THE OHIO STATE UNIVERSITY

Office of Academic Affairs

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M e m o r a n d u m

To: Council on Academic Affairs
From: W. Randy Smith, Vice Provost for Academic Programs and Vice Chair, Council on Academie Affairs
Subject: Master of Energy Sustainability
Date: January 12, 2026

Late in November 2025, the combined Graduate School, Council on Academic Affairs subcommittee approved the proposal for a new Master of Energy Sustainability degree program.

During December 2025, Professor Elena Irwin, who led the proposal development, worked with the Office of Academic Affairs and the three lead colleges - Arts and Sciences, Engineering, and Food Agricultural and Environmental Sciences - to address two issues for which further clarifications were needed. The result was:

- The proposal now focuses just on the Master's program and **not** on any potential programs for which there had been no details provided in the original proposal;
- A detailed implementation plan was developed showing the fiscal dimensions/impacts of this proposal on the three colleges and related departments, over the next few years.

With those clarifications, on January 6, 2026, a meeting was held that included Professor Irwin, the Deans and fiscal officers of the three colleges, and the Vice Provost for Academic Programs and the Office of Academic Affairs' Associate Vice President for Resource and Budget Management. All agreed that the proposal was ready to be reviewed by the Council on Academic Affairs.

Reed, Katie

From: Kowalsky, Lisa
Sent: Wednesday, November 26, 2025 1:41 PM
To: Reed, Katie
Subject: Forwarding Revised Proposal: Master of Sustainable Energy
Attachments: MasterSustainableEnergy(MSE)Degree_PROPOSAL_OSU(FINAL_GS-Approved 11-24-25 _RequestedChanges 11-26-25).pdf

Dear Katie,

Attached is a copy of the revised MSE proposal that TJ sent on my behalf on Monday while I was out of office. It was sent to us today, and Maria indicated that I should just forward the file to you directly since you've got the previous one already, but please let me know if you need anything else from me.

Have a wonderful Holiday break!

Best,
Lisa

THE OHIO STATE UNIVERSITY
GRADUATE SCHOOL

Lisa Clouser (Kowalsky)

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Pronouns: she/her/hers

Proposal for an Interdisciplinary Graduate-Level Professional Degree: *Master of Energy Sustainability* (MES) (34 semester credits)

Submission Date of Original Final Proposal: January 30, 2025
(GS/CAA Committee Approved 11/24/25 . . .
Resubmitted for CAA Review w/ Recommended Changes November 26, 2025)

Goal

The overarching goal is to launch a new interdisciplinary graduate-level professional *Master of Energy Sustainability* (MES) degree using a framework to initially offer an MES degree *Generalist Pathway* curriculum and eventually add various curricula for MES degree *Specialist Pathways.* All pathways to earn the MES degree will align with 10 *Foundational Competencies* and the associated 19 semester credits of *Foundational Courses*. The plan is to launch the proposed 34 semester credit *Generalist Pathway* curriculum by academic year 2026-2027. Graduates from the program will demonstrate knowledge, skills, and attitudes to prepare them for careers across the spectrum of energy resource and technology sectors.

Facilitating Units

- **Ohio State University Sustainability Institute**
  - **Sustainability Education and Learning Committee** (represented by Co-Chairs Elena Irwin and Michael Bisesi and its **Graduate and Professional Education Subcommittee**)
- **Graduate School** (represented by Maria Miriti)

Collaborating and Sponsoring Academic Units (represented by their respective Graduate and Professional Education Subcommittee members/proposal co-authors)

- **College of Arts and Sciences** (represented by David Cole and Max Woodworth)
  - Department of Geography
  - School of Earth Sciences
- **College of Engineering** (represented by Daniel Gingerich and Rajiv Ramnath)
  - Department of Civil, Environmental, and Geodetic Engineering
  - Department of Computer Science and Engineering
  - Department of Mechanical and Aerospace Engineering
- **College of Food, Agricultural, and Environmental Sciences** (represented by Jeremy Brooks, Jonathan Fresnedo Ramirez, and Brent Sohngen)
  - School of Environment and Natural Resources
  - Department of Agricultural, Environmental, and Development Economics
  - Department of Horticulture and Crop Sciences

Executive Summary

This proposal to develop and implement the new *Master of Energy Sustainability* (MES) degree represents one of several actions and outcomes from the coordinated and collaborative efforts at The Ohio State University, via its Sustainability Institute (SI), to enhance and expand sustainability-related education, research, and community engagement. The focused visioning initiative, led by SI Faculty Director Elena Irwin, was officially launched during January 2023 and involved applicable groups of faculty and administrators. The first product from the initiative is the document *Advancing Education at Ohio State: Education and Workforce Development* that was completed and released during June 2023. The document, found here https://oaa.osu.edu/sustainability, shares a vision to *promote the health, justice and well-being of people, biodiversity, and the environment of Ohio, the nation, and the world by educating and empowering sustainability leaders, practitioners, and change agents across the lifespan of learning at The Ohio State University.* In relation to this, the document summarizes plans for actions and outcomes specifically focused on sustainability-related education and workforce development at Ohio State.

A Graduate and Professional Education Subcommittee (GPES), under the SI Sustainability Education and Learning Committee (SELC) established in 2018, was organized and launched during January 2024 as one of four subcommittees to implement the plan and applicable education initiatives. This specific proposal was developed by the GPES members with the goal to launch an interdisciplinary graduate-level professional *Master of Energy Sustainability* (MES) degree at Ohio State during the 2026-2027 academic year. This effort aligns well with the United Nation Sustainable Development Goal #7 *Ensure access to affordable, reliable, and sustainable and modern energy for all*.[1] The conceptual framework and model for this program is shown in Figure 1 and summarized in more detail throughout the proposal.

The proposed MES degree program is interdisciplinary involving three Colleges and will leverage the Ohio State *EmPOWERment* program, which started in 2019 as a National Science Foundation funded National Research Traineeship. The overarching aspiration is to contribute to meeting the societal challenge of fostering a sustainable energy future. To date, the Ohio State *EmPOWERment* program has 46 affiliated faculty members, a 14-member internal advisory council, plus a 7-member external advisory council.

Rationale for Developing and Implementing the New MES Degree

The world is experiencing an energy revolution focused on the dual challenges of meeting a growing global demand for energy and reducing the impact of energy generation and utilization. Presently, the spectrum of technologies is vast and ranges from conventional fossil fuel-based technologies to alternatives that do not use fossil fuel as an energy resource. *Sustainable energy* includes a foundational provision of energy to meet the needs of the present without compromising the ability of future generations to meet their needs. However, inherent to sustainable energy requires going beyond energy technologies and energy generation. It requires building a more holistic sustainable energy system that

[1] United Nations (2015). *Transforming Our World: The 20230 Agenda for Sustainable Development*. https://sdgs.un.org/publications/transforming-our-world-2030-agenda-sustainable-development-17981

includes the additional focus areas of energy resources plus energy transmission, distribution, demand, and use.

