ARIZONA STATE UNIVERSITY

GENERAL STUDIES COURSE PROPOSAL COVER FORM

Course information:

Copy and paste ***current*** *course information from [Class Search/Course Catalog](#).*

College/School	College of Liberal Arts and Sciences	Department/School	**School of Earth & Space Exploration**

Prefix:	**SES**	Number:	**141**	Title:	Energy in Everyday Life	Units:	4.0

Course description: **.0 Energy is a concept that threads throughout science and engineering and is at the heart of understanding how the world around us works. What is energy? How is energy used in biological, chemical, electrical, mechanical, nuclear systems that impacts our daily lives? What would our world be like if there was a nearly infinite supply of inexpensive energy? Serves the needs of undergraduate students and future K-8 teachers of mastering basic concepts of energy generation, delivery, conversion, efficiency and what makes energy universal. This transdisciplinary online survey course helps students understand concepts and develop skills that crosscut scientific disciplines, such as the ability to observe, think critically and gather data to make order-of-magnitude estimates.**

Is this a cross-listed course? No If yes, please identify course(s):

Is this a shared course? No If so, list all academic units offering this course:

Note- For courses that are crosslisted and/or shared, a letter of support from the chair/director of ***each*** *department that offers the course is required for* ***each*** *designation requested. By submitting this letter of support, the chair/director agrees to ensure that all faculty teaching the course are aware of the General Studies designation(s) and will teach the course in a manner that meets the criteria for each approved designation.*

Is this a permanent-numbered course with topics? No

If yes, all topics under this permanent-numbered course must be taught in a manner that meets the criteria for the approved designation(s). It is the responsibility of the chair/director to ensure that all faculty teaching the course are aware of the General Studies designation(s) and adhere to the above guidelines.

Chair/Director Initials

_____ (Required)

Requested designation: Natural Sciences–SQ

Mandatory Review: (Choose one)

Note- a ***separate*** *proposal is required for each designation.*

Eligibility: Permanent numbered courses **must** have completed the university's review and approval process. For the rules governing approval of omnibus courses, contact Phyllis.Lucie@asu.edu.

Submission deadlines dates are as follow:

For Fall 2018 Effective Date: October 1, 2017

For Spring 2019 Effective Date: March 10, 2018

Area(s) proposed course will serve:

A single course may be proposed for more than one core or awareness area. A course may satisfy a core area requirement and more than one awareness area requirements concurrently, but may not satisfy requirements in two core areas simultaneously, even if approved for those areas. With departmental consent, an approved General Studies course may be counted toward both the General Studies requirement and the major program of study.

Checklists for general studies designations:

Complete and attach the appropriate checklist

- Literacy and Critical Inquiry core courses (L)
- Mathematics core courses (MA)
- Computer/statistics/quantitative applications core courses (CS)
- Humanities, Arts and Design core courses (HU)
- Social-Behavioral Sciences core courses (SB)
- Natural Sciences core courses (SQ/SG)
- Cultural Diversity in the United States courses (C)
- Global Awareness courses (G)
- Historical Awareness courses (H)

A complete proposal should include:

- ☒ Signed course proposal cover form
- ☒ Criteria checklist for General Studies designation being requested
- ☒ Course catalog description
- ☒ Sample syllabus for the course
- ☒ Copy of table of contents from the textbook and list of required readings/books

It is respectfully requested that proposals are submitted electronically with all files compiled into one PDF.

Contact information:

Name	Becky Polley	E-mail	rebecca.polley@asu.edu	Phone	(480) 965-5768

Department Chair/Director approval: ***(Required)***

ARIZONA STATE UNIVERSITY

Chair/Director name (Typed):	Christopher Groppi	Date:	10/24/17
Chair/Director (Signature):			

SQ Justification: SES 141 *Energy in Everyday Life*

Energy in Everyday Life was previously approved for SQ credit as SES 194 in Fall 2013. The course was subsequently approved by CLAS, University Senate, and the Provost's Office for the permanent course number SES 141 in Spring 2017.

Energy in Everyday Life has been taught for SQ credit every semester since 2013.

The Fall C version of SES 141 is restricted to WP Carey students in the ProMod Sustainability degree program. The course partners with and is closely integrated with the English 101 and WP Carey 101. For example, SES 141's three (3) "outdoor activity" assignments and one (1) end-of-corse design project are closely aligned with assignments in ENG 101 and WPC 140. Enrollment is typically ~30 students.

The Spring B version of SES 141 is open to all on-ground and ASU Online students (i.e., i-course and o-course). Enrollment has grown from ~100 students in 2013 to over 800 students in 2017, and is poised to exceed 1000 students in the next year or so.

Energy in Everyday Life is an online course with 7 units. Each unit consists of 10 video modules, 1 homework assignment, 3 Discovery Labs - a digital manipulative originally funded by the Mary Lou Fulton Teachers College and ASU Online. Every other unit there are three novel "outdoor activities" (Home energy assessment, Lemon Battery, and Solar Water Distiller), and three (3) exams. The course ends with design project where students integrate their accumulated knowledge with the course learning objectives.

The ensuing documentation closely follows what was approved for SQ credit as SES 194 in Fall 2013.

