June 24, 2020

TO: Karl Scholz, Provost
    William Karpus, Dean, Graduate School

FROM: David A. Noyce, Executive Associate Dean


The College of Engineering Academic Planning Council (APC) has recommended for approval the attached review and self-study of the Master of Engineering named option in Sustainable Systems Engineering.

The Sustainable Systems Engineering named option is directed at working engineers and focuses on the application of sustainability principles to engineering practices, particularly sustainability techniques, frameworks and technologies and to gain skills in developing creative and cross-disciplinary solutions to modern environmental problems. The students and the alumni of the program indicated they were satisfied with the program overall and indicated it has provided them with the necessary education and credentials to advance in their career.

Although the review committee noted the enthusiasm and dedication of the program director and the instructors for educating students on sustainable energy systems, the committee also notes that both the program director and instructors are over-committed. This has limited the ability to better administer the program and has impacted marketing efforts, resulting in lower than expected enrollments.

To address these limitations and determine ways to improve the financial position of the program, the review committee suggests that the program develop a strategic plan to address the following:

- assess the demand for the program
- include the word “energy” in the named option title
- hire a program director solely dedicated to the program
- create a program executive committee, similar to the Master of Engineering Online Environmental Engineering program
- identify ways to better engage the wide diversity of UW-Madison expertise in energy sustainability topics

The review committee also suggests the program conduct another review in five years.

On behalf of the College of Engineering, I accept the APC’s recommendation to approve this program review.

Attachments: Review Committee Report
              Department Self-Study
cc: Jocelyn Milner, APIR
Karen Mittelstadt, APIR
Parmesh Ramanathan, Associate Dean, Graduate School
Jenna Alsteen, Graduate School
Chris Brace, Assistant Dean for Graduate Affairs, College of Engineering
William Likos, Chair, Dept. of Civil and Environmental Engineering
Greg Harrington, Chair, Program Review Committee
Review Committee Report for  
Master of Engineering in Engineering 
Named Option: Sustainable Systems Engineering  

Date submitted: June 4, 2020

Review Committee Members:

- Christopher Choi, Dept of Biological Systems Engineering
- Greg Harrington, Dept of Civil and Environmental Engineering (chair)
- Cathy Middlecamp, Nelson Institute for Environmental Studies
- Barry Van Veen, Dept of Electrical and Computer Engineering

A. Summary of review committee activities and materials reviewed

The committee based this report on information gleaned from the following sources:

- The program’s self-study report, dated October 13, 2019.
- Interviews with the Associate Dean for Engineering Professional Development, the Program Director, and three members of the instructional team.
- Interviews with three alumni of the program and one student currently enrolled in the program.
- Program information published at www.wisc.edu
  - https://epd.wisc.edu/online-degrees/sustainable-systems-engineering/
  - https://energy.wisc.edu/education/for-students/academic-programs/master-engineering-sustainable-systems-engineering
  - https://pdc.wisc.edu/degrees/sustainable-systems-engineering/
  - https://guide.wisc.edu/graduate/engineering-college-wide/engineering-meng/engineering-sustainable-systems-engineering-meng/
- Data available from the Office of Academic Planning and Institutional Research (APIR)

B. Evaluation of the strengths and weaknesses of the program

In the committee’s opinion, the program provided a detailed and comprehensive self-study report that fairly represented the program’s strengths, weaknesses, challenges, and opportunities. We commend the program for taking what we consider a comprehensive and introspective look at itself and for making an assessment that includes an accurate presentation of the program’s limitations. Our report summarizes what we believe are the items most worthy of emphasizing.
Strengths

- A broad program that focuses on sustainable energy systems, including both the supply side (e.g., solar, wind, geothermal, microgrids) and the demand side (e.g., efficient buildings). Students and alumni were particularly complimentary of the supply side aspects.
- A program team that is passionate about efforts to improve the sustainability of existing energy systems and believes that UW-Madison should lead in this endeavor. They are enthusiastic about being part of an educational program dedicated to the sustainable energy systems and are committed to delivering a quality education that can be a source of pride for both the students and UW-Madison.
- Potential for access to many experts now working at UW-Madison, and also the potential to develop a more robust program, should revenue streams grow and permit it.
- UW-Madison’s commitment to maintaining a high level of synchronous online education, which places the university ahead of other institutions working in the subject area.
- Positive student and alumni satisfaction with the program overall. Some stated it has given them the credential needed to change their career path in their desired direction. The educational program is perceived as one that achieves its mission and learning outcomes.