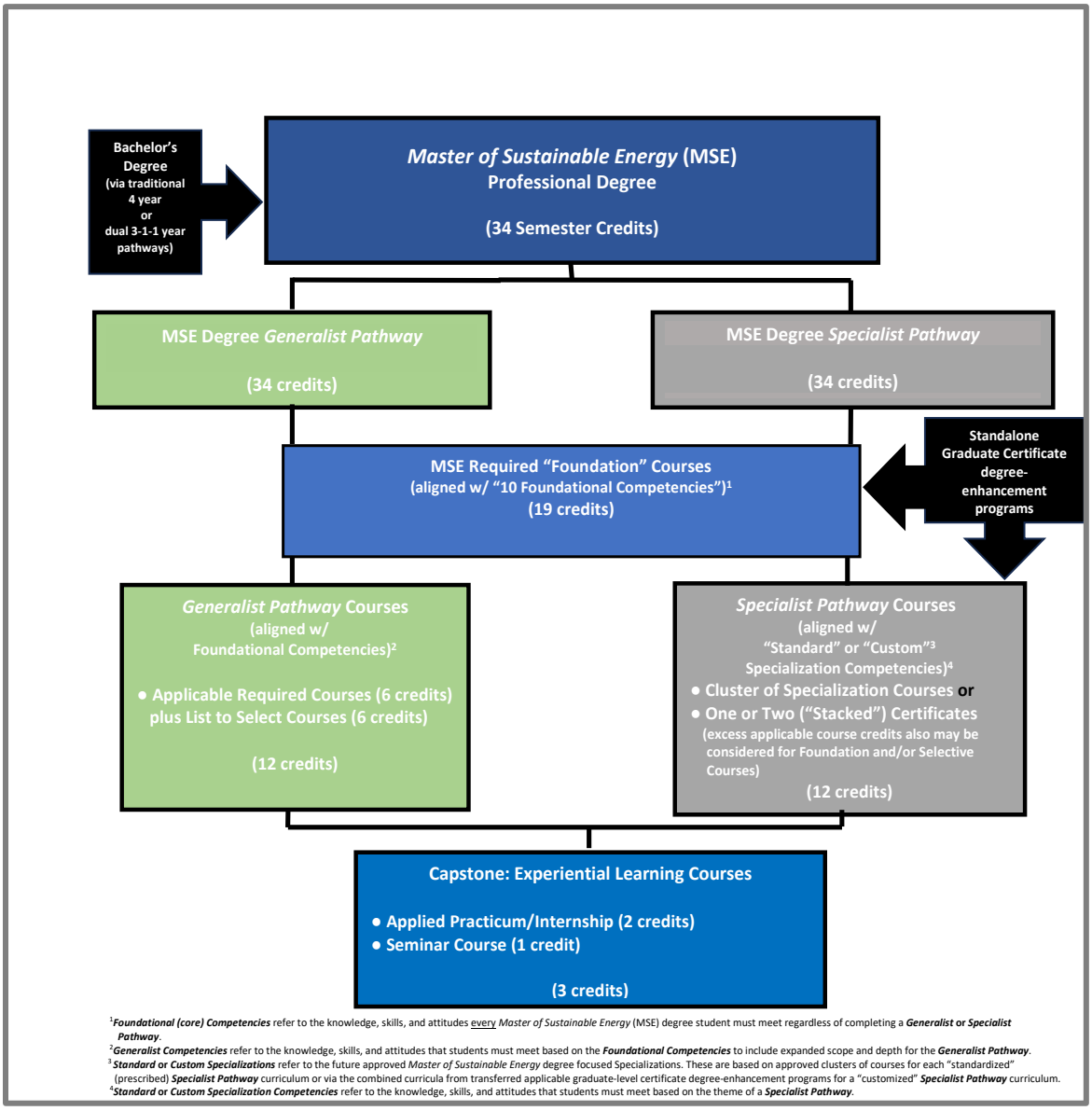

Figure 1. Model for the MES Degree *Generalist* and *Specialist Pathways*

The transition to a more sustainable energy system will require understanding and evaluating technical and non-technical interventions throughout the entire system, from generation-to-distribution-to-use. Evaluating and implementing these technologies, with the overarching goal of ensuring that society's energy needs are met without adversely affecting the natural or social environment, requires a foundation in applied energy sciences while also leveraging and integrating skills and techniques developed in a variety of complementary disciplines. Likewise, maximizing the impact of technological developments will require a deeper understanding of the complex socio-economic, cultural, and political factors that adequately foster or hinder widespread distribution of sustainable energy production and

transmission facilities as well as consumer needs and demand for sustainable energy and products that are dependent on it.

The MES Degree and Workforce Development

An Ohio State University Workforce Development Committee led by Vice Provost Randy Smith and co-led by former Vice Dean Michael Bisesi created and adopted a framework for workforce development summarized in the document *The Conceptual Elements for Framing and Defining Workforce Development at The Ohio State University*. Within the framework document that was completed and released during May 2020 two major workforce categories are defined as follows:

1) The *emerging workforce* category are those focusing exclusively on full-time pursuit of a degree program that upon completion will lead to applicable employment and a career. The education and training required is exclusively academic credit-based.
2) The *present workforce* category refers to those who are focused primarily on working full-time as well as those who are interested in working full-time but are underemployed or unemployed. This group may have an interest in pursuing academic part-time education and training to earn a credential in the form of an academic credit-based degree or certificate program to enhance their knowledge and skills to meet present and/or future needs or wants. This same group may be interested in pursuing other shorter education and training in the form of non-credit modules, short courses, and workshops.

As an extension of this effort plus to prepare the *Advancing Education at Ohio State: Education and Workforce* document, a Sustainability Education Visioning Committee (SEVC) collected applicable employer stakeholder data by 1) conducting a survey distributed to 100 external recipients, 2) hosting 3-hour listening sessions to allow for more comprehensive details about and understanding of survey responses, and 3) facilitating individual interviews for those unable to participate in the scheduled listening sessions. These coordinated integrated efforts resulted in a collection of 1,100 data points, from which nine primary areas of emphasis emerged:

1) Employers are thinking about sustainability and are concerned about related issues such as the political climate, the circular economy and waste reduction, environmental justice, climate change, net zero emissions, population growth, the regulatory environment, and technology.
2) Sustainability touches all jobs, and employers expect their employees to have a base level of sustainability knowledge that is supplemented with in-house job training.
3) Employers need knowledge and expertise regarding policy/regulatory processes, waste, and materials management, ESG knowledge, and expertise in areas such as climate change, energy purchasing, and information systems.
4) Employees need to be able to work in interdisciplinary environments and with teams.
5) Employees need to possess both hard and soft skills, including subject matter expertise, a sustainability mindset, training in basic STEM, project management, communication, policy, regulation, and engineering/manufacturing processes.
6) Job candidates ideally come with real-world experiences, and these can be gained through capstones, internships and other interactions with practitioners and alumni inside and outside the classroom.
7) There is a need for training to keep up with technological change and changes in jobs.
8) Employers believe that Ohio State has an opportunity to better prepare its students by providing experiential learning, teaching interdisciplinary and systems thinking, promoting diversity and social sustainability, and integrating sustainability throughout the curriculum.