Frank Timmes
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ASU--[SQ] CRITERIA

I. - FOR ALL *QUANTITATIVE* [SQ] NATURAL SCIENCES CORE AREA COURSES, THE FOLLOWING ARE CRITICAL CRITERIA AND MUST BE MET:

YES	NO		Identify Documentation Submitted
☒	☐	**A.** Course emphasizes the mastery of basic scientific principles and concepts.	Criteria Justification, Detailed Syllabus
☒	☐	**B.** Addresses knowledge of scientific method.	Criteria Justification, Detailed Syllabus
☒	☐	**C.** Includes coverage of the methods of scientific inquiry that characterize the particular discipline.	Criteria Justification, Detailed Syllabus
☒	☐	**D.** Addresses potential for uncertainty in scientific inquiry.	Criteria Justification, Detailed Syllabus
☒	☐	**E.** Illustrates the usefulness of mathematics in scientific description and reasoning.	Criteria Justification, Detailed Syllabus
☒	☐	**F.** Includes **weekly** laboratory and/or field sessions that provide hands-on exposure to scientific phenomena and methodology in the discipline, and enhance the learning of course material.	Criteria Justification, Detailed Syllabus
☒	☐	**G.** Students submit written reports of laboratory experiments for constructive evaluation by the instructor.	Criteria Justification, Detailed Syllabus
☒	☐	**H.** Course is general or introductory in nature, ordinarily at lower-division level; not a course with great depth or specificity.	Criteria Justification, Detailed Syllabus

II. - AT LEAST ONE OF THE FOLLOWING ADDITIONAL CRITERIA MUST BE MET WITHIN THE CONTEXT OF THE COURSE:

YES	NO		Identify Documentation Submitted
☒	☐	**A.** Stresses understanding of the nature of basic scientific issues.	Criteria Justification, Detailed Syllabus
☒	☐	**B.** Develops appreciation of the scope and reality of limitations in scientific capabilities.	Criteria Justification, Detailed Syllabus
☐	☒	**C.** Discusses costs (time, human, financial) and risks of scientific inquiry.	

NOTE: CRITERIA FOR [SG] COURSES BEGIN ON PAGE 4.

III. - [SQ] COURSES MUST ALSO MEET THESE ADDITIONAL CRITERIA:			
YES	**NO**		**Identify Documentation Submitted**
☒	☐	**A.** Provides a substantial, quantitative introduction to fundamental principles governing behavior of matter and energy, in physical or biological systems.	Criteria Justification, Detailed Syllabus
		B. Includes a college-level treatment of some of the following topics **(check all that apply below):**	
☒	☐	**a.** Atomic and molecular structure	Criteria Justification, Detailed Syllabus
☒	☐	**b.** Electrical processes	Criteria Justification, Detailed Syllabus
☒	☐	**c.** Chemical processes	Criteria Justification, Detailed Syllabus
☒	☐	**d.** Elementary thermodynamics	Criteria Justification, Detailed Syllabus
☒	☐	**e.** Electromagnetics	Criteria Justification, Detailed Syllabus
☒	☐	**f.** Dynamics and mechanics	Criteria Justification, Detailed Syllabus

[SQ] REQUIREMENTS CANNOT BE MET BY COURSES:

- **Presenting a qualitative survey of a discipline.**
- **Focusing on the impact of science on social, economic, or environmental issues.**
- **Focusing on a specific or limiting but in-depth theme suitable for upper-division majors.**

SES 141 - Energy In Everyday Life

Course description: Energy is a concept that threads throughout science and engineering and is at the heart of understanding how the world around us works. What is energy? How is energy used in biological, chemical, electrical, mechanical, nuclear systems that impacts our daily lives? What would our world be like if there was a nearly infinite supply of inexpensive energy? Serves the needs of undergraduate students and future K-8 teachers of mastering basic concepts of energy generation, delivery, conversion, efficiency and what makes energy universal. This transdisciplinary online survey course helps students understand concepts and develop skills that crosscut scientific disciplines, such as the ability to observe, think critically and gather data to make order-of-magnitude estimates.

Enrollment requirements: Credit is allowed for only SES 141 or SES 194 (Energy in Everyday Life)

[Print the complete syllabus]

Course Number
SES 141

Course Title
Energy in Everyday Life

Credits
4 SQ credits

Prerequisites
None. The mathematics level is arithmetic - addition, subtraction, multiplication, and division - and scientific notation (powers of ten).

Required Materials
None.

Faculty
Name: Frank Timmes
Email address: ftimmes@asu.edu
TA: None

Catalog Description
Energy is a concept that threads throughout science and engineering and is at the heart of understanding how the world around us works. What is energy? How is energy used in biological, chemical, electrical, mechanical, nuclear systems that impacts our daily lives? What would our world be like if there was a nearly infinite supply of inexpensive energy?
Energy in Everyday Life is an online survey course designed to serve the needs of undergraduate students and future K-8 teachers to master basic concepts of energy, energy generation, delivery, conversion, efficiency and what makes energy universal. This multi-disciplinary course will help students understand concepts and develop skills that crosscut scientific disciplines - such as the ability to observe, think critically, and gather data to make order-of-magnitude estimates.

Course Overview
This is an online introductory science course on energy with an emphasis on examples from everyday life. We will develop and use concepts from chemistry, thermodynamics, physics, biology, electricity, and engineering to explore the types, conversions, and uses of energy.