Limitations

- Unsustainable enrollment levels, as noted in the self-study. The program has struggled to maintain a sustainable enrollment and, hence, a sustainable revenue stream. In part, this was due to an early uncertainty in the market for the degree program, but there now appears to be better recognition of a market for sustainable energy systems.
- An overcommitted program director, as noted by the self-study and all members of the administrative and instructional team – including the program director. This has been manifested in lack of capacity to:
  - Develop and maintain a strong marketing and recruiting program.
  - Meet certain administrative responsibilities (e.g., timelines for academic program reviews).
  - Develop a sense of program “ownership” among all members of the instructional team (e.g., moving beyond their sense of owning their classes and into a sense of collective ownership of the entire program and also an understanding of how the program meets its learning objectives from a larger picture perspective).
  - Develop collaborations with other campus units, such as the Nelson Institute for Environmental Studies.
• An overcommitted instructional team. All instructional staff are working overload to support this program as a result of their passion for sustainability. The business model needs to change to provide appropriate levels of support.
• A lack of needed infrastructure. For example, a search for the program on UW-Madison’s site revealed multiple landing spots (listed on the previous page) with conflicting information, some of which is out of date.
• Policies that restrict potential growth. For example, on-campus students can take a few courses, but not all of them, and do not contribute revenue to the program. This is a potentially large and unused resource.

General Remarks

• Students and alumni indicated overall satisfaction with the program. There were a few remarks concerning ways to improve courses, advising, admissions, graduation process, and other administrative functions. It should be noted that these remarks seemed to be a matter of personal preference and experience (several of the aspects described as limitations by some were named as strengths by others).
• In addition to its potential as a revenue generator, the program has the potential to enhance UW-Madison’s position in national sustainability ranking systems. An example is the Sustainability Tracking, Assessment, and Rating System (STARS).

C. Advice to the program, dean, and/or provost for improving the program

The program has reduced its expenses to an extent that it can maintain a positive net revenue. Students and alumni are generally satisfied with the program, and it could be further strengthened, given the university’s interest in achieving and maintaining a broad expertise in the subject. However, several substantive limitations must be addressed.

Given the program’s current financial stability, now seems a good time to develop a strategic plan for the long term. The Associate Dean for Engineering Professional Development indicated a desire to develop such a plan, and we believe he should be given the opportunity to do so. In developing this strategic plan, we suggest that the Associate Dean consider these measures:

• Determining whether there is sufficient demand to warrant expanding the program to achieve its originally envisioned enrollments and revenues.
• Changing the name of the degree program to include the word “energy”.
• Hiring a program director who is committed solely to administering and teaching in the program. The program should support the salary and benefits paid to the program director and the program team.
• Creating a program executive committee by applying a model similar to the ME Online Environmental Engineering program.
• Determining the best ways to engage the wide diversity of UW-Madison expertise in energy sustainability topics and also generate the revenue flow that would be needed to achieve that engagement.

D. Recommendations for future directions

We believe the strategic planning effort described in the previous section should be used to identify future directions for the program.

E. Specifications for any necessary follow-up action

We recommend that the program conduct another internal assessment of its progress in 5 years, rather than waiting a full 10 years until the next campus review.
Self-Study for Sustainable Systems Engineering – M.Eng.

Date submitted:  October 30, 2019

Primary Contact:  James M. Tinjum

Department(s)/Academic Unit(s):  Engineering Professional Development

School(s)/College(s):  College of Engineering

A.  Response to previous program review recommendations

In August of 2016, via an EPD internal review, the SSE program was recommended to evolve to a curriculum that emphasized (and marketed to) more sustainable energy and demand-side energy considerations. At the time of this internal review, enrollment for the program had been significantly lower than originally envisioned through all years of operation [Table 1].

Table 1. New Student Enrollment – Projected versus Actual

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<th>AY15</th>
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<td>14</td>
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[1] 2012 SSE GFEC Program Proposal “Request for Approval of a New Option in the Existing Master of Engineering Degree Major”

As a result of this lower than anticipated enrollment, program revenue had fallen well short of expectations, while program expenses were at a level to support the much larger, projected enrollments. In the Executive Summary of this internal review, the following comments, in part, were made:

- The SSE program has struggled since inception to achieve the enrollment levels necessary to maintain financial viability.
- Low enrollment has led to low revenue which has led to program down-sizing and simplification.
- Increasing credits/student/year has successfully increased revenue; expenses have been reduced in spite of a 10% university assessment; however, the program net continues to be negative.
- The program has been conceptually difficult to market, as the very nature of sustainability is broad, diffuse, and open to interpretation.
• Two key faculty (Pat Eagan and Mark Finster) retirements will result in the loss of the three foundational sustainability courses in the next 1-2 years (1/3 of total program credits).