9) Employers believe Ohio State can help better prepare existing employees by creating alternative credentials such as certificates, training programs, and modular videos, fostering real world experiences, creating partnerships, and teaching critical thinking and communication.

The nine areas of emphasis align with a need and demand for the proposed sustainability-related MES degree and are further emphasized, as examples, by the following employer stakeholder responses to applicable questions: 1) 90% of respondents said "yes" when asked, *Is there a basic level of knowledge about sustainability that you would like all your employees to possess?* 2) 80% answered "yes" to *Do any positions in your organization require more specialization related to sustainability?* and 3) 80% responded "yes" to *Looking ahead, are there any sustainability-related knowledge and/or skills you expect your organization to need in the future?*

Indeed, there are both need and demand for degree programs focused on sustainability and energy related to continued technology expansion and workforce development. These are global needs, as reported for examples, in the International Energy Agency (IEA). *World Energy Outlook*[2] and the International Renewable Energy Agency (IRENA) *Renewable Energy and Jobs – Annual Review*[3].

The applicable public and private employment sectors are engaged in energy-related activities ranging from exploring novel sources of energy to developing and deploying generation, distribution, and conservation of energy efficient technologies. Understanding their impact on the environment and society requires that both the *emerging workforce* and *present workforce* are appropriately and adequately educated in the energy-related natural and social sciences and professions (e.g., engineering, business). Although the employment of graduates from The Ohio State University is not limited geographically to only Ohio, representatives from various energy sectors located in Ohio have stated that there is a demand for an appropriately and adequately educated workforce.

Phases for the Proposed Master of Energy Sustainability (MES) Degree Program

The framework of the MES degree model (Figure 1) reflects pathways for developing and implementing *generalist* and *specialist* curricula that align with identified societal and workforce needs and wants applicable to all aspects of sustainable energy. The first phase is to launch the 34-semester credit Master of Energy Sustainability (MES) degree *Generalist Pathway* to provide an opportunity for both the emerging workforce and the present workforce to expand and enhance their knowledge, skills, and attitudes through completion of a sustainability-themed curriculum. The curriculum will emphasize and focus primarily, but not exclusively, on a variety of applicable energy topics. The Generalist Pathway curriculum was developed by first establishing ten *Foundational Competencies* (listed later in Table 2) and then aligning courses and course content with these competencies (shown later in Table 3).

[2] International Energy Agency (2024). *World Energy Outlook*. https://www.iea.org/reports/world-energy-outlook-2024
[3] International Renewable Energy Agency (2024). *Renewable Energy and Jobs – Annual Review*. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2024/Oct/IRENA_Renewable_energy_and_jobs_2024.pdf

While this initial phase focuses on the MES degree *Generalist Pathway*, the second phase will involve the SI SELC Graduate and Professional Education Subcommittee working with academic units to catalyze and facilitate planning for and developing "standardized" and "customized" *Specialist Pathways*. Curriculum development for all MES degree pathways will embed the more general ten *Foundational Competencies* and the aligned required *Foundational Courses* (18-credits). The *Specialist Pathways*, however, will also include developing three to five *Specialization Competencies* and aligning them with *Specialization Courses* for each of the respective specialist curricula. For example, the MES degree specializations can be developed and offered across a spectrum of focus areas including business and economics, policy, environmental and geological (e.g., subsurface), energy engineering technology, among other areas.

The second phase will also include concurrently developing applicable graduate-level certificate programs. The vision is to provide all students with sufficient foundational content, but also choices for "standardized" (prescriptive) energy-focused specializations as well as options for others to apply individual or combined ("stacked") energy-related certificates for competency-based "customized" specializations. For example, some may initially pursue and complete a certificate program. The framework of the MES degree model will allow those students to apply one or even stack two applicable certificate programs and count some or all the completed courses toward the *Generalist Pathway*, a "standardized" *Specialist Pathway*, or a "customized" *Specialist Pathway*.

Options for the MES degree *Generalist Pathway* and *Specialist Pathways* align with responses from employer stakeholders collected during the SEVC visioning process when participants were asked, *What types of positions within your organization require more specialized sustainability-related knowledge and skills?* For one example, 10 of 39 (26%) respondents indicated that "energy planning management" required more specialization. Indeed, in Ohio, and beyond, there has been and continues to be emphasis on expanding and enhancing sources of and technologies for generating energy that is sustainable from natural resource, economic, and environmental perspectives. The proposed options for MES degree pathways will create opportunities for offering curricula with applicable scope and depth to meet the needs and wants of the emerging workforce and present workforce while simultaneously aligning employers' interests as well.

Examples of Other Applicable Graduate-Level Degree Programs in the Big Ten plus Ohio

Given the global (i.e., regional, national, and international) needs and demands regarding resources for, sources of, and technology for sustainable energy, it is encouraging to know that there are several universities within Ohio and the Big Ten that presently offer master-level degree programs that align with sustainability and emphasize energy resources, technologies, and their impact (Table 1). Most of the universities listed that have already developed and implemented applicable graduate-level degree programs have focused on the engineering aspects. The Master of Energy Sustainability (MES) degree proposed here is similar but not the same as those degree programs listed in Table 1. As described earlier in this proposal, the framework of the Ohio State MES degree model initially allows for a more general sustainable energy pathway/curriculum plus eventually varieties of specialized sustainable energy-related pathways/curricular offerings.

Although Ohio State is behind in having a specific master-level degree in this space, the University presently has several units with faculty engaged in conducting high-level basic and applied energy-related research and directing/teaching energy-related courses. In addition, representative faculty from these units are contributing to the EmPOWERment project funded by the National Science Foundation. Indeed, there is a need for expansion with an emphasis on education and research beyond this, with sustainable energy focus, which allows for more interdisciplinary collaboration and cooperation. Leveraging faculty knowledge and skills plus other resources across academic units, as proposed here, will lead to more efficient and effective education and training of students. Indeed, given its size, scope, and depth, Ohio State alone and in collaboration and cooperation with other applicable agencies, organizations, companies, and universities, is well-positioned to be among the leaders in sustainability, including energy-focused education and research.

Table 1. Examples of Similar Degree Programs at Big Ten and Ohio Universities.

