

**MEMO**

**To:** The UVM Faculty Senate  
**From:** Curricular Affairs Committee of the Faculty Senate, Colby Kervick and Stephen Everse, Co-Chairs  
**Date:** January 5, 2024  
**Re:** New Minor in Sustainable Energy Engineering

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On January 4, 2024, the Curricular Affairs Committee unanimously supported the creation of a new Minor in Sustainable Energy Engineering submitted by the College of Engineering and Mathematical Sciences (CEMS). Participating faculty are from all three engineering departments (Civil and Environmental; Electrical and Biomedical; Mechanical), and Physics. The intended start date is 2024 Fall semester.

***Program Description and Rationale***

**Description:** The Sustainable *Energy Engineering* minor is designed for undergraduate, engineering students who are interested in applying their knowledge of engineering fundamentals, analysis, and sustainable design principles to clean energy generation and efficient utilization. Students will gain foundational understanding of energy technologies and the energy industry, including technological, policy, and economic considerations related to conventional and sustainable energy. This minor crosses across multiple engineering disciplines and will give students pursuing accredited disciplinary engineering degrees an added interdisciplinary credential toward pursuing careers in sustainable energy fields.

Completion of the minor requires 4 courses totaling 14 credit hours of core requirements, plus 6 credit hours of electives (with prerequisites; open to all majors, and no eligibility restrictions). The minor takes advantage of current required and elective coursework contributing to the engineering majors, and most engineering students should be able to complete the minor by adding 3-7 credits.

**Rationale:** Reliance on energy-rich sources of fossil fuels has supported the tremendous growth of our modern society in a variety of sectors including food supply, industrial growth, mobility, comfort, and overall economic prosperity. This development has come at a price as the fossil fuel combustion generates over three-quarters of the worlds' carbon dioxide emissions severely affecting public health, causing climate change, and impacting our planet's sustainability. The procurement of sustainable energy is therefore one of the major challenges facing humanity in the twenty-first century.

The United States has the vision *to build a strong domestic energy sector that can manufacture*

*and deploy clean energy for the benefit of all Americans.* Similar efforts are underway in many parts of the world. Vermont's energy goals include meeting 90% of State's overall energy needs from renewable sources by 2050. The City of Burlington's goal is to achieve net zero energy by 2030.

The Sustainable *Energy Engineering* minor is designed for undergraduate, engineering students who are interested in applying their knowledge of engineering fundamentals, analysis, and sustainable design principles to clean energy generation and efficient utilization. Students will gain foundational understanding of energy technologies and the energy industry, including technological, policy, and economic considerations related to conventional and sustainable energy sources.

The proposed minor aligns well with the University vision as it relates "*to be among the nation's premier small research universities, preeminent in our comprehensive commitment to liberal education, **environment, health, and public service.***" The minor also fits UVM's identified distinctive strengths in "Healthy Societies, Healthy Environment."

### ***Evidence for Demand***

In 2021, U.S. energy sector jobs grew 4.0% over 2020, outpacing overall U.S. employment, which climbed 2.8% in the same time period. The energy sector added more than 300,000 jobs, increasing from 7.5 million total energy jobs in 2020 to more than 7.8 million in 2021 (2022 U.S. Energy and Employment Report). Overall, the transition to clean energy is expected to generate 10.3 million net new jobs globally by 2030 (World Economic Forum).

Many prospective, incoming, and existing UVM students inquire about building credentials toward careers in the energy sector and degree options in the sustainable energy field. A minor in Energy Engineering is popular among engineering students and being offered at many universities, nationally (e.g., UC Berkley, CU Boulder, Penn State) as well as regionally (e.g., UMass Lowell, U Maine, Clarkson, Northeastern). The proposed minor will help maintain and possibly enhance attractiveness of UVM's Engineering programs among prospective students, and is accessible for non-engineering students (e.g. Physics).