• Prospective, existing, and past students have a strong energy interest in energy.

• Employment prospects for engineers in energy efficiency and renewable energy are strong.

• UW-Madison has centers of strength in energy efficiency, renewable energy, and energy policy.

• Program efficiencies can be achieved by shifting some program personnel.

As part of this in-department program review, the following recommendations (bold text) were made (with program response to review recommendations provided in italics).

1. Pursue approval for a program name change to Sustainable Energy Systems Engineering

   We, ultimately, did not pursue approval for a program name change after discussion with GFEC. Instead, we worked to add elective/replacement courses to the program that could also be delivered to a broader set of students and thus be more efficiently delivered. However, we did begin to market the program to emphasize (1) design and implementation of sustainable/renewable energy systems and demand side energy efficiency areas and (2) the transition from a fixed, structured, lock-step curriculum to a flexible curriculum that included additional elective offerings that are delivered, in part, by other online graduate programs in Engineering, including:

   • Technical Project Management (MEM)
   • Engineering Economic Analysis and Management (MEM)
   • CEE 723 Energy Principles of Environmental Engineering

   Furthermore, with Professor James Tinjum taking over in the capacity of SSE Program Director in the Spring of 2017 with the departure of the Interim SSE Program Director (Matt Griswold), the program is now able to offer Wind Energy 3D (Develop, Design, Deliver) as an online renewable energy design course within the SSE curriculum. Previously offered as GLE 401/CEE 639, the online version of Wind Energy 3D was first offered in the summer of 2018 as a Special Topics class within EPD (690) and is in the approval process to convert to a long-term, permanent course number.

2. Address the pending retirements of core SSE faculty that teach courses in Sustainability Science, including:

   • EPD 660 Core Competencies of Sustainability, Professor Pat Eagan (3 credits)
We were fortunate to successfully recruit Dr. Najoua Jouini to take over instruction of this course on an alternating fall basis (even-year falls) and thus retain this core sustainability science course within the curriculum.

**EPD 661 Industrial Ecology: Sustainability Tools in Context, Professor Pat Eagan (3 credits)**
- We are in the process of retiring EPD 661 because of (1) lack of qualified and available faculty to teach and (2) limited need for the course given the shift to a more energy-centric curriculum.

**OTM 770 Sustainable Approaches to System Improvement, Professor Mark Finster (4 credits)**
- For OTM 770, we were also fortunate to successfully recruit Dr. Najoua Jouini to take over instruction of this course on an alternating fall basis (odd-year falls) and thus retain this core sustainability science course within the curriculum. As OTM 770 is a course within the Business School curriculum, we had to secure a Business School faculty vote to approve the course being taught by a non-Business School instructor.

Furthermore, we are able to maintain 10 credits of coursework in the sustainability science area with the development of a new online course in CEE titled “Sustainability Tools” that will be taught by Professor Andrea Hicks. CEE639 will first be taught as a Special Topics class in the summer of 2020.

3. **Begin development of energy-focused courses, including:**

- **PubAff 809: Introduction to Energy Analysis and Policy (Professor Greg Nemet)**
  - We were not able to induce Dr. Nemet to offer this course as an online section (even with full support from Learning Technologies) because he teaches the course as a very “hands-on, interactive, in-class discussion-based course”

- **EPD xxx: Building Energy Efficiency (Lee DeBaillie), also potentially leveraged with co-development of a non-credit short course of the same name/content**
  - With Lee DeBaillie later transferring to the College of Engineering to be the Program Director of the Accelerated Masters program, the development and instruction of this course transitioned to Dr. Joy Altwies. The class is first being offered as a Special Topics course this fall (Fall 2019) but is in the process of being converted to and approved as a long-term, permanent course with an appropriately numbered course assignment.

- **EPD xxx: Sustainable Systems Engineering, by combining EPD 660&661 sustainability courses into a single overview course**
With EPD 660 now being taught by Dr. Najoua Jouini and EPD 661 being replaced by a new online offering (CEE639, Sustainability Tools, by Professor Andrea Hicks), this course development was not necessary.