University	Degree Offered	Number of Semester Credits	Examples of Curricular Requirements
Big 10 Universities			
University of Illinois	Master of Engineering in Energy Systems	32	Professional development requirement (practicum, project, or coursework)
Indiana University	Master of Science in Environmental Science - Energy and Climate Change	42	Capstone or Thesis. Internship required over the summer.
University of Maryland	Master of Engineering in Energy Systems Engineering	30	Coursework-only
Penn State University	Master of Professional Studies in Renewable Energy and Sustainability Studies	33	3-credit capstone or unique topics research
Purdue University	MSChE – Energy Systems and Fundamentals	30	Capstone
Rutgers University	Master of Engineering in Energy Systems Engineering	30	3 credit credits in industry internship or a hands-on project
University of Michigan	MSE in Energy Systems and Sustainability Engineering	30	Thesis (6 credits) or additional coursework
University of Wisconsin	Engineering MS: Energy Engineering Concentration	30 (thesis) or 31 (non-thesis)	Thesis or non-thesis. Non-thesis requires capstone or comprehensive exam
Ohio Universities			
University of Cincinnati	Master of Engineering in Sustainable Energy	30	Capstone
Ohio University	Master's degree Engineering - Sustainable Energy	30	Thesis or non-thesis.
University of Dayton	MS - Renewable and Clean Energy Engineering	30	Thesis (24 credits of coursework, 6 credits research) or non-thesis.
University of Toledo	Master of Energy Engineering	30	Coursework or project option (fewer courses with a work-related project w/ employer/advisor)

University	Degree Offered	Number of Semester Credits	Examples of Curricular Requirements
Cleveland State	MS Mechanical Engineering – Sustainable Energy Systems	33	Project
Wright State	MSE Renewable and Clean Energy	30	Thesis or non-thesis

Accordingly, the Ohio State MES degree model proposed here will provide a sustainable energy-focused and versatile framework for graduate students to complete contemporary education and training that will lead to opportunities for applicable employment and/or more advanced studies. In addition, as mentioned, the proposed MES degree program at Ohio State will be collaboratively and cooperatively interdisciplinary. This approach will provide students with a broader scope of perspectives from the faculty engaged in sustainable energy research sustainable energy as well as related technologies, economics, issues, challenges, and solutions. Given the global needs and demands, there is room for this new degree program from Ohio State plus the other similar (but not the same) energy-focused master's degree programs offered by the other universities listed above in Table 1.

Ten *Foundational Competencies* for the MES Degree *Generalist Pathway* and *Specialist Pathways*

The proposed curriculum aligns with the nationally-established sustainability competencies that have been adopted by the Ohio State Sustainability Institute's (SI's) Sustainability Education and Learning Committee (SELC). In turn, the curriculum aligns with one or more of SI's *Six-Dimensions of Sustainability*. Accordingly, the proposed MES degree program is categorized as a sustainability-related degree program based on national and local categorizations. However, central to this proposed MES degree, ten sustainable energy-focused competencies were established to develop the curriculum required to earn the MES degree (Table 2). These ten competencies and the aligned curriculum are the basis for the required energy-focused knowledge, skills, and attitudes that the students will acquire while pursuing and upon successful completion of the MES degree program.

Table 2. MES Degree *Foundational Competencies* Based on Identified Needs for Applicable Sustainable Energy Knowledge, Skills, and Attitudes

Foundational Competencies for MES Degree
1 - Compare the types and characteristics of major conventional and emerging technologies used or proposed to generate electricity in a low-impact future.
2 - Articulate the social and behavioral features of energy use and transitions and the factors that may influence technical and non-technical solutions to energy conservation and the move to lower-impact energy systems.
3 - Summarize the mechanisms by which conventional and emerging technologies for energy extraction and generation create environmental and ecological impacts.
4 - Determine the impact of local, national, and international governmental and non-governmental institutions and global governance in promoting sustainable energy and mitigating climate change.

Foundational Competencies for MES Degree
5 - Summarize and apply theories and principles of economics, business, finance, policy, ethics and law as each relates to sustainable energy systems.
6 - Communicate a definition of sustainable energy systems that draw upon elements from different disciplinary perspectives and definitions of sustainability.
7 - Describe the ways that society currently and may in the future transport, store, and use energy.
8- Describe trends in demand for energy over time and explore how the relationship between changes in energy demand and energy production can aid in identifying pathways to sustainable energy through social, behavioral, and other mechanisms that generate overall energy demand.
9 - Acquire software, analysis, modelling, and computation skills to address sustainable-energy problems.
10 - Assess the opportunities and uncertainties in the sustainable energy landscape to develop solutions plus determine market needs and growth to develop potential technical and business strategies.

The Curricular Framework for the Master of Energy Sustainability (MES) Degree *Generalist Pathway*

The curriculum required to complete and earn the proposed Master of Energy Sustainability (MES) degree program *Generalist Pathway* consists of a set of foundational courses (19 semester credits), applicable general courses (12 semester credits), and an experiential learning capstone and seminar (3 semester credits). A total of 34 semester credits are required for the degree curriculum (Table 3.1). A general Plan of Study for completing the MES Degree Generalist Pathway within 12-months is shown in Table 3.2. Course descriptions for the Foundational Courses plus selections for the General Pathway courses are shown in Appendix A. The only course that needs to be developed is the Practicum in Sustainable Energy, which will be developed by the three Program Co-Directors (once named), or they may identify an applicable practicum course from their respective units. The first offering of the Practicum in Sustainable Energy course will be Summer 2027.

The non-thesis experiential learning capstone requires most students to complete an applied practicum placement or rotations at applicable public or private agencies or organizations. Students with their faculty advisor will identify three major Foundational Competencies that align with the experiential learning capstone. Students will be responsible for documenting major activities completed, alignment with the identified competencies, and summarizing the experience in a narrative document that is due upon completion of the practicum. While most students will pursue the required non-thesis experiential learning capstone as a practicum, some students may be eligible for substituting a research thesis or project or waving the 3-credit practicum/internship requirement. Examples include but are not limited to: (i) Students who may already have one-year or more applicable work experience may have the option to use competency-aligned and documented experience for the capstone. (ii) Students without reasonable access to an internship site may be permitted to complete a research project instead. This will be determined by the MES degree Program Co-Directors and Admission Committee faculty members on a case-by-case basis.