Learning Outcomes
See the Course Schedule for a detailed listing of the activities and assignments. At the completion of this course, students will be able to:

- Understand the use of the scientific method and how it helps solve puzzles through order of magnitude estimates.
- Use concepts in science and engineering to qualitatively describe, and quantitatively estimate, essential features of the physical world.
- Define characteristics that are essential to the transport and conversion of energy.
- Critically compare and contrast modes of energy generation and usage.

Course Topics, Schedule & Grading
Activities used for instruction and assessment of learning include: video modules, video transcript readings, hallway discussions, and assignments. Click the "Course Schedule" link in the menu on the left to see the assignment point values and due dates.

Order Of Magnitude Estimates

Most technical education courses emphasizes exact answers. For example, if you are a chemist, you might solve for the energy levels of the hydrogen atom to six decimal places. If you are an economist, you might measure inflation rates to two or three decimal places. In this course, you learn complementary skills. You learn that an approximate answer is not merely good enough; it is often more useful than an exact answer. When you approach an unfamiliar problem you first want to grasp the main ideas, because these ideas structure your understanding of the problem. It is easier to refine this understanding than to create a highly refined analysis as the first step.

The term "order of magnitude estimate", reflects this course's emphasis on approximation. An order of magnitude is a factor of 10. To be "within an order of magnitude" is to estimate a quantity to within a factor of 10. This course introduces how to make such approximations.

For more than a decade now, Fortune 500 companies have asked such open-ended questions as part of their interview process. For example, "How many gallons of water are in the ocean?". There is, of course, no exact answer. The point of asking such interview questions is to see how you begin to solve such questions in a live environment. They want to see your initial steps, how you decompose such open-ended questions into manageable chunks, and finally end up with a reasonable order-of-magnitude estimate. This is the skill set that this course introduces. We are not interested in providing you with N numbers that you then stick into a given formula to grind out an answer to six significant figures. Instead, we are interested in developing the *thinking* processes so that you can provide those N numbers and relevant formulas yourself. Thus, this course offers the opportunity to develop practical, critical thinking, job skills.

Grading

The maximum number of points possible is 1000. The breakdown is as follows. Each of the seven Assignments is worth 30 points (210 points total). Each of the three Activities is worth 30 points (90 points total). Each of the three Exams is worth 150 points (450 points total). The Design Project is worth 40 points. Each of the twenty one Discovery Labs is worth 10 points (210 points total).

Three attempts are allowed on any Assignment, with the highest score being recorded. Unlimited attempts are allowed on the Discovery Labs. You may collaborate on Assignments or Discovery Labs in groups up to six people.

One attempt is allowed on any Exam. Collaborations are not allowed on any Exam. The Exams have the same style and content level as the assignments. There is no time limit on the Exams.

The end-of-course Design Project is your opportunity to express what interests you about energy in any medium you prefer.

No low score is dropped from the Final Grade calculation.

There is no final exam in this course.

The Final Grades for the course are based on the number of points you earn. You can see your scores from the "My Grades" link, and will generally be available within 48 hours after the assignment or Exam deadline. Final Grades for the course are generally based on 90% or better will get an A, 80% or better a B, 70% or better a C, 60% or better a D, below 60% is a failing grade.

Communicating with the Instructor

This online course uses a discussion board called "Hallway Conversations" for questions about the course content. Prior to posting a question, please check the syllabus, announcements, and existing posts. If you do not find an answer, post your question. You are encouraged to respond to the questions of your classmates. Email questions of a personal nature to your instructor. You can expect a response within 48 hours. Questions not of a personal nature will be referred to our Hallway Conversations.

Online Course
This is an online course. There are no in-person meetings. You can log into your course via MyASU or https://my.asu.edu.

Email and Internet
ASU email is an official means of communication among students, faculty, and staff. Students are expected to read and act upon email in a timely fashion. Students bear the responsibility of missed messages and should check their ASU-assigned email regularly.
All instructor correspondence will be sent to your ASU email account.

Course Time Commitment
This four-credit SQ course requires approximately 180 hours of work (45 hours per credit hour). Please expect to spend around 24 hours each week preparing for and actively participating in this course.

Late Assignments
Late assignments or exams will be graded at 50% of the maximum score, except for verified medical reasons or ASU sponsored activities (which require advanced notification). **Claiming your computer or internet went down is not a valid exception.**
Notify the instructor **BEFORE** an assignment is due if an urgent situation arises and the assignment will not be submitted on time. Published assignment due dates (Arizona Mountain Standard time) are firm. Please follow the appropriate University policies to request an accommodation for religious practices or to accommodate a missed assignment due to University-sanctioned activities.

Submitting Assignments
All assignments, unless otherwise announced, MUST be submitted to the designated area of Blackboard. Do not submit an assignment via email.

Extra Credit Assignments
There are no extra credit assignments in this course.

Drop/Add/Withdrawal Dates
This course adheres to a compressed schedule and there is a limited timeline to drop or add the course. Consult with your advisor and notify your instructor to add or drop this course. If you are considering a withdrawal, review the following ASU policies: Withdrawal from Classes, Medical/Compassionate Withdrawal, and a Grade of Incomplete.

Grade Appeals
Grade disputes must first be addressed by discussing the situation with the instructor. If the dispute is not resolved with the instructor, the student may appeal to the department chair per the University Policy for Student Appeal Procedures on Grades.