- **Fundamentals of Thermal Science (Overview of heat transfer and thermodynamics for energy analysis)**
  - Thermal and Energy Geotechnics is being developed as a new course in Geological Engineering (with anticipated co-delivery to SSE students). The anticipated first offering is Fall of 2021.

- **There are numerous other ideas – some are good short-term solutions and others more applicable to a long-term mature program.**
  - Distributed Sustainable Energy Resource (DSER) System Design was developed and first delivered as a Special Topics class in the Spring of 2019 (which was also made available to on-campus students in GLE and those pursuing the Energy Sustainability Undergraduate Certificate). The course is being prepared for submission, review, and approval as a permanent course in time for the next anticipated offering in the Spring of 2021.

4. **Begin marketing of the new program courses**
   - A new ‘one-page’ marketing brochure with the flexible curriculum plan was developed in 2018, in parallel to changes to the website. Furthermore, we now intensively market the program offering through Web Information Sessions every Spring and Fall in addition to special sessions in various continuing professional development courses.

5. **Pursue graduate school approvals needed to change/add courses**
   - As described above, permanent course designations for a variety of courses that were recently developed and/or offered as Special Topics courses are flowing through the approval system.

6. **Transition Lee DeBaillie from Program Director to course instructor, student advisor, and subject matter expert. Phase-in Matt Griswold as Program Director.**
   - As previously discussed, Lee DeBaillie (formerly 50% appointment to SSE) is now the director of the Accelerated Masters program in the College of Engineering and Matt Griswold, who took over the PD role in the interim, resigned his position in early 2017.
   - Professor James Tinjum took on the Program Director responsibilities for Matt Griswold in February of 2017. Dr. Tinjum also took on the student academic advisor role, teaches the required Capstone Design class, teaches the Wind Energy
and DSER design courses, and also advises SSE students that take Independent Study.

7. Allow for spring and fall admittance if possible. Flexible admission is offered by some competitors and is sometimes a request from program inquirers.
   - SSE now recruits to and allows spring and fall admittance.
   - In addition, applicants are reviewed on an ad hoc basis (previously was conducted by committee meetings) and usually are decided on within 7 days of receipt of a complete admission package.

The SSE program is designed to be a part-time online master’s degree program focused on serving working engineers. The program is 100% online with no residency requirements. The program was originally proposed as a flexible curriculum requiring completion of 27 total credits. Of these credits, 14 were required from 5 fixed courses and 13 were flexible from a set of approved electives. In concept, three informal specialization tracks in facilities, energy and infrastructure provided guidance for the selection of electives. The original proposal lists 43 potential elective credits over 16 courses. The total program credits required to graduate has increased to 30, and the required and available elective course credits each now number 15 for students starting fall 2016. Table 2 presents a summary of the above recommended and in process changes for the SSE curriculum.

The last annual review for the program (Spring 2019) was submitted to the Master of Engineering Oversight Committee on 05/15/19 and is largely reflective of the continued implementation of the above recommendations. The Spring of 2018 annual review is also linked for review and consideration.
Table 2. Recommended Curriculum Pivot

<table>
<thead>
<tr>
<th>Core Curriculum as of January 2017</th>
<th>Evolving Flexible Curriculum</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Geosci411, Energy Resources, 3 cr</td>
<td>Sustainability/Science Course Recommendations (9 cr minimum)</td>
</tr>
<tr>
<td>• EPD690, Special Topics, 1-3 cr</td>
<td>• EPD660, Core Competencies of Sustainability, 3 cr</td>
</tr>
<tr>
<td>• BSE367, Renewable Energy Systems, 3 cr</td>
<td>• BSE367, Renewable Energy Systems, 3 cr</td>
</tr>
<tr>
<td>• EPD669, Sustainable Systems Capstone, 3 cr</td>
<td>• OTM770, Sustainable Approaches to System Improvement, 4 cr</td>
</tr>
<tr>
<td>• EPD730, Sustainable Facilities, 3 cr</td>
<td>• Geosci411, Energy Resources, 3 cr</td>
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<tr>
<td>• EPD700, Connected Learning Essentials, 1 cr</td>
<td>• CEE 629, Sustainability Tools, 3 cr</td>
</tr>
<tr>
<td>• EPD702, Professional Presentations, 1 cr</td>
<td>Engineering/Design Course Recommendations (12 credits minimum)</td>
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<tr>
<td>• EP602, Sustainable Energy Seminar, 1-3 cr</td>
<td>• ECE355 Electromechanical Energy Conversion, 3 cr</td>
</tr>
<tr>
<td>• EPD708, Creating Breakthrough Innovations, 1 cr</td>
<td>• EPD416, Statistics for Engineering Applications, 3 cr</td>
</tr>
<tr>
<td>• EPD785, Effective Negotiation Strategies, 1 cr</td>
<td>• EPD669, Sustainable Systems Engineering Capstone, 3 cr (required)</td>
</tr>
</tbody>
</table>