Table 3.1 Curriculum for the MES Degree *Generalist Pathway*: Courses and Aligned General *Foundational Competencies*

Courses	Credits	Colleges (Units)	Aligned Foundational Competencies
Foundational Courses (19 credits)			
AEDE 6320 Energy Economics	3	CFAES (AEDE)	3,5
AEDECON 6500/ ENVENG 6020/ FABENG 6020/ISE 6020 /PUBAFRS 6020/ GEOG 6020 Foundations of Data-Driven Sustainable Energy Systems	3	CFAES/COE/ GCPA/ASC	1,2,4,5,6
PUBAFRS 8620 Innovating for Sustainable Energy Systems	4	GCPA	2,7,10
GRADTDA 5621 Big Data Computing Foundations 1	3	TDAI/COE(CSE)	9
Select 6 Credits: **ENR 7150** Environmental Risk and Decision-Making **ENR 7430** Sustainability Psychology **MECHENG 5194** Comparative Energy	6	 CFAES (SENR) CFAES (SENR) COE (MECH)	 2,8 8 1,7,8
Sub-Total Foundational Course Credits	**19**		
General Pathway Courses (12 credits)			
ENVENG 5170 Sustainability and Circular Economy	3	COE (CEGE)	3,5
GEOG 5802 Globalization and Environment	3	ASC (GEO)	4
Select 6 Credits: **MECHENG 6526** Combustion **MECHENG 5194** Comparative Energy **MATSCEN 5572** Materials for Energy Technology **AEDECON 6300** Environmental Resource Economics **GEOG 5900** Weather, Climate, and Global Warming **GRADTDA 5620** Practical Learning and Mining for Big Data **CIVILEN 6211** Simulation of Building Energy Performance **ISE 5043** Power Systems-Analysis and Operation **CRPLAN 5550** Financing Sustainability **ENR 7400** Communicating Environmental Risk **GEOG 5301** Sustainable Transportation	6	 COE (MAE) COE (MAE) COE (MES) CFAES (AEDE) ASC (GEOG) TDAI/COE (CSE) COE (CEGE) COE (ISE) COE (CRPPLAN) CFAES (SENR) ASC (GEO)	 1,3 1,7,8 1,3 5 3 9 9 3,5,9 5 2,6,8 4,9
Sub-Total General Pathway Course Credits	**12**		
Capstone Courses (3 credits): Experiential Learning + Selectives + Seminar			
<insert alpha code> Practicum in Sustainable Energy	2	Interdisciplinary	identify 3 competencies
EARTHSC 8860 Seminar in Energy Resources	1	ASC (SES)	Identify 3 competencies
Sub-Total Capstone Course Credits	**3**		
TOTAL MES Degree Curriculum Credits	**34**		

Table 3.2 General Plan of Study Completing the MES Degree within 12-months.

Courses	Credits	Delivery Mode
Autumn Semester		
AEDE 6320 Energy Economics	3	Online
AEDECON 6500/ENVENG 6020/FABENG 6020/ISE 6020 /PUBAFRS 6020/ GEOG 6020 Foundations of Data-Driven Sustainable Energy Systems	3	In-Person
GRADTDA 5621 Big Data Computing Foundations 1	3	Online
Select a 3-credit course from the three listed courses that follow: **ENR 7150** Environmental Risk and Decision-Making or **ENR 7430** Sustainability Psychology or **MECHENG 5194** Comparative Energy (see prerequisites)	3	In-Person
GEOG 5802 Globalization and Environment (**or during Spring**)	3	In-Person
Selective Course (**or during Spring or Summer**)		

Spring Semester		
PUBAFRS 8620 Innovating for Sustainable Energy Systems	4	In-Person
Select a 3-credit course from the three listed courses that follow: **ENR 7150** Environmental Risk and Decision-Making or **ENR 7430** Sustainability Psychology or **MECHENG 5194** Comparative Energy (see prerequisites)	3	In-Person
ENVENG 5170 Sustainability and Circular Economy	3	In-Person
GEOG 5802 Globalization and Environment (**or during Autumn**)	3	In-Person
EARTHSC 8860 Seminar in Energy Resources	1	In-Person
Selective Course (**or during Autumn or Summer**)		
Summer Term		
Practicum in Sustainable Energy	2	Off-Site
Selective Course (**or during Autumn or Spring**)	3	

Administrative Oversight

The administrative oversight, admissions, curriculum, assessment, and advisement for the MES degree *Generalist Pathway* will be provided and conducted by representatives from each of the three sponsoring colleges (College of Arts and Sciences; College of Engineering; and College of Food, Agriculture, and Environmental Sciences). Each of the three collaborating and cooperating colleges will have a designated faculty member serving as the interdisciplinary degree Program Co-Director. In turn, these individuals will coordinate with applicable faculty members from their respective units to engage in collaborative intercollege activities including application and admissions reviews, MES Generalist Pathway curriculum, program and student assessment, course scheduling, and student advisement. Application for admission, tracking for student retention, and graduation will be centralized administratively via the Graduate School. General program operations will be facilitated and centralized via the Sustainability Institute and a central Program Coordinator working with the respective Program Co-Directors.

Admissions and Graduation

The MES degree *Generalist Pathway* Admissions Committee, consisting of applicable faculty representation from each of the three collaborating colleges, will use the criteria specified in the Ohio State *Graduate School Handbook* Section 2.2 Admission Criteria (https://gradsch.osu.edu/graduate-school-handbook-gsh/gsh-section-2-admissions#section2.2). In addition to the Graduate School Admission criteria listed below, MES degree admission will require completion of a college-level foundational course in calculus with grade C or higher.

Admission Criteria for All Applicants:

- The equivalent of a four-year bachelor's or advanced degree from a regionally accredited college or university, earned by the expected date of entry into the graduate program.
- Calculus with grade C or higher.
- A minimum 3.0 cumulative GPA (on a 4.0 scale or equivalent) for the last bachelor's or advanced degree earned.
- Transcripts or other credentials documenting that prerequisite academic work has been completed.

Note: A standardized GRE test score is required only if:

- Applicant's degree is from an unaccredited college or university *and* your program requires the score.
- Applicant's cumulative GPA is below 3.0 for the last bachelor's or advanced degree earned *and* the program requires the score.

Additional Admission Criteria for International Applicants:

Success at Ohio State depends upon your ability to converse in, write and understand English. The university requires official TOEFL, Duolingo or IELTS Academic test scores from all international applicants, except:

- Applicants who are citizens of, or who have received a bachelor's degree or higher by the time of matriculation from, one of the countries or territories exempt from the English proficiency requirement (see exemptions below).
- Applicants who have held U.S. permanent resident, asylee or refugee status for more than one year by the start date of the first term of enrollment.

Note: If applicants' courses were taught in English but they do not meet either of the above exceptions, they are still required to submit proof of English proficiency. Refer to https://gpadmissions.osu.edu/intl/additional-requirements-to-apply.html for additional details and minimum test score criteria.

In relation to admission, the criteria for retention and graduation will follow those specified in Sections 4, 5, and 6 of the *Graduate School Handbook* (https://gradsch.osu.edu/graduate-school-handbook-gsh).