Student Conduct and Academic Integrity
Academic honesty is expected of all students in all examinations, papers, laboratory work, academic transactions and records. The possible sanctions include, but are not limited to, appropriate grade penalties, course failure (indicated on the transcript as a grade of E), course failure due to academic dishonesty (indicated on the transcript as a grade of XE), loss of registration privileges, disqualification and dismissal. For more information, see http://provost.asu.edu/academicintegrity. Additionally, required behavior standards are listed in the Student Code of Conduct and Student Disciplinary Procedures, Computer, Internet, and Electronic Communications policy, and outlined by the Office of Student Rights & Responsibilities. Anyone in violation of these policies is subject to sanctions.

Students are entitled to receive instruction free from interference by other members of the class. An instructor may withdraw a student from the course when the student's behavior disrupts the educational process per Instructor Withdrawal of a Student for Disruptive Classroom Behavior.

Appropriate online behavior is defined by the instructor and includes keeping course discussion posts focused on the assigned topics. Students must maintain a cordial atmosphere and use tact in expressing differences of opinion. Inappropriate discussion board posts may be redacted or deleted by the instructor.

The Office of Student Rights and Responsibilities accepts incident reports from students, faculty, staff, or other persons who believe that a student or a student organization may have violated the Student Code of Conduct.

Prohibition of Commercial Note Taking Services

In accordance with ACD 304-06 Commercial Note Taking Services, written permission must be secured from the official instructor of the class in order to sell the instructor's oral communication in the form of notes. Notes must have the notetaker's name as well as the instructor's name, the course number, and the date.

Course Evaluation

Students are expected to complete the course evaluation. The feedback provides valuable information to the instructor and the college and is used to improve student learning. Students are notified when the online evaluation form is available.

Syllabus Disclaimer

The syllabus is a statement of intent and serves as an implicit agreement between the instructor and the student. Every effort will be made to avoid changing the course schedule but the possibility exists that unforeseen events will make syllabus changes necessary. Please remember to check your ASU email and the course site often.

Accessibility Statement

In compliance with the Rehabilitation Act of 1973, Section 504, and the Americans with Disabilities Act as amended (ADAAA) of 2008, professional disability specialists and support staff at the Disability Resource Center (DRC) facilitate a comprehensive range of academic support services and accommodations for qualified students with disabilities.

Qualified students with disabilities may be eligible to receive academic support services and accommodations. Eligibility is based on qualifying disability documentation and assessment of individual need. Students who believe they have a current and essential need for disability accommodations are responsible for requesting accommodations and providing qualifying documentation to the DRC. Every effort is made to provide reasonable accommodations for qualified students with disabilities.

Qualified students who wish to request an accommodation for a disability should contact the DRC by going to https://eoss.asu.edu/drc, calling (480) 965-1234 or emailing DRC@asu.edu. To speak with a specific office, please use the following information:

ASU Online and Downtown Phoenix Campus University Center Building, Suite 160 602-496-4321 (Voice)	**Polytechnic Campus** 480-727-1165 (Voice)
West Campus University Center Building (UCB), Room 130 602-543-8145 (Voice)	**Tempe Campus** 480-965-1234 (Voice)

Computer Requirements

This course requires a computer with Internet access and the following:

- Web browsers (Chrome, Internet Explorer, Mozilla Firefox, or Safari)
- Adobe Acrobat Reader (free)

- Adobe Flash Player (free)
- Microphone (optional) and speaker

Technical Support

This course uses Blackboard to deliver content. It can be accessed through MyASU at http://my.asu.edu or the Blackboard home page at https://myasucourses.asu.edu
To monitor the status of campus networks and services, visit the System Health Portal at http://syshealth.asu.edu/.
To contact the help desk call toll-free at 1-855-278-5080.

Student Success

This is an online course. To be successful:

- check the course daily
- read announcements
- read and respond to course email messages as needed
- complete assignments by the due dates specified
- communicate regularly with your instructor and peers
- create a study and/or assignment schedule to stay on track

Course Schedule and Assignments

ACTIVITIES/ASSIGNMENTS	POINTS	DUE DATE All assignments are due at **07:00 am** MST on dates shown
UNIT 1: MECHANICS		
Watch and takes notes on these video modules: 01 About this course 02 What is energy? 03 Kinematics 04 Dynamics 05 Work and Energy 06 Conservation 07 Power and energy scale 08 Order of magnitude estimate guidance 09 Order of magnitude estimate - Energy in gallon of gas 10 Yea, ok, but what IS energy?		28Aug
Lab 1	10	28Aug
Lab 2	10	28Aug
Lab 3	10	28Aug
Assignment 1	30	28Aug
Activity 1 - Report submission	20	28Aug
Activity 1 - Sharing in Yellowdig - 1 post and 1 reply	10	28Aug
UNIT 2: CHEMISTRY		
Watch and takes notes on these video modules: 11 Chemical energy 12 Atomic structure 13 Atomic energy levels 14 Valence electrons 15 Bond types 16 Bond energetics 17 Order of magnitude - circumference of the earth 18 Kickstarting a reaction 19 Specific energy densities 20 Catalysts and inhibitors		11Sep
Lab 4	10	11Sep
Lab 5	10	11Sep
Lab 6	10	11Sep
Assignment 2	30	11Sep
Exam #1	150	11Sep
UNIT 3: CHEMISTRY AND THERMODYNAMICS		
Watch and takes notes on these video modules: 21 Photosynthesis and respiration 22 Batteries 23 Fuel cells 24 Order of magnitude estimate - average arizona household energy usage 25 Temperature and kinetic energy 26 Heat flow 27 Temperature scales - ole's and daniel's 28 Temperature scales - anders' and william's 29 Temperature tech: bulbs and bimetallics 30 Temperature tech: infrared and light		25Sep
Lab 7	10	25Sep
Lab 8	10	25Sep
Lab 9	10	25Sep
Assignment 3	30	25Sep
Activity 2 - Report submission	20	25Sep
Activity 2- Sharing in Yellowdig - 1 post and 1 reply	10	25Sep
UNIT 4: THERMODYNAMICS AND NUCLEAR		
Watch and takes notes on these video modules: 31 Thermal radiators 32 Order of magnitude estimate - cost to heat water 33 Temperature tech: popup, galileo 34 Temperature tech: crystal oscillators 35 Heat reservoirs 36 Heat engine efficiency 37 Real heat engines 38 Order of magnitude estimate - rubber on the roads 39 Powering the sun 40 Binding protons and neutrons		11Oct