### Elective Options, including (but not limited to)

- EP602, Sustainable Energy Challenges Seminar, 1 cr
- EPD612, Technical Project Management, 3 cr
- EPD611, Engineering Economics and Management, 3 cr
- EPD701, Writing for Professionals, 1 cr
- EPD 02, Professional Presentations, 1 cr
- EPD713, Key Legal Concepts for Professionals, 1 cr
- EPD785, Effective Negotiations, 1 cr
B. Overview of the Program

The Master of Engineering named option, Sustainable Systems Engineering (SSE), was officially approved in spring 2012 and was established within the Master of Engineering, Engineering major. SSE is an online non-pooled program designed to instruct non-traditional engineering students in the application of sustainability principles to engineering practices. The SSE inaugural class started in fall 2012. The SSE program is currently administered under the Office of Engineering Professional Development (EPD) within the College of Engineering at the University of Wisconsin-Madison.

The mission of the SSE degree is to instruct non-traditional engineering students in the application of sustainability principles to engineering practices. In particular, to gain knowledge about sustainability techniques, frameworks and technologies and to gain skills in developing creative and cross-disciplinary solutions to modern environmental problems.

The SSE program was approved in spring 2012 by the University Academic Planning Council. The admission requirements for the SSE option were created to meet or exceed the requirements for a Master of Engineering degree and the Graduate School. Total required credits for graduation have been increased to 30 to meet enhanced graduate school requirements.

The strategic objective of the program is to train engineers to develop more robust solutions to human problems. In particular, to readily cross discipline boundaries, to recognize systems-based interrelations, to account for the needs and perspectives of all potential stakeholders, and to develop creative linkages between disparate bodies of knowledge. In The Guide, the SSE program is described as

*The named option Sustainable Systems Engineering is an online master’s degree program designed to prepare students to understand and apply the policy, science, engineering, and economics of tomorrow’s sustainable energy and resource transformation. Through objective, reliable, and cost-effective engineering methods, students will create sustainable solutions for society’s grand challenges.*

There are few true online sustainable engineering master’s programs in the U.S. Some programs are close relatives, such as “green technology” or “sustainable energy” programs. There are only a handful of programs that offer fully online sustainable engineering degrees. To exist in this area is, to some degree, to stand out. With that said, the main attributes that differentiate the present program from the competition include small classes, synchronous
classes, and engaged faculty and staff. Outlined below are some of the programs that are considered potential competitors and possibly institutional peers to the SSE program.

Villanova University, College of Engineering
- Master of Science Sustainable Engineering
- Offers online, on-campus, full and part-time, certificate
- Synchronous with on-campus courses, recordings available online
- Six areas of emphasis, large course selection, flexible completion schedule
  - Alternative and Renewable Energy
  - Water Resources Sustainability
  - Environmental Sustainability
  - Sustainable Infrastructure and Built Environment
  - Sustainable Materials
  - International Development
- 30 credits total: (4) 3-credit required core courses, (4) 3-credit courses from one of six tracks, (1) 6-credit thesis
- No explicit completion time
- $1,310/credit + small fees
- [http://www1.villanova.edu/villanova/engineering/grad/masters/sustainable.html](http://www1.villanova.edu/villanova/engineering/grad/masters/sustainable.html)

Arizona State University
- Master of Science in Engineering, Sustainable Engineering
- 100% online, thesis and non-thesis options
- 30 credit hours – (4) 3-credit required courses, (3) 3-credit electives, 6-credits thesis/project/capstone
- Three elective specialization tracks
  - Infrastructure Systems
  - Energy Systems
  - Earth Systems
- Courses appear to be asynchronous
- $978/credit

