I: Criteria
To qualify for consideration for cross listing, all courses must:

- be requested by both departments or programs;
- count as credit toward an existing major, minor, or certificate program;
- not be experimental or have a reserved variable content course number (x90-X99)
- carry the same title (both parent and sibling courses) and, if possible, carry the same course number;
- be implemented within comparable course levels, e.g., (U), (UG), or (G);
- be offered under an existing rubric.

Under no circumstances will a course have more than three crosslistings.

II: Summary of courses requested for crosslisting

<table>
<thead>
<tr>
<th>Requesting Dept / Program (must be department of parent course)</th>
<th>Applied Computing and Electronics Department/ Energy Technology Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parent Course Prefix and Number</td>
<td>NRGY 102</td>
</tr>
<tr>
<td>Sibling Course(s) Prefix (Pre CCN) and Number</td>
<td>CCS 102</td>
</tr>
<tr>
<td>Course Title</td>
<td>Introduction to Sustainable Energy Systems II</td>
</tr>
</tbody>
</table>

III. Endorsement/Approvals
Complete the form and obtain signatures before submitting to Faculty Senate Office

| Please type / print name | Signature | Date | Approve *
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Requestor:</td>
<td>Bradley Layton</td>
<td></td>
<td>10-1-14</td>
</tr>
<tr>
<td>Phone/ email:</td>
<td>X7865</td>
<td></td>
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<tr>
<td>Parent Program Chair/Director:</td>
<td>Penny Jakes</td>
<td></td>
<td></td>
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<tr>
<td>Sibling Program Chair(s) / Director(s):</td>
<td>Nicky Phear</td>
<td></td>
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<tr>
<td>Dean(s):</td>
<td>Lynn Stocking</td>
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</tbody>
</table>

*Signatory Comments (required for disapproval):

IV. Rationale
Do these courses need to be cross listed to fill an external requirement?

If YES, define external requirement and attach documentation.

Yes. Layton’s NSF ATE grant.

Excerpt from grant narrative: “This course will be led by University of Montana faculty member and co-PI Nicky Phear and will be team-taught with other faculty such as Nobel Laureate Steve Running (see letter). Over the course of the semester, Climate Change Studies students will partner with Energy Technology students to measure and report on local climate-change observables, or to design and build a solutions technology. For example, students might mine data from the Intergovernmental Panel on Climate Change that has been gathered from a particular region in Montana, such as forest fire damage, and then suggest a solution, such as how to better harvest lumber from forests at risk of burning. Students may also elect to install sustainable technologies such as solar thermal systems on campus with funding from The University’s KRELF (Kress Revolving Energy Loan Fund). This course resonates nicely with our sustainability theme in that students will interact directly with their immediate environment and become inspired to discover ways to adapt old technologies to “do more with less.”
If NO, complete narrative: In 500 words or less explain why only cross-listing this course serves the need for delivering academic content. You must identify how both the parent and sibling units contribute to the cross-listed course’s content and how cross listing contributes to the respective units’ missions of serving students. The narrative must also identify additional reasons for cross listing such as a specialized need for advertising to prospective students, sharing resources across departments (equipment, space, instructors, etc.), or mutual contribution to course content.

<table>
<thead>
<tr>
<th>V. Syllabus</th>
</tr>
</thead>
<tbody>
<tr>
<td>See attached PDF.</td>
</tr>
</tbody>
</table>

| VI. Justification for third crosslisting: |
| In 500 words or less describe the extenuating circumstances making a third course necessary. |

| VII Copies and Electronic Submission. | After approval, submit signed original, and electronic file to the Faculty Senate Office, UH 221, camie.foos@mso.umt.edu. |
Introduction to Sustainable Energy Systems II

Course Number: NRGY 102/CCS 102  
Credits: 3  
Meeting times: TR 11:10 – 12:30 HB17  
Course Instructor: Bradley Layton  
bradley.layton@umontana.edu  
406.243.7865  
Office Hours: 9:30 am – 11:00 am TR or by appt  
Pre-/Co-requisites: NRGY 101 Introduction to Energy Systems I or consent of instructor  
Final: Final will be available online during finals week or F2F by request

Course Description
NRGY 102 Introduction to Energy Systems II is a survey of renewable energy systems and technologies. The course addresses the physical and technical aspects of wind, solar, geothermal, hydro, tidal, biological, and wave energy systems. Consideration is also given to the engineering, economic, social, environmental, and political factors that determine implementation and sustainability.