Lab 10	10	11Oct
Lab 11	10	11Oct
Lab 12	10	11Oct
Assignment 4	30	11Oct
Exam #2	150	11Oct

UNIT 5: NUCLEAR

Watch and takes notes on these video modules: 41 Binding energies 42 Fission 43 Our local nuclear power plant 44 Radioactive decay 45 Order of magnitude estimate - trash as transportation fuel 46 Sources of radioactivity 47 Fusion 48 Tokamak fusion 49 Laser fusion 50 Order of magnitude estimate - energy of a hurricane		23Oct
Lab 13	10	23Oct
Lab 14	10	23Oct
Lab 15	10	23Oct
Assignment 5	30	23Oct
Activity 3 - Report submission	20	23Oct
Activity 3 - Sharing in Yellowdig - 1 post and 1 reply	10	23Oct

UNIT 6: ELECTRICAL

Watch and takes notes on these video modules: 51 Electricity 52 Introduction 53 Charges 54 Electric fields 55 Voltage and current 56 Magnetic fields 57 Order of magnitude estimate - length of thread 58 DC and AC 59 Resistance and power 60 Energy flow in circuit		06Nov
Lab 16	10	06Nov
Lab 17	10	06Nov
Lab 18	10	06Nov
Assignment 6	30	06Nov
Exam #3	150	06Nov

UNIT 7: ELECTRICAL AND ALTERNATIVES

Watch and takes notes on these video modules: 61 Mythbusters I, what is electricity 62 Mythbusters II, franklin kite 63 Magnets 64 Generators and motors 65 Renewables and hydroelectric 66 Wind 67 Photovoltaics I 68 Photovoltaics II 69 Solar thermal 70 Solar heating		20Nov
Lab 19	10	20Nov
Lab 20	10	20Nov
Lab 21	10	20Nov
Assignment 7	30	20Nov
Design Project	40	07Dec

Course Prefix	Number	Title	General Studies Designation
SES	141	Energy in Everyday Life	SQ

Explain in detail which student activities correspond to the specific designation criteria. Please use the following organizer to explain how the criteria are being met.

Criteria (from checksheet)	How course meets spirit (contextualize specific examples in next column)	Please provide detailed evidence of how course meets criteria (i.e., where in syllabus)
		Designations in this column refer to the Schedule (U=Unit)
I. A. Course emphasizes the mastery of basic scientific principles and concepts.	This course requires that students learn fundamental scientific principles from different fields and disciplines.	For example: Physics: Unit 1: Mechanics, Energy, Kinetics, Dynamics, Power, Conservation Laws Chemistry: Units 2 and 3: Chemical energy, Bonds, Photosynthesis, Batteries, Fuel Cells Thermodynamics: Units 3 and 4: Temperature, Heat, Thermal Radiators, Heat Engines Nuclear: Units 4 and 5: Fusion (stellar and terrestrial), Fission, Radioactivity Electrical: Unit 6 and 7: Charges, Current, Electric and Magnetic Fields, DC and AC current, Generators Alternatives: Unit 7: Hydroelectric, Wind, Photovoltaics, Solar

I. B. Addresses knowledge of scientific method.	Use of the scientific method as a rigorous means of addressing scientific questions is a unifying theme in the course. Labs routinely require students to use scientific methods to arrive at conclusions.	For example: Discovery Lab: Gasoline, “How much energy is in a gallon of gasoline?” Discovery Lab: Streep Lamp, “How much does it cost (in dollars) to operate one street lamp in Tempe for one year? “
I. C. Includes coverage of the methods of scientific inquiry that characterize the particular discipline.	The course transcends a focus on narrow disciplinary methods to showcase how methods are used across disciplines. Students encounter content and pathways of discovery considered central to a number of disciplines.	For example: Discovery Lab: Number of cells in the human body. All 3 outdoor activities: (a) Home energy assessment, (b) Lemon battery, and (c) Solar water still.
I. D. Address potential for uncertainty in scientific inquiry.	A number of labs in the course focus students’ attention on how the availability of information and its uncertainty impacts the conclusions we draw about the physical world.	For example: Discovery lab: City Manager, “If you were building a new city with a projected population of 100,000, how many gas stations would you need? ”
I. E. Illustrates the usefulness of mathematics in scientific description and reasoning.	The course directly addresses the importance of quantitative measurement in scientific description and reasoning.	For example: All 3 outdoor activities: (a) Home energy assessment, (b) Lemon battery, and (c) Solar water still.