University of Southern California, Viterbi School of Engineering
- Master of Science in Green Technologies
- 100% online, certificates available
- Synchronous with on-campus courses, recordings available online, proctored exams
• 27 credits - (2) courses in three topical areas + (3) electives
• Three areas of specialization:
  o Green Systems and the Environment
  o Energy Technology and Efficiency
  o Sustainability and Society
• 27 credits total
• No explicit completion time
• $1,845/credit + small fees
• https://gapp.usc.edu/green-technologies

University of Maryland, School of Engineering
• Master of Engineering Sustainable Energy Engineering
• 100% online, certificate available
• Synchronous with on-campus courses, recordings available online, proctored exams
• Mediasite lecture capture technology
• 30 credits over 10 courses, 5 required core course and 5 electives
• 12 credit certificate
• 2-5 year completion time
• $1,098/credit + small fees
• http://www.oaee.umd.edu/programs/sustainable-energy

Northeastern University, College of Engineering
• Master of Science Energy Systems
• 100% online, on-campus
• Strong emphasis on financial concepts
• 35.5 credit hours via (6) required core courses and (4) electives
• Online delivery method - unknown
• 2+ years completion time
• $1,471/credit + small fees
• http://www.coe.neu.edu/degrees/ms-es

C. Program Assessment and Evaluation

SSE program decisions are approved through the EPD Curriculum Committee. SSE also falls under the College of Engineering Master of Engineering Oversight Committee. The program has adopted the Master of Engineering learning goals developed by the College of Engineering.
• acquire a strong background in engineering principles and a thorough knowledge of the latest technologies in the field
• demonstrate practical engineering knowledge and career enhancing competencies through workplace related projects
• demonstrate an ability to formulate, analyze, and solve advanced engineering problems
• recognize and apply principles of ethical and professional conduct

The original design of the SSE program was comparable with competitors. In particular, core courses were required, and a large swath of elective courses were to be organized around several specialization tracks: Energy Systems, Infrastructure and Facilities. Low enrollment, and resulting low-revenue generation, reduced the number of elective courses in development and we thus do not maintain clear specialization tracks (e.g., wind energy is a technical track in the Penn State online degree program). As of fall 2019, the program does not have specialization tracks. However, we have ‘binned’ sets of courses [see Table 2] into (1) Sustainability Science, (2) Engineering Design, and (3) Professional Development, Technical or Management Electives. The broad array of electives in competing programs appears to be maintained through college-wide efforts to live stream or record a host of on-campus engineering courses. Resources are not expended on “separate” online courses, and a large list of electives adds the flexibility desired in a sustainability program.

The SSE option was designed for mid-career engineers who desire to build technical and leadership skills to:
• Lead sustainability initiatives through their organization
• Apply sustainability concepts and practices to engineering design
• Engage stakeholders in sustainability issues
• Apply engineering tools to perform needs assessments, environmental modeling, life-cycle cost and benefits design and analyses, optimization, and impact statements on affected populations

These attributes are evaluated in the Sustainable Systems Engineering Capstone course, in which students are required to take after they have taken a minimum of 15 credits in the program.
D. Recruiting, Admissions, and Enrollment

After an initial burst of development, available elective credits plateaued and then started to decline, reflecting the lower-than-expected enrollment and revenue [Table 3]. Available elective credits continued to decline as under-enrolled courses were removed from the program. Furthermore, the three specializations are no longer used, as there are too few elective courses to create three discernable topical groups.

By its own nature, a sustainability program is difficult to market. Sustainability is broad, lacks an accepted universal definition, is relative to context and stakeholders, and is often a coat rack of political agendas. Years ago, it appeared that a new engineering discipline like “sustainable engineering” might arise, but recent trends suggest that sustainability concepts are being integrated directly into the traditional engineering disciplines. Furthermore, while there are few clear sustainability engineering programs, there has been an explosion of sustainability degree programs in general – further muddying the waters. From 2008 to 2012 the number of sustainability degree programs increased from 13 to 141.

A significant portion of the prospective students are showing the desire for a self-service model where they are able to find all that they need to apply without ever engaging with the student services team. Many prefer to learn of all program attributes through the website, then apply without contacting the student services team. These students are typically known as “stealth applicants.” The EPD model is to provide the service that each individual student needs and wants. There is targeted assistance with the application and enrollment process for the students, but they can easily complete the process on their own as well. To better inform stealth applicants, it is recommended that website copy be continually updated to highlight program changes.