Course Overview
Introduction to Energy Systems II is the second of a two-part course. It provides students with a comprehensive look at the history and nature of sustainable energy systems. Consideration is given to the primary sources of the earth’s energy supplies and their ability to meet and sustain the increasing rate of consumption with current and emerging technologies.

Problems and opportunities associated with integration of these energy systems into existing energy infrastructure are also discussed.

Introduction to Energy Systems II provides students with a working knowledge of the fundamental principles of inexhaustible and renewable energy as well as practical examples of technologies designed to harness them. It provides the student with tools for assessing the current global, state and local human consumption rates and habits as well as opportunities and constraints for future applications.

Course Objectives
Upon completion of this course, the student will be able to:

- Quantify the rate of global and regional human metabolic and technological energy consumption;
- Put the current rate of consumption into context with historical and prehistoric consumption rates;
- Evaluate the physical and technical aspects of renewable energy and energy supply/demand systems;
- Identify the technologies, their key elements and basic principles, that we use to capture, convert, store, distribute energy;
Identify factors that contribute to the economic viability of energy generation from renewable sources, and evaluate the efficacy of conservation and efficiency measures;

Discuss the problem of sustainability in the context of renewable energy and identify technical and social barriers and solutions to the use of renewable energy sources;

Assess the costs and benefits associated with different renewable energy sources and technologies;

Perform fundamental energy-related calculations such as those involving the laws of thermodynamics and energy conversion efficiencies;

Undertake elementary economic analyses of a renewable energy project, taking into account the effect of such factors as discount rates and project lifetimes;

Develop a practical and theoretical knowledge of the full suite of renewable energy systems and apply that knowledge to real world situations.

Required Texts

Assessment/Grading Policies
Grades are based upon successful completion of the following:

- Essays 15%
- Exams (6) 60% Final Exam @ 10% replaces previous lowest
- Summaries (5) 15%
- Summary responses/participation 10%

Grading scale
A = 90-100
B = 80-89
C = 70-79
D = 60-69
F < 60

Homework/Exams/Summaries/Participation
Homework consists of several essays and summaries. Due dates are listed at the bottom of the syllabus. It is the student’s responsibility to check for schedule updates at least semi-weekly.

Exams consist of six unit/chapter exams. Please consult the Exam folder in the Course Information module for detailed information on taking exams. There are no make-up exams without prior approval. If you foresee missing an exam because of a scheduling conflict or due to illness, you must notify the instructor in advance to arrange for an alternative time to take the exam PRIOR to its regularly scheduled date. The final exam is cumulative and replaces the previous lowest exam grade.

Summaries Instructions for completing this exercise can be found in Learning Unit 1. For those who have taken NRGY 101 or SCN175, please note that while the basic requirements of the 300+ word assignments remain the same, the expectations are higher for the quality of work and the complexity of articles. The student must still meet the basic requirements (formatting, spelling, grammar, citation, etc.), but the summaries must indicate an increased ability to read more technically complex articles and to summarize them critically with greater detail and quantitative analysis. Your responses should also
reflect an increased ability to think analytically and raise additional discussion points about issues, and to relate the issues to course material. For each summary, you must include at least one equation, cite the reading required, and cite an additional relevant peer-reviewed non-web reference.

Essays are similar to summaries, but involve individual research rather than reading a prescribed article.

Participation and Attendance
Traditional 3-credit courses meet for 3 hours per week. For every in-class hour, the student is expected to spend 3-4 hours outside of class reading, preparing, and doing homework. Thus, the student ideally spends 12-15 hours per week on this course, depending upon time management and study skills. The time commitment is the same for an online course.

Participation is based upon timely completion of assignments, exams and discussion board submissions. This also means submitting assignments as instructed. The bulk of this portion of the grade is determined by the quality of your Discussion Board participation (responses to classmates’ summaries).

Drop/Add Policy
The Drop/Add Policy may be found at the in the Provost’s website.

Academic Honesty Policy
All students must practice academic honesty. Academic misconduct is subject to an academic penalty by the course instructor and/or a disciplinary sanction by the University. All students must be familiar with the Student Conduct Code.