I. F. Includes weekly laboratory and/or field sessions that provide handson exposure to scientific phenomena and methodology in the discipline, and enhance the learning of course material.	The course includes weekly research explorations that include digital labs and manipulatives, as well as “do at home” laboratory activities.	All 7 Units. All 21 Discovery Labs. All 3 outdoor activities.
I. G. Students submit written reports of laboratory experiments for constructive evaluation by the instructor	Students will be required to submit weekly lab reports that include statements of hypotheses, discussion of methods, analysis of data, and discussion of results.	All 7 Units. All 21 Discovery Labs. All 3 outdoor activities.
I. H. Course is general or introductory in nature, ordinarily at lowerdivision level; not a course with great depth or specificity.	The course is a transdisciplinary survey that explores the varied disciplinary content and practices	See answer for I.A.

II.A. Stresses the understanding of the nature of basic scientific issues.	As the course is organized around an ongoing transdisciplinary endeavor, students in Energy in Everyday Life really engage the nature of science and the interconnections between scientific disciplines. Students come away with an understanding of basic scientific content and process issues such as how to reduce bias, effectively communicate results, and the role of uncertainty in science.	For example: All 7 Units. All 21 Discovery Labs. All 3 outdoor activities.
II. B. Develops appreciation of the scope and reality of limitations in scientific capabilities.	Students explore the factors behind limitations in scientific capabilities, including the role of technology and the boundaries of current scientific understanding.	For example: Discovery Lab: Brain power, “How much power does your brain consume? ”
II. C. Discusses costs (time, human, financial) and risks of scientific inquiry.	Not a significant component of the course, but tangentially addressed in the course’s exploration of the financial costs and societal risks of alternative fuel sources.	For example: Unit 7

III.A. Provides a substantial, quantitative introduction to fundamental principles governing behavior of matter and energy, in physical or biological systems.	The primary focus of Energy in Everyday Life is the centrality of energy and matter ot the natural world, scientific inquiry, and everyday life.	All 7 Units All 21 Discovery Labs. All 3 outdoor activities.
III. B. Includes collegelevel treatment of some of the following topics:		
a. Atomic and molecular structure	Students explore how matter interacts with radiation, learning that many physical properties, such as composition, temperature, density, speed, and rotation, can be determined from spectra.	For example: Units: 2, 3, 4 Discovery Lab:Water Drop, "How many molecules are in a drop of water? "
b. Electrical processes	Students explore electrical processes in the context of energy transport, storage, and conversion.	For example: Units: 6, 7 Discovery Lab: Street Lamp, "How much does it cost (in dollars) to operate one street lamp in Tempe for one year? "

c. Chemical processes	Students examine how the release or absorption of energy during chemical reactions different contexts, including photosynthesis, fermentation, cooking, and battery storage.	For example: Units: 2, 3 Discovery Lab: Daily Coal, “How many railroad cars of coal are needed every day for a 1 GigaWatt electrical power plant?”
d. Elementary thermodynamics	Conservation of energy is a recurring theme throughout the course. Students have repeated exposure to the 1st Law of Thermodynamics in applied pragmatic contexts.	For example: Units: 3, 4 Discovery Lab: Hydropower, “How much water flow is need for a 1 Gigawatt hydroelectric power plant? How many Niagara Falls is this?”
e. Electromagnetics	The emission and absorption of radiation is a major topic, as is how electrical energy is transported.	For example: Units: 6, 7 Discovery Lab: Solar power, “How much solar energy hits the Earth? ”
f. Dynamics and mechanics	Throughout the course, students engage concepts central to Newtonian kinematics and dynamics as applied to energy.	For example: Units: 1, 7 Discovery Lab: Mountain Soda, “How much do you change your gravitational potential energy climbing a medium-sized mountain? How does this compare to the energy in a can of soda? ”

Criteria Justification: *Energy in Everyday Life* ASU [SQ] Criteria

I. Critical Criteria

A. Course emphasizes the mastery of basic scientific principles and concepts.

The topic of energy is inherently transdisciplinary, and addresses concepts and principles across science, technology, and everyday life. across a number of disciplines. Students explore topics ranging from physics to chemistry to economics, environmental science and sustainability science. Specific examples of basic principles and concepts the students engage include: the definitions of energy; the emission and absorption of radiation by matter; photosynthesis; chemistry of reactions; heat engines; and the frontiers of energy production such as fracking, photovoltaics and ocean tides. *Energy in Everyday Life* teaches students the ways in which many of these principles and concepts interact with each other in everyday life. This approach solidifies the principles and concepts encountered.

B. Addresses knowledge of scientific method.

Energy in Everyday Life is organized around an ongoing human endeavor: harnessing the energy around us. The course does not teach a static body of unrelated facts to be memorized, but introduces science as a dynamic process, guided by a methodology that uses scientific principles and concepts to develop and test hypotheses in a quantitative manner, with an end goal of elucidating fact from perception. The course is inherently designed to expose students to science as an iterative process of investigation.