Each student has an interview with a graduate coordinator as part of the application process. This allows EPD to assess the student’s capabilities and fit with the program. Information gained through these interviews provide valuable insights into a student’s likelihood to succeed within the program not usually made clear through application materials.

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1 Interdisciplinary Environmental and Sustainability Education: Results from the 2012 Census of U.W. Four Year Colleges and Universities, The Council of Environmental Deans and Directors of the National Council for Science and the Environment, September 2012
### Table 3. Program Applications, Admits, New Enrollment, and Degrees Awarded

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</table>
As of October of 2019, the SSE has 34 total graduates. The distributions of SSE applicants, admits, new enrollment, semester-specific enrollment, and degrees awarded by semester is shown in Table 3 (previous page). Total students in the program (note that students are not always ‘active’ every semester) in recent years has been in the mid 20’s, far short of the anticipated student numbers as shown in Table 1. This resulted in annual financial losses from program inception through the FY2017; however, expenses have been drastically cut through a variety of measures and the program has been net positive for fiscal years 2018 and 2019 (see Table 4) and continues to project as net positive for the near-term future.

Table 4. 3-year Program Revenue and Expenses

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Students</th>
<th>Revenue</th>
<th>Expenses</th>
<th>Net</th>
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<tr>
<td>FY17 Year5 - Actual</td>
<td>27</td>
<td>$225,884</td>
<td>$235,192</td>
<td>($9,308)</td>
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<td>FY18 Year6 - Actual</td>
<td>27</td>
<td>$178,221</td>
<td>$139,114</td>
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<td>FY19 Year7 - Actual</td>
<td>24</td>
<td>$217,485</td>
<td>$159,828</td>
<td>$57,657</td>
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</table>

E. Advising and Student Support

In FY2017, the program was supported by a 50% Program Director, 20% FTE in student services, 54.5% FTE in learning design and technology support, 37% FTE in administration and 42% FTE in marketing. In the current FY2020, the program is supported by a 20% Program Director, 15% FTE in student services, 10% FTE in learning design and technology support, 10% FTE in administration and 10% FTE in marketing.

Students are supported throughout their journey from inquiry to application to matriculated student. The student services team works with students on their specific needs and career aspirations and how the degree will support their goals. Once in the program, student services and the program director (who is also their advisor) will aid in plan of studies and any special requirements needed. Their diligent work with each individual is another key differentiator of the program, but one that is difficult to describe through marketing/advertising messages.

Students provide feedback with each course and have an open channel to the graduate coordinator, program director, and instructor in the event of a grievance. The first step for
any grievance is with the professor. If the situation cannot be resolved it would be escalated to the program director and then action taken depending on the situation. The escalation path would go from the program director to the director of EPD online degrees and ultimately to the EPD department chair. Depending on the nature of the grievance it may go through the escalation within the academic department.

F. Program Community and Climate

The teaching approach follows an engaged model including synchronous learning sessions and consistent collaboration with fellow students and the faculty member while still taking advantage of the flexibility online instruction provides. Assignments are typically project based but there are some courses that will use case studies and traditional style homework. Weekly discussion topics and homework align with the material in that particular week’s lecture with the focus on applying the information being taught in the course.

Courses are taught online with one live web conference scheduled per week. Typically, readings and homework are assigned weekly, along with required class discussion forum participation and quizzes. Projects are used extensively, and students can apply their learning to workplace situations. Online engagement is emphasized, allowing for interaction and networking with both faculty and student peers. Exams are, largely, not utilized. Roughly 60% of the course credits are taught by tenured faculty.

G. Degree Completion and Time to Degree

Starting in the Fall of 2018, the SSE program began the transition to a more flexible curriculum [see Table 2]. The benefits are as follows:

- Improved course enrollment with more course options available each term
- Flexible electives fit the interdisciplinary nature of the program well, allowing individuals to tailor electives to meet individual needs
- Greater pool of course availability for students
- Degree completion time is anticipated to be reduced when students have the option to take more than one course per term, if desired
- All fall and spring terms are a recommended minimum of 4 credits, thus satisfying financial aid requirements

While there is considerable flexibility, there is not as much as when the program was launched. Due to student numbers and financial constraints, many courses are offered on a two-year basis. As such, students that are generally in the program for upwards of three
years only have one, possibly two, opportunities to take a significant number of the courses within the curriculum. This is where advising comes into play where the Program Director and/or Student Services takes an active role in advising and planning a degree completion plan, generally within the first semester of the student’s enrollment. Of the 30 total credits required for graduation, only 3 are required (Sustainable Systems Engineering Capstone). Students work on a plan of study to meet their individual needs. Students enter Fall or Spring. The program, on average, takes three years for degree completion.