### ***Relationship to Existing Programs***

This minor is comprised of courses offered through all three engineering departments (Civil & Environmental, Electrical & Biomedical, and Mechanical), plus two physics courses among nine elective options listed below. No similar minors in title or content are currently offered at UVM, and no identified concerns were raised.

All three engineering departments' Program Educational Objectives state "The educational objectives of UVM's engineering program are to provide our graduates with disciplinary breadth and depth to **fulfill complex professional and societal expectations** by:....". Providing economical sustainable energy is not only an expectation of the engineering professions, but it is also a societal expectation domestically as well as globally. CEMS's vision is to help "create a more **sustainable and equitable future** through its excellence in education and research focused on **solving the complex problems facing our world**" and its mission states "..... Prepare the next generation of technical and societal leaders who thrive in a world that is volatile, complex, and full of promise, and who are committed to a **sustainable and equitable**

world....”.

### Curriculum

The coursework for the minor comprises Core Requirements (4 courses, 14 credit hours), and Electives (min. 6 credit hours, from 9 course options). There is one new required course, CEMS 3910 (previously approved, and an enrolled section in spring 2024). See below for more info, required and elective courses, and prerequisites.

There are no eligibility restrictions or majors with undue overlap. The minor is built using existing, regularly offered courses, almost all of which have room to absorb additional students. Although open to all majors, the minor is designed for engineering students, most of whom should be able to complete it with 3-7 added credits.

#### Required Courses

A. Core Requirements (4 courses, 14 credit hours): Provides foundational knowledge around engineering aspects of energy, along with policy and economic context.

Core Requirements		
Number	Name	Credits
*CEMS 3910	Energy Policy & Economics	3
EE 2125 / 2145 / 2175	Electrical Circuits	4
EE 3315	Electrical Energy Systems	4
ME 1210	Thermodynamics	3

\*New course expected to be offered once a year and piloted in AY 2023-24.

(01/02/24) RE CEMS 3910: CourseLeaf shows proposal process was followed for a required new course (VIII).

A new course proposal for CEMS 3910 was approved 01/30/23, and a cross-listed section is offered in spring 2024. In parallel with this proposal submission, a course edit was submitted 11/07/23 as per proposal-stated intent to revise the prerequisites: “Minimum Sophomore standing or Instructor permission ~~CEMS 1500; minimum Sophomore standing.~~”.

#### Elective Courses

B. Electives (minimum 6 credit hours): Students pick any two of the courses below. More elective courses related to energy are anticipated in coming years.

Electives (min. 6 credits from the following)		
Number	Name	Credits
CEE 4570	Sustainable Resource Recovery Design	3
CEE 5850	Geo-energy Systems	3
EE 3310	Low Carbon Electric Power	3

EE 3320	Power Electronics	3
EE 5310	Electrical Energy Systems Analysis	3
ME 3260	Renewable Energy Harvesting	3
ME 3262	Energy Systems Engineering	3
PHYS 1200	Energy and the Environment	3
PHYS 3400	Thermal and Statistical Physics	3

### Prerequisites

Needed for the Core Courses:

MATH 1248: Calculus II (4 credits)

\*CEMS 1500: CEMS First Year Seminar (1 credit)

\*See above (RE CEMS 3910) about removal of this prerequisite, pending course edit approval.

PHYS 1500: Physics for Engineers I (3 credits)

CHEM 1400: General Chemistry I (3 credits)

Some elective courses may need additional prerequisites:

CEE 3515: Water & Wastewater Treatment Processes (3 credits)

ME 2230/CEE 3600: Fluid Mechanics/Hydraulics (3 credits)

PHYS 1550: Physics for Engineers II (4 credits)

### ***Admission Requirements and Process***

There are no eligibility restrictions, and the minor is open to all majors, although designed and more easily attainable for engineering students. Currently, CEMS students are able to request minors and certificates to be added. CEMS student services approves these requests after consulting the student's advisor and/or department chair if needed. The degree audit keeps track of the minor fulfillment. It is anticipated that most students pursuing the proposed minor to be from Electrical Engineering, Environmental Engineering or Mechanical Engineering.