The lectures, labs, and outdoor activities associated with each unit of *Energy in Everyday Life* reinforce this design. For example, *Energy in Everyday Life* students learn about the scientific method by applying it in laboratory exercises and during lecture discussions. The motivating principle behind these exercises is that students learn general and specific scientific ideas by interacting with realistic simulations and examining realistic (sometimes real) data. The scientific method is taught in these exercises by having students examine a phenomena at the outset of each lab exercise and then formulating hypotheses. They are then given the tools necessary to test their hypotheses and are required to explain how their explorations validate or disprove their hypotheses. As students encounter new data in the lab, they engage in the process of refining their model. In this way, students gain direct experience with the scientific method. In addition, *Energy in Everyday Life* offers historical examples of how scientists have modified their hypotheses and conclusions over time, based on new or changing data.

C. Includes coverage of the methods of scientific inquiry that characterize the particular discipline.

As an inherently transdisciplinary course, *Energy in Everyday Life* does not focus students' attention on the methods of a particular scientific discipline, but instead seeks to introduce students to a range of scientific disciplines and to highlight the methodological similarities between disciplines i.e., the universal qualities of scientific inquiry. On the way to this understanding students encounter content considered central to a number of scientific disciplines.

For example, in Unit 5 students explore content and concepts in the realm of sustainability, earth/space science, and physics through an outdoor activity (building a solar powered water still) that explores the challenges involved in efficient energy collection. Students consider the impact of angles, cloud cover, seasonal conditions while trying to determine the maximum efficiency of solar devices. Students find the insolation onto the surface of their device where the surface directly faces the Sun and as the angle increases between the direction at a right angle to the surface and the direction of the rays of sunlight, the insolation is reduced in proportion to the cosine of the angle. Students quantitatively assess the impact of the local conditions on the measured insolation. Ultimately, they come to understand that these local factors help explain how and why solar energy energy generation on the surface of the Earth depends strongly on local conditions. In addition, students learn that engineers, sustainability scientists, physicists, and mathematicians can learn more about their own fields by viewing a problem from the viewpoint of another discipline.

D. Addresses potential for uncertainty in scientific inquiry.

Energy in Everyday Life intrinsically familiarizes students with the existence of uncertainty in scientific knowledge. Students encounter the role of uncertainty in science directly in Units 1, 2, and 4, particularly in terms of the limitations involved in measurement. In addition, transformations of energy is a backbone concept of *Energy in Everyday Life,* and lays the framework for breaking down the topic of energy conservation so as to isolate key areas and assess their uncertainties.

This message is reinforced in a number of Units and laboratory exercises, many of which how students how the availability of information and its uncertainty impacts the conclusions we draw about our physical world on a daily basis. For example, students' explorations in the Discovery Labs encourages students to break down a complex questions into a sequence of smaller problems each of which has different degrees of uncertainty. Students earn how to combine those sources of uncertainty into the final values. That is, students engage the scientific and mathematical process of uncertainty propagation

Finally, the *Energy in Everyday Life* addresses uncertainty in the form of competing hypotheses about a natural phenomenon. At their core, competing hypotheses reflect uncertainty in the data or model an acknowledgement that there are not enough verifiable acts to come to consensus model. This aspect of uncertainty contributes to the student's deeper appreciation of the dynamism of the scientific process.

E. Illustrates the usefulness of mathematics in scientific description and reasoning.

In *Energy in Everyday Life* students are immediately exposed to the notion that mathematics is an essential component for scientific inquiry. All 21 of the Discovery Labs - a digital manipulative originally funded by the Mary Lou Fulton Teachers College and ASU Online - train students how to make a reasonable order of magnitude estimate to a complex question. This is one of the motivations in designing this an "SQ" course.

F. Includes weekly laboratory and/or field sessions that provide handson exposure to scientific phenomena and methodology in the discipline, and enhance the learning of course material.

Students in *Energy in Everyday Life* are assigned laboratory exercises each week that require them to investigate key science concepts in an iterative, inquiry driven manner. In a typical weekly exercise, students develop a hypothesis at the outset of the exercise. They then obtain (realistic) data or make observations to test their hypothesis and possibly modify their hypothesis. Cumulatively, the Discovery Labs compel students to revisit conclusions in light of new information/data, highlighting the iterative nature of scientific inquiry. A critical aspect of most of these exercises is that they are computer-based and collaborative.

G. Students submit written reports of laboratory experiments for constructive evaluation by the instructor.

Students in *Energy in Everyday Life are* required to submit weekly lab reports that include answering questions about the labs, giving statements of their hypotheses, a description of their methods, presentation of data obtained or generated, an analysis of the data, and summarizing their results. A correct invalidation of a flawed hypothesis be considered as meritorious as validation of a correct one. These digital reports are assessed by the TAs and/or the instructor.

H. Course is general or introductory in nature, ordinarily at lowerdivision level; not a course with great depth or specificity.

Energy in Everyday Life is a transdisciplinary scientific survey of the many ways that energy weaves throughout both scientific inquiry and the natural world. As such it gives students an introduction to a variety of scientific fields and content knowledge, with an emphasis on the dynamics of the scientific process. Beyond examining practices common to many scientific disciplines, the course also emphasizes the interconnectedness of the natural worlda much broader focus than most introductory science courses, which focus inquiry through a disciplinary lens.