Accommodations
To request an accommodation, please contact the Course Instructor. For more information, visit accommodation website or call 406.243.2243 (Voice/Text).

Communication
Communication is vital to your success in this course. Contact information is provided in this Syllabus. As the Course Instructor, I try to answer all calls and e-mails promptly. Communicating with the Course Instructor is the Student’s responsibility especially with regard to meeting deadlines. In general, late assignments are not accepted and exams cannot be made up. If an unforeseen event happens, please contact the Course Instructor immediately, and PRIOR to a deadline, to make alternative arrangements for meeting your class responsibilities.

Online support
may be obtained via courseware-support@umontana.edu or x4999

Email policy at UM
According to University email policy, an “employee must use only UMM assigned student email accounts for all email exchanges with students, since such communication typically involves private student information.” For more information on setting up and using your GrizMail account, visit the UMontana Information Technology Website.
Outline

Learning Unit One (Weeks 1-4)
Introducing Renewable Energy (Boyle Ch 1)
Review: force, energy, power; energy conservation (1st law of TD); forms of energy; conversion and efficiency; present-day energy use; fossil fuels and climate change; renewable energy sources; renewable energy and sustainability

Solar Thermal Energy (Boyle Ch 2)
Nature and availability of solar radiation; rooftop solar water heaters; glass; low-temp solar applications; active solar heating; passive solar heating; daylighting; solar thermal engines and electricity generation; economics, future potential, and environmental impacts

Solar Photovoltaics (Boyle Ch 3)
History of PV; PV in silicon: basic principles; Crystalline PV: reducing costs, raising efficiency; thin-film PV; innovations in PV; electrical characteristics of silicon PV cells and modules; PV systems for remote power; grid-tie PV systems; costing energy from PV; environmental impacts; safety; integration and future prospects

Learning Unit Two (Weeks 5-6)
Bioenergy (Boyle Ch 4)
Past and present uses; biomass as fuel; bioenergy sources: energy crops and wastes; combustion of solid biomass; production of gaseous fuels from biomass; production of liquid fuels from biomass; environmental concerns; economics

Learning Unit Three (Week 7-9)
Hydroelectricity (Boyle Ch 5)
Hydro schemes around the world; the resource; stored energy and available power; history of water power; types of hydroelectric plants; Francis turbines; propellers; impulse turbines; applications; scale: large, medium, small, micro; environmental impacts; integration; economics; future prospects

Tidal Power (Boyle Ch 6)
Nature of the resource; technical; environmental, economic factors; integration; future prospects; types of systems: tidal barrages, tidal streams, tidal currents; assessment of potential

Learning Unit Four (Weeks 10 - 12)
Wind Energy (Boyle Ch 7)
Nature of the resource; wind turbines; aerodynamics; power and energy from turbines; environmental impacts; economic assessment; commercial development and potential; offshore sources

Wave Energy (Boyle Ch 8)
Nature of the resource; sample applications; wave energy technologies; economics; environmental impacts; integration; future prospects

Learning Unit Five (Week 13)
Geothermal Energy (Boyle Ch 9)
Overview of the resource; nature of the resource; historical uses; technologies for exploitation; environmental impacts; sustainability; economics; future prospects

Learning Unit Six (Week 14)
Integration (Boyle Ch 10)
Analysis of existing energy infrastructure; location and availability of RE supplies; sustainability and harvest rates; system solutions for integration of RE; hydrogen economy; economics; case study: Danish system; global considerations

<table>
<thead>
<tr>
<th>Schedule of Due Dates</th>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
<th>Week 5</th>
<th>Week 6</th>
<th>Week 7</th>
<th>Week 8</th>
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<tbody>
<tr>
<td>nothing due</td>
<td>Biosketch</td>
<td>Summary 1</td>
<td>Exam 1 Ch 1-3</td>
<td>Summary 2</td>
<td>Exam 2 Ch 4</td>
<td>Summary 3</td>
<td>Essay I</td>
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<tr>
<td>Exam 3 Ch 5 &amp; 6</td>
<td>Summary 4</td>
<td>Exam 4 Ch 7 &amp; 8</td>
<td>Exam 5 Ch 9</td>
<td>Essay III</td>
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