Curriculum check sheets will be prepared for each of these majors to outline how the minor could be fit with the major degree requirements. Most students majoring in these three degrees are expected to complete the minor by taking up to two extra courses beyond their major degree requirement. Prof. Zach Ballard will be the lead contact for the minor administration. No minimum GPA or other requirements to stay in the program are mentioned in the proposal.

### ***Anticipated Enrollment and Impact on Current Programs***

Enrollments in the listed courses are expected to increase some, which may have a slight impact on faculty workload, but within their existing course capacities. Correspondence with Mandar Dewoolkar, Professor and Chair of Civil & Environmental Engineering, and the proposal-designated contact, indicated 10-15 students are anticipated in the first year, and 20-25 students per year thereafter.

### ***Advising***

Currently, CEMS students are able to request minors and certificates to be added. CEMS student services approves these requests after consulting the student's advisor and/or

department chair if needed. The degree audit keeps track of the minor fulfillment.

Most students anticipated to pursue the proposed minor are expected to be from Electrical Engineering, Environmental Engineering or Mechanical Engineering. Curriculum check sheets will be prepared for each of these majors to outline how the minor could be fit with the major degree requirements. Most students majoring in these three degrees are expected to complete the minor by taking up to two extra courses beyond their major degree requirement. Prof. Zach Ballard will be the lead contact for the minor administration.

The noted contact designee added that students will be advised by CEMS Student Services staff, students' faculty advisors, and Dr. Zach Ballard. A preliminary table of guidelines (the above-named "check sheets") have already been prepared for each department.

### ***Assessment Plan***

The proposal states assessment of the minor will be conducted on a three-year cycle and include direct and indirect activities. Further correspondence summarized/outlined three learning objectives referenced in three numerated points about the Assessment Plan:

(Learning Objectives)

Upon completion of the minor, students will be able to:

1. Demonstrate understanding of the laws governing energy transformation between different forms.
2. Demonstrate knowledge of how economics and policies impact sustainable energy production.
3. Develop deeper understanding of one to two select forms of sustainable energy.

(Assessment Plan)

1. Assignment and exam questions on Objectives 1 and 2 in course CEMS 3910 Energy Policy & Economics.
2. Assignment and exam questions related to Objective 1 in course ME 1210 Thermodynamics.
3. Successful completion of 6 credits of approved electives that are selected for the minor to address Objective 3.

### ***Staffing Plan, Resource Requirements, and Budget***

No new staffing required. One new course (CEMS 3910) is expected to be taught by an existing or PT faculty member, funded by CEMS. Library resources presently available provide sufficient support for the minor, as outlined in a letter from CEMS subject librarian, Graham Sherriff.

### ***Evidence of Support***

The proposal included the CEMS faculty vote endorsing the creation of the new minor (37 in favor, 1 abstain, 1 against), and letters of support from the Chairs of the CEMS Curricular Committee and all participating departments, and the CEMS Dean.

- Amber Doiron, Chair, CEMS Curricular Committee (unanimous support from committee for proposed minor)
- Mandar Dewoolkar, Professor and Chair, Civil and Environmental Engineering

- Marilyn Cipolla, Professor and Chair, Electrical and Biomedical Engineering
- Douglas Fletcher, Professor and Chair, Mechanical Engineering
- Randall Headrick, Professor and Chair, Dept. of Physics
- Linda Schadler, Dean, CEMS

No public comments were received during the circulation period.

### ***Summary***

The well-reasoned proposal describes a new minor that complements existing majors in CEMS, not limited to but especially suited to engineering majors. The proposal addresses societal need to transition to sustainable energy, and associated job market opportunity and prospective student demand. The proposed minor is well-fitted to the vision of UVM, and does not rely on new resources.