Anticipated Enrollment for the MES Degree *Generalist Pathway*

It is estimated that initially there will be ten students enrolled during year one for the MES degree Generalist Pathway. Estimated future enrollment is 30 or more students per year (Table 4). The anticipated enrollment numbers are estimates based on the increased public awareness of plus need and demand for professionals in the sustainable energy related sector. It is projected and expected that enrollments will increase during subsequent years with expanded program awareness plus general and targeted program marketing and student recruitment. In addition, the overall MES degree enrollments will increase too when curricula options are added for students to pursue one of several choices for MES degree Specialist Pathways. Detailed information on how students will be informed of the MES degree program is summarized in Appendix B: Program Implementation.

Table 4. Five-Year Estimated Annual MES Degree *Generalist Pathway* Student Enrollments.

Academic Year	Estimated Number New Students
2026-27	10
2027-28	15
2028-29	20
2029-30	25
2030-31	30

Assessment

The overall assessment plan will use specific evaluation tools to collect both direct and indirect measures of several components. The overall process will collect, organize, interpret, summarize, and report quantitative and qualitative outcome measurement data as program, including student, performance indicators, and, for continuous quality improvement. The MES degree Program Co-Directors plus the Program Coordinator will oversee the Assessment Plan including the annual data collection, review, and reporting.

The program assessment plan consists of two parts. Part 1 is focused on overall program evaluations and measures related to admissions through program completion and alumni job placements (Table 5.1.). Part 2 involves conducting specific evaluations to assess whether students meet each of the ten MES degree *Foundational Competencies* aligned with the specific topic modules within the required *Foundational Courses* (Tables 5.2 and 6).

Table 5.1. Part 1 - Admission through Graduation

Indirect Measures for MES Degree Program Evaluation and Assessment
• Number of Applications • Quality of Applicant Pool • Admissions (Rubric/Summary) • Survey Students (Satisfaction w/ Program and Program Support for Continuous Quality Improvement) • Student Evaluation of Instruction (Satisfaction w/ Course and Instruction for Continuous Quality Improvement) • Retention (% Retained) and Graduation Rates (Cumulative GPA ≥3.0/4.0, % Graduated, Time-to-Degree) • Survey Graduating Students (Satisfaction w/ Program and Program Support for Continuous Quality Improvement) • Survey Alumni (Applicable Employment/Use of Degree)

Table 5.2. Part 2 - Alignment of Competencies with Required Foundational Courses and Student Evaluation Modes.

Direct Measures for Student Evaluation and Assessment
• Case Studies/Applied Case-Based Scenarios) • Problem Sets • Presentations (oral and poster) • Papers • Quizzes • Exams • Facilitated Discussions (e.g., Seminar) • Cumulative Course Performance

One or more of the required *Foundational Courses* is/are aligned with each of the ten MES degree program *Foundational Competencies*. See page 8 for the list of competencies and Table 3 on page 9 showing the required *Foundational Courses* and for each course the aligned *Foundational Competencies*. The MES degree graduate students are expected to score ≥80% for each evaluation mode that corresponds with the courses and the specific course module topic(s) within that align with each respective competency.

Table 6. Alignment of Competencies with Required Foundational Courses and Student Evaluation Modes.

Ten Foundational Competencies (see pp. 7-8 and Table 2)	Applicable Required Foundation Courses (credits)	Applicable Student Evaluation Modes per Course (i.e., Quizzes; Exams; Problem Sets; Applied Case Studies; etc.)	Measurement to Demonstrate Acquired Competency
Foundational Competency 1	**AEDECON 6500/ ENVENG 6020/ FABENG 6020/ISE 6020 /PUBAFRS 6020 (3 cr.)** Foundations of Data-Driven Sustainable Energy Systems	Case Study Paper	Score ≥80% per Evaluation Mode
Foundational Competency 2	**PUBAFRS 8620 (3 cr.)** Innovating Sustainable Energy Systems	Paper; Presentation	Score ≥80% per Evaluation Mode
Foundational Competency 3	**AEDE 6320 (3 cr.)** Energy Economics	Quiz; Exam	Score ≥80% per Evaluation Mode
Foundational Competency 4	**AEDECON 6500/ ENVENG 6020/ FABENG 6020/ISE 6020 /PUBAFRS 6020 (3 cr.)** Foundations of Data-Driven Sustainable Energy Systems	Case Study Paper	Score ≥80% per Evaluation Mode
Foundational Competency 5	**AEDE 6320 (3 cr.)** Energy Economics	Quiz; Exam	Score ≥80% per Evaluation Mode
Foundational Competency 6	**AEDECON 6500/ ENVENG 6020/ FABENG 6020/ISE 6020 /PUBAFRS 6020 (3 cr.)** Foundations of Data-Driven Sustainable Energy Systems	Case Study Paper	Score ≥80% per Evaluation Mode
Foundational Competency 7	**PUBAFRS 8620 (3 cr.)** Innovating Sustainable Energy Systems	Paper; Presentation	Score ≥80% per Evaluation Mode
Foundational Competency 8	**ENR 7150 (3 cr.)** Environmental Risk and Decision-Making or **ENR 7430 (3 cr.):** Sustainability Psychology	Paper; Presentation Paper; Project	Score ≥80% per Evaluation Mode
Foundational Competency 9	**GRADTDA 5621 (3 cr.)** Big Data Computing Foundations 1	Case Studies; Project	Score ≥80% per Evaluation Mode
Foundational Competency 10	**PUBAFRS 8620 (3 cr.)** Innovation for Sustainable Energy Systems	Paper; Presentation	Score ≥80% per Evaluation Mode

Appendix A

Descriptions, Prerequisites, Modes of Delivery, and Terms Offered for the MES Degree Foundational and General Pathway Courses

Courses	Credits	Colleges (Units)	Course Descriptions	Course Prerequisites	Modes of Delivery / Semester
Foundational Courses (19 credits)					
AEDECON 6320 Energy Economics	3	CFAES (AEDE)	Explores the economics of the energy sector. It addresses key drivers of demand for energy, sources of energy supply, the pace of technological change in energy production and use, critical externalities of energy production, and governmental approaches to regulate the energy sector.	None	Online Autumn
AEDECON 6500/ ENVENG 6020/ FABENG 6020/GEOG 6020 / ISE 6020 /PUBAFRS 6020 Foundations of Data-Driven Sustainable Energy Systems	3	CFAES/COE/ ASC/GCPA	Introduction to issues impacting sustainable energy systems across technology, law and policy, business models, resilience, data, geospatial, and decision sciences.	Not open to students with credit for AEDECON 6500, ENVENG 6020, FABENG 6020, GEOG 6020, or PUBAFRS 6020. (Cross-listed in AEDECON 6500, ENVENG 6020, FABENG 6020, GEOG 6020, or PUBAFRS 6020.)	In-Person Autumn
PUBAFRS 8620 Innovating for Sustainable Energy Systems	4	GCPA	Provides students with the design tools and a framework to understand complex problems and develop within weeks minimal viable products or solutions that address energy-sector needs. Through an intense process of stakeholder interviews and continuous feedback, students acquire experience in systematic innovation, refining problem-statements, and navigating public and private sector organizations.	None	In-Person Spring
GRADTDA 5621 Big Data Computing Foundations 1	3	TDAI/COE(CSE)	Professionals must be able to locate, scrape, ingest and clean data sources to produce useful information for exploration and visualization to address work-related challenges. The course is on programming in JavaScript and Python and tools like	None	Online Autumn