H. Career Services and Post-Graduation Outcomes

Over half of existing SSE students are employed in the energy industry—generation, transmission, energy efficiency, or consulting thereof. A number of students are also employed on the facilities side of the industry, often with corporate or district goals of energy sustainability. It has been the single clearest trend in student background. Not surprisingly, students are interested in energy courses—many of the SSE curriculum on the design/engineering side are thus energy-related courses.

From an employment perspective, there has not been a clear sustainability discipline emerging for engineers. Although there is certainly benefit in engineers possessing this knowledge in any employment context, there have been few solid sustainable engineering positions opening-up in the market. In contrast, a major component of sustainable efforts—the energy efficiency and renewable energy field—has been expanding rapidly. In the United States, energy efficiency spending by utilities is expected to double from 2010 to 2025\(^2\), revenue from energy service companies is expected to nearly triple from 2011 to 2020\(^3\), and two-thirds of world-wide spending on new electric generation capacity is expected to be renewable-based and total $8.1 trillion from 2016-2040\(^4\).

Furthermore, UW-Madison has some concentrated areas of energy (renewable and efficiency) expertise.

- EPD maintains much of the building energy efficiency expertise at UW-Madison
- The Grainger Institute for Engineering has a strategic plan to enhance research in the area of Sustainable Energy.
- Undergraduate Certificate in Engineering for Energy Sustainability

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\(^4\) 2015 New Energy Outlook, Bloomberg New Energy Finance
• Nelson Institute Graduate Certificate in Energy Analysis and Policy
• Wisconsin Energy Institute
• Wisconsin Public Utilities Institute

Due to these trends and student employment opportunities and career goals, we intend to keep the SSE degree heavily invested in the energy and energy efficiency arena.

I. Overall Analysis of the Self-Study and the State of the Program:

The current status of the SSE program can be summarized as follows:
• The SSE program has struggled since inception to achieve forecasted enrollment.
• Low enrollment has led to low revenue, which has led to program down-sizing and simplification.
• Increasing credits/student/year has successfully increased revenue; expenses have been significantly reduced in spite of a 10% university assessment.
• Due to student numbers and financial constraints, many courses are offered on a two-year basis. As such, students that are generally in the program for upwards of three years only have one, possibly two, opportunities to take a significant number of the courses within the curriculum.
• The program has been conceptually difficult to market, as the very nature of sustainability is broad, diffuse, and open to interpretation.
• Two key faculty retirements has resulted in the transitioning of the three foundational sustainability courses (1/3 of total program credits).
• Prospective and existing students and program alumni have a strong interest in energy and sustainability.
• Employment prospects for engineers in energy efficiency and renewable energy are strong.
• UW-Madison has centers of strength in energy efficiency, renewable energy and energy policy.

Recommendations:
• Continue to market the SSE program as a sustainable energy systems-focused program.
  o Continue to develop and deliver an energy-focused marketing campaign
  o As the program was in a state of flux for several years, the EPD marketing team has experienced near 100% turnover, and marketing budgets have been limited, overall strategic marketing efforts have been minimized. To increase applicant interest and program enrollment, a comprehensive marketing plan should be developed and implemented.
• Transition Program Director to an individual that has a sufficient, dedicated percentage to market and grow the program, including the directive, tools, resources, and goals to do so.
• Leverage professional development renewable energy and sustainable systems courses for recruiting.

The current tuition of $1,300 per credit hour is on the high-end charged by competitors, particularly the ever-expanding universe of universities and programs that offer some form of ‘sustainability’ focused online degree. Although, anecdotally, we have not had students voicing consistent complaints about tuition levels or going to a competitor based on price (we do lose students to competing programs due to curriculum availability), a market study should be conducted to see if a $1,100 per credit hour price point is appropriate for the SSE program.

Additional Considerations for Graduate Students

J. Funding

As SSE is an online masters-only degree, we do not have PhD students and we do not offer RA or TA funding. Furthermore, we do not have scholarships available for SSE students.

K. Professional Development and Breadth

As SSE is an online masters-only degree, we do not generally provide opportunities or funding for students to attend and present at professional meetings. We, also, do not offer teaching experience development as students are not offered TA positions.