculum Overview

Sample Student Schedule 2		
Coursework Option with Depth in Renewable Energy (32 credits) **(for sample student missing both Mechanical Engineering and Electrical Engineering background)**		
Fall I ME 5505 Fundamentals of Thermal-Fluid Energy Systems (*Foundation*, 4 credits) ECE 5605 Introduction to Electrical Power Systems (*Foundation*, 4 credits)	**Winter I** ME 5530 Renewable Energy (*Depth*, 4 credits) ECE 5625 Microgrid Design and Operation (*Depth*, 4 credits)	**Summer I**
Fall II ME 6530 Fuel Cell Science and Technology (*Elective*, 4 credits) ECE 5600 AC Motors Analysis and Design (*Depth*, 4 credits)	**Winter II** ME 5590 Energy and Sustainability Engineering Seminar and Practice (*Capstone*, 4 credits) ISE 5490 Industrial Sustainability (*Elective*, 4 credits)	**Summer II**

Proforma

- ✓ 1 new faculty in area of sustainability (previously approved with the H_2OU cluster)
- ✓ 1 new TA to provide teaching support (program includes 3 new courses)

- ✓ Projected net income of ~ $215k / year by year 5
  (based on enrollment of 15 new students / year by year 5).