Courses	Credits	Colleges (Units)	Course Descriptions	Course Prerequisites	Modes of Delivery / Semester
			Hadoop and Scala. This two-semester sequence is to be taken in parallel with a two-semester sequence on fundamental statistical data analytic methods.		
Select 6 Credits: **ENR 7150** Environmental Risk and Decision-Making **ENR 7430** Sustainability Psychology **MECHENG 5194** Comparative Energy	3	CFAES (SENR) COE	ENR 7150: Theory of individual and participatory decision-making processes under risk and uncertainty and applications to improve decision making in environmental risk management contexts. ENR 7430: This course helps students expand their understanding of the psychological bases of environmental problems. It focuses on leveraging psychological tools to address such problems. Students learn about theories and methods relevant to behavior change, explore the applicability of these approaches to changing environmental behaviors, and gain practical experience doing this with real-world problems. Understand the principle and energy efficiency of renewable energy technologies and prepare engineering students for evaluating and developing those technologies. The course will be a combination of technological examples, fundamental principles, and project-based deep dive into renewable energy technologies. Technologies covered include wind electricity, hydroelectricity, geothermal, solar thermal, hydrogen, CO2 capture, battery, capacitors, fuel cell, solar photovoltaic, magnetocaloric cycle, electrocaloric cycle, and thermoelectric cycle. Target audience: junior/senior undergraduates and graduate students. Recommended preparation: introductory energy technology or introductory thermodynamics knowledge.	ENR 7150: Not open to students with credit for 8150. ENR 7430: Graduate standing plus any ONE of the following: • Any undergraduate- or graduate-level psychology course • ENR 3400 • ENR 5400 • **Instructor permission** 3500, 3501, AEROENG 2405, MATSCEN 2251, CBE 3508, CHEM 4310, FABE 3120, Grad Standing in Engineering, or Grad Standing in Chemistry.	7150: In-Person Autumn 7430: In-Person Spring 5194: In-Person Spring

Courses	Credits	Colleges (Units)	Course Descriptions	Course Prerequisites	Modes of Delivery / Semester
Sub-Total Foundational Credits	**19**				
General Pathway Courses (12 credits)					
ENVENG/ENVSCI 5170 Sustainability and Circular Economy	3	COE (CEGE) CFAES (SENR)	An introduction to life-cycle thinking and the circular economy with emphasis on quantitative sustainability assessment and decision-making.	3200, or Grad standing in Engineering, or permission of instructor. Not open to students with credit for ENVSCI 5170. Cross-listed in EnvSci.	In-Person Spring
GEOG 5802 Globalization and Environment	3	ASC (GEO)	Transnational dimensions of changes to the natural environment; ways that global economic activity, international institutions, and global environmentalism contribute to environmental problems and solutions.	Not open to students with credit for 635.	In-Person Autumn and Spring
Select 6 Credits:					
MECHENG 6526 Combustion	3	COE (MAE)	MECHENG 6526: Fundamentals of energy conversion through combustion, thermodynamics and chemical kinetics of combustion, premixed flames, deflagration vs. detonation waves, diffusion flames, droplet combustion, and thermal ignition.	MECHENG 6526: 3503, 3504 (504), or 4510 (510), or permission of instructor. Not open to students with credit for 726.	MECHENG 6526: In-Person Spring
MATSCEN 5572 Materials for Energy Technology	3	COE (MES)	MATSCEN 5572: Structure property relationships of materials in energy applications. Photovoltaic materials, solid state photonic materials, electrochemical devices such as batteries, fuel cells and chemical sensors, superconductors, memory and nuclear materials.	MATSCEN 5572: 2241, and 3271 or ECE 2300; and enrollment as MATSCEN-BS major; or Grad standing; or permission of instructor.	MATSCEN 5572: In-Person Autumn
AEDECON 6300 Environmental Resource Economics	2	CFAES (AEDE)	AEDECON 6300: Application of economic theory and methods to current problems in environmental and resource economics.	AEDECON 6300: 4001 (500) or Econ 4001 (501). Not open to students with credit for 831.	AEDECON 6300: In-Person Spring
GEOG 5900 Weather, Climate, and Global Warming	3	ASC (GEOG)	GEOG 5900: An introduction to the fundamental physical and mathematical principles governing both day-to-day weather and the average of weather, or climate. Objectives are to understand the physical	GEOG 5900: Not open to students with credit for 520 or AtmosSc 2940 (230).	GEOG 5900: Online Autumn
GRADTDA 5620 Practical Learning and Mining for Big Data	3	TDAI/COE (CSE)			
CIVILEN 6211 Simulation of Building Energy Performance	3	COE (CEGE)			
ISE / ECE 5043 Power Systems-Analysis and Operation	3	COE (ISE / ECE)			
CRPLAN 5550 Financing Sustainability	3	COE (CRPPLAN)			
ENR 7400 Communicating Environmental Risk	3	CFAES (SENR)			
GEOG 5301 Sustainable Transportation	3	ASC (GEO)			

Courses	Credits	Colleges (Units)	Course Descriptions	Course Prerequisites	Modes of Delivery / Semester
			processes of the earth-atmosphere system, describe its weather features and climate characteristics today, and outline how they might change in the future because of global warming.		
			GRADTDA 5620: Building computational and interpretative skills in data analytics and computing foundations, students will explore practical ways to create data mining and machine learning workflows. Students will learn to mine associations and patterns, to classify, and build predictive models and recommendation systems for data and questions in the context of enterprises.	GRADTDA 5620: Enrolled in TDAI or MES degree program.	GRADTDA 5620: Online Summer
			CIVILEN 6211: Simulation of building energy consumption under various design or retrofit scenarios. Prediction of the impact of design decisions and energy conservation measures on building energy consumption. Employment of EnergyPlus and OpenStudio, free but sophisticated and open-source building energy modeling tools, to develop and simulate a model of a real building.	CIVILEN 6211: Grad standing in the College of Engineering, or permission of instructor.	CIVILEN 6211: In-Person Spring
			ISE / ECE 5043: Power systems analysis and operations, including steady-state analysis, state estimation, and economic operation.	ISE 5043: 3040, and ECE major; or Sr standing and ISE major; and MATH 2568; or Grad standing in engineering or biological sciences or math and physical sciences.	ISE 5043: In-Person Spring
			CRPLAN 5550: This course examines sustainability through the lens of financing. The primary foci are two essential elements of green infrastructure - food systems and clean energy. Students will explore the systems and industry behind food and energy and develop comprehensive road maps that	CRPLAN 5550: CRPLAN 3400, Grad standing, or permission of instructor.	CRPLAN 5550: Uncertain; has not been offered recently but could be offered with