II. At least one of the following additional criteria must be met

A. Stresses the understanding of the nature of basic scientific issues.

Energy in Everyday Life provides students with insights into several basic scientific issues because it is organized around an ongoing transdisciplinary endeavor. As such, students leave the course with a better mastery of the nature of science and the goals of scientific research than is typical of introductory science courses. This course also emphasizes the interconnections between physics, chemistry, life sciences, geoscience, economics, environmental science and sustainability science, and highlights how these disciplines work together to attack the global issues of energy and the local issues of energy in daily life. Hence, *Energy in Everyday Life* stresses the transdisciplinary nature of modern day science.

As a result of working through the Units in *Energy in Everyday Life*, students arrive at an mastery of basic scientific content and process issues such as how to reduce bias, effectively communicate results, and the reality of uncertainty in leading-edge science.

B. Develops appreciation of the scope and reality of limitations in scientific capabilities.

From the beginning, students in *Energy in Everyday Life*, develop an appreciation for the scope and limitations in scientific capabilities. For example, in Unit 1 students learn that we don't know what energy "is". We can describe it quantitatively, how it is transported from one form to another, but not what it "is" at fundamental level. They also learn about the techniques that re currently using to tackle new challenges, and the limitations in these cutting-edge capabilities. For example, in learning about how we generate and store energy for everyday life, students learn about the difficulties in storing the massive amounts of energy needed by modern civilization and hence the need for alternative methods of transmission and improvements in storage devices. Students are taught the basic methods by which we store energy capacitors, inductors, and batteries and the basic physics and electrical engineering underlying these technologies. Through this knowledge they gain an appreciation of the limitations of these devices. They learn about ongoing efforts to significantly alter these devices or do away with them altogether that overcome the limitations of existing technologies.

C. Discusses costs (time, human, financial) and risks of scientific inquiry.

The *Energy in Everyday Life* course does not specifically address this topic. However, the course touches upon the financial costs of fuel sources and the infrastructure to support those sources (e.g., electrical charging stations for cars instead of gas stations); the possible societal risks associated with alternative fuel sources; and the time it may take before we generate useable amounts of energy from some alternative fuel sources (e.g., fusion reactors).

III. Additional Criteria

A. Provides a substantial, quantitative introduction to fundamental principles governing behavior of matter and energy, in physical or biological systems.

The primary focus of *Energy in Everyday Life* is the centrality of energy in the natural world, scientific inquiry, and everyday life. Students engage the topic quantitatively in Unit 1 (Mechanics), Unit 2 (Chemistry), Unit 3 (Chemistry and Thermodynamics), Unit 4 (Thermodynamics and Nuclear), Unit 5 (Nuclear), Unit 6 (Electrical), and Unit 7 (Electrical and Alternatives).

B. Includes a collegelevel treatment of some of the following topics: a. Atomic and molecular structure

Related to *Energy in Everyday Life*'s treatment of electromagnetic radiation is the important idea that matter interacts with radiation. In Unit 2 and 4 students learn that the exact nature of this interaction is determined by atomic and molecular structure up to energies characteristic of x-rays. As a result, students learn that many physical properties composition, temperature, density, color, speed, and rotation can be determined from spectra. Also in Unit 4, students learn that the molecular structures of atmospheric gases determine why some gases absorb infrared radiation, leading to planetary warming (the greenhouse effect), while other gases do not. As a practical example of the interaction between matter and energy, in Unit 6 students learn how a microwave oven operates.

b. Electrical processes

Students in *Energy in Everyday Life* encounter electrical processes in Unit 6 within the context of energy transport, storage and conversion. For example, students master elementary aspects of electromagnetics, generators, and motors. Also in Unit 6, students learn about losses and efficiencies as part of the discussion on energy transport and the electrical grid. In Unit 7 students learn additional components of electrical processes (potential differences, electrons, holes, etc) during the discussion on photovoltaics and wind energy turbines.

c. Chemical processes

The driving force for chemical processes is the release or absorption of energy during chemical reactions. In Unit 2 of *Energy in Everyday Life* students learn this concept through energetic considerations of organisms to perform photosynthesis and respiration; and how much energy it takes to create water from hydrogen and oxygen. In Unit 4 students explore the interchange between chemical energy and mechanical energy in heat engines. In Unit 6, students learn chemical energy release and absorption within the context of the storage of energy within batteries.

d. Elementary thermodynamics

In *Energy in Everyday Life* the conservation of energy is a recurring theme. Students are introduced to the 1st Law of Thermodynamics in Unit 4, and conservation of energy appears repeatedly in several Units. For example, In Unit 4 students learn about the inevitable energy losses from an idealized heat engine. Elementary thermodynamics also plays a large role in Unit 7 when when students explore potential alternative energy generation technologies.

e. Electromagnetics

The emission and absorption of radiation is a major topic in *Energy in Everyday Life* because it is fundamental to the transport of energy. In Unit 4 students become qualitatively and quantitatively familiar with thermal radiators (e.g., Planck function, Wien's Law, etc) and spectra (wavelength, frequency, speed of light, etc). In Unit 7 students learn about the absorption of energy from photons to generate electricity.

f. Dynamics and mechanics

In *Energy in Everyday Life* students encounter Newtonian mechanics in Unit 1 when work, energy, and power are given their definitions. In Unit 6 students master the Newtonian mechanics of hydroelectric power. In Unit 7 students revisit the topic when examining wind power generation.