Courses	Credits	Colleges (Units)	Course Descriptions	Course Prerequisites	Modes of Delivery / Semester
			communities can use to build robust and financially supported sustainability systems for food and energy. ENR 7400: Introduction to the design and implementation of public-focused risk communication as it relates to environmental, agricultural and public health contexts. GEOG 5301: Sustainable transportation generates accessibility while minimizing harm to people and the natural environment. This course examines the problems associated with transportation, including climate change, air quality, non-renewable resources, safety, congestion and social equity. We will also examine solutions to these problems, including pricing, planning, policy and technology.	ENR 7400: Graduate standing or permission of instructor GEOG 5301: None listed	demand (per Dr. Conroy) ENR 7400: In-Person Spring GEOG 5301: In-Person Spring
Sub-Total General Pathway Credits	**12**				
Capstone Courses (3 credits): Practicum + Seminar					
<insert alpha code> Practicum in Sustainable Energy	2	Interdisciplinary	Experiential learning opportunity with a public or private organization of agency.	Completion of a minimum of 12 credits of the curriculum	
EARTHSC 8860 Seminar in Energy Resources	1	ASC (SES)	Study of selected deposits of subsurface energy resources.	Permission of instructor. Repeatable to a max 12 cr.	Spring In-Person
Sub-Total Capstone Credits	**3**				
TOTAL MES Degree Curriculum Credits	**34**				

Appendix B

Program Implementation

1. **How will students be informed of the program?**

   There are multiple ways students will be informed of the program. We plan to:

   - Inform academic and faculty advisors of the opportunity to share with their undergraduate students in the three associated colleges, College of Food, Agricultural, and Environmental Sciences (Schol of Environment and Natural Resources), College of Arts and Sciences (School of Earth Sciences), and College of Engineering. Advisors in adjacent colleges (College of Public Health, Fisher College of Business, and the Glenn College of Public Affairs.
   - Create an accessible, dynamic webpage as part of the Sustainability Institute's website
   - Utilize internal Ohio State marketing –
     - Ohio State today
     - Advisor Beat (academic advising newsletter)
     - Sustainability Institute newsletters (faculty and external)
     - Sustainability Institute's Student Advisory Board
     - Sustainability Education and Learning Committee (SELC)
     - Honors and Scholars
     - Information for energy-related faculty to share in classes
     - CABS advertisement
   - Host student engagement activities focused on building the sustainable energy community
     - Sustainable Energy Accelerator (week-long competition where students work on a real-world challenge facing industry)
     - Sustainable Energy Networking Events (partnership with the Battelle Center for Science, Engineering, and Public Policy)
     - Battelle Center Student Community of Practice and Engagement events (hosted by Battelle Center)
   - Leverage external channels to communicate with prospective students
     - Sustainability Institute's external advisory board (when established)
     - Handshake events for internal and external audiences
     - Otterbein, Denison, Capital, Ohio Wesleyan, etc.

2. **How will students be advised regarding the opportunities and challenges associated with the option?**

   Prospective students will have access to information from the Sustainability Institute Website and will also be directed to the Program Coordinator and MES Program Co-Directors. Matriculated students will be provided with general advisement via Program Coordinator and posted Webpage information, plus designated faculty members, including but not limited to Program Co-Directors involved with the MES degree program.

3. **Describe how the success of the program will be assessed?**

   Refer to "Assessment" section of the proposal pages 12-14.

4. Specific actions and any corollary issues (positive and negative) that will arise from implementation. Frequently addressed issues include but are not limited to the following:

a) How will the proposal affect specific groups/constituencies (faculty, graduate/undergraduate students, staff, alumni, accrediting organizations, etc.)?

The Master of Energy Sustainability (MES) degree program will enhance opportunities to address employment needs and demands for the current and emerging energy workforce. In addition to pursuing the MES degree as a standalone degree program, undergraduate students will have the opportunity to take courses to prepare for the MES with the possibility of a 3+2 (AKA 4+1+1) combined BS-MES degree program. One of the goals of the MES degree program is to offer available and accessible pathways to energy careers for people from varied academic backgrounds. Faculty conducting applicable energy research projects at Ohio State will have a place to direct interested students. Additionally, since only one new course is being developed for the Generalist Pathway, associated faculty will not see a significant shift in their teaching obligations.

b) What programmatic changes will take place internally?

Three MES degree Program Co-Directors, one from each of the collaborating colleges, will be named to administer the program in partnership with the MES degree Program Coordinator housed in the Sustainability Institute.

c) How will the program affect students, faculty, and staff outside the proposing unit?

Since the MES degree program is interdisciplinary, there will be initial and eventual opportunities to expand the collaborative and cooperative partnerships with other academic units. This will occur naturally as new Specialization Pathways are developed and implemented as part of the MES degree program model as shown in Figure 1.

d) Does the content of the proposal overlap in scope or substance with the interests of other units?

The focus and content of the MES degree program does not conflict with or encroach on programs offered by other academic units. The degree program model, beginning with this initial MES degree Generalist Pathway, is designed to enhance expand opportunities for students as well as faculty members at Ohio State. In addition, as summarized on pages 6 and 7, the new MES degree program will be complementary to, not the same as, other graduate-level energy-related programs in the State.

e) A summary of the adequacy and availability of resources including but not limited to fiscal impact statements, commitments of funding from any sources, and memoranda of understanding between collaborating units.

An MOU will be developed with each collaborating unit to leverage and optimize the efficient use of essential resources in the form of people (e.g., faculty; staff), places (e.g., classrooms; labs), and things (e.g., funding; marketing/recruitment).

Appendix C

Applicable Letters of Support

- College of Arts and Sciences
  - Letter of Support from Andrew Martin, Associate Dean of Undergraduate Education
  - Email Letter of Support from Kim Kinsel, Chief Administrative Officer
- College of Engineering
  - Letter of Support from Rosie Quinzon-Bonello, Assistant Dean for Curriculum and Assessment
  - Email Letter of Support from Bobby Srivastava, Chief Administrative Officer
- College of Food, Agricultural, and Environmental Sciences
  - Conditional Letter of Support from Cathann Kress, Vice President for Agricultural Administration and Dean
  - Email Letter of Support from Terry Snoddy, Senior Fiscal Officer
- Sustainability Institute
  - Letter of Support from Elena Irwin, Director, Sustainability Institute, Distinguished University Professor, College of Food, Agricultural, and Environmental Sciences