(UGC Final Copy)

ARIZONA STATE UNIVERSITY
PROPOSAL TO ESTABLISH A NEW GRADUATE DEGREE

This template is to be used only by programs that have received specific written approval from the Provost's office to proceed with internal proposal development and review. A separate proposal must be submitted for each individual new degree program.

DEGREE PROGRAM

College/School(s) offering this degree: Ira A. Fulton Schools of Engineering

Unit(s) within college/school responsible for program: School of Multi-Scale Science and Engineering: Mechanical, Aerospace, Chemical & Materials Engineering

If this is for an official joint degree program, list all units and colleges/schools that will be involved in offering the degree program and providing the necessary resources: not applicable

Proposed Degree Name: Professional Science Master's in Solar Energy Engineering and Commercialization

Master's Degree Type: Select Masters Degree Type

Doctoral Degree Type: Select Doctoral Degree Type

If Degree Type is Other, provide proposed degree type: Professional Science Master's
and proposed abbreviation: PSM

Proposed title of major: Solar Energy Engineering and Commercialization

Is a program fee required? Yes ☒ **No** ☐ (*program fee approved by ABOR on March 11, 2010)*

Requested effective term: Fall and year: 2010
(The first semester and year for which students may begin applying to the program.)

PROPOSAL CONTACT INFORMATION

(Person to contact regarding this proposal)

Name: Patrick Phelan **Title:** Professor & MACME Graduate Program Chair

Phone: 480-965-1625 **email:** phelan@asu.edu

DEAN APPROVAL

This proposal has been approved by all necessary unit and College/School levels of review, and the College/School(s) has the resources to offer this degree program. I recommend implementation of the proposed degree program. (*Note: An electronic signature, an email from the dean or dean's designee, or a PDF of the signed signature page is acceptable.*)

College Dean Name:

College Dean Signature __(see next sheet)__________________________ **Date:** __________

College Dean name:
(If more than one college involved)
College Dean Signature ____ **Date:** __________

Academic Unit Dean Approval Signature Page

DEAN APPROVAL

This proposal has been approved by all necessary unit and College/School levels of review, and the College/School(s) has the resources to offer this degree program. I recommend implementation of the proposed degree program. (*Note: An electronic signature, an email from the dean or dean's designee, or a PDF of the signed signature page is acceptable.*)

College Dean Name: Deirdre R. Meldrum

College Dean Signature ______________ **Date:** 3-19-10

Paul C. Johnson, Executive Dean

College Dean name:

(If more than one college involved)

College Dean Signature ______________ **Date:** ________

ARIZONA STATE UNIVERSITY
PROPOSAL TO ESTABLISH A NEW GRADUATE DEGREE

This proposal template should be completed in full and submitted to the University Provost's Academic Council [mailto:curriculum@asu.edu]. It must undergo all internal university review and approval steps including those at the unit, college, and university levels. A program **may not** be implemented until the Provost's Office notifies the academic unit that the program may be offered.

DEGREE PROGRAM INFORMATION

Master's: Select Masters Degree Type

Doctoral: Select Doctoral Degree Type

If Degree Type is Other, provide proposed degree type: Professional Science Master's
and proposed abbreviation: PSM

Proposed title of major: Solar Energy Engineering and Commercialization

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1. PURPOSE AND NATURE OF PROGRAM

A. Brief program description (This is a catalog type description of no more than 250 words. Include the distinctive features of the program that make it unique. Do not include program or admission requirements.)

The Professional Science Master's in Solar Energy Engineering & Commercialization offers advanced, interdisciplinary education in solar energy to students with backgrounds in science, technology, engineering, or mathematics (STEM). The objective of the program is to enable graduates to pursue careers in industry, government, or the nonprofit sector that involve solar energy and its utilization. Students in the program must select courses from both technical and nontechnical tracks, including solar energy policy, spanning a number of academic programs and schools. Opportunities exist for engagement with the solar energy industry and/or government policymakers, leading to a required culminating applied research project. The degree program is meant to be completed in 12 months for full-time students.

B. Total credit hours required for the program: 30

C. Are any concentrations to be established under this degree program? ☐ Yes ☒ No

2. PROGRAM NEED. Explain why the university needs to offer this program (include data and discussion of the target audience and market).

Solar energy is arguably the most important type of sustainable (i.e., renewable) energy for the State of Arizona, given our location at the heart of the greatest solar resource in the USA. At present, although there are a number of solar-energy-related courses at ASU, including courses in electrical engineering, mechanical & aerospace engineering, alternative energy technologies (ASU Poly), and architecture & landscape architecture, there is no existing graduate program that integrates this interdisciplinary field into a single graduate degree.

Given the nature of the technical and nontechnical (e.g., social, behavioral, policy, regulatory) challenges facing solar energy projects, it is essential to provide education in both technical and nontechnical aspects. Therefore, we are proposing a novel Professional Science Master's (PSM) degree, which will become one of several PSM degrees already offered by ASU (see http://psm.asu.edu/). To our knowledge, such a PSM degree that focuses on solar energy does not exist at any other institution. In fact, our proposed PSM degree program is the subject of a pending NSF (National Science Foundation) proposal submitted in November 2009 (ASU proposal # 10046292).

Why does ASU need to offer this new degree program? First of all, ASU has profound interests in solar energy research, through the ASU Solar Initiative (http://solar.asu.edu/index.shtml), but to date no corresponding dedicated solar energy education programs have apparently been developed. There is great interest in solar energy within the State of Arizona, judging by the creation of a Solar Energy Advisory Task Force by Governor Brewer on 1/5/2010 that directs state agencies and universities to coordinate planning efforts for renewable-energy projects, including solar. At the state and national level, solar energy holds the potential for significant job creation. The predicted number of renewable-energy jobs by 2030 (including solar) ranges from 1.3 million to 7.3 million (American Solar Energy Society, 2009). Recently, President Obama stated "To finally spark the creation of a clean energy economy, we will double the production of alternative energy in the next three years" (Obama speech at George Mason University on 1/8/2010).

A brief needs assessment of the proposed PSM in Solar Energy Engineering & Commercialization was conducted for the pending NSF proposal mentioned above. In this needs assessment, Dr. Susan Haag of the ASU Center for Research on Education in Science, Mathematics, Engineering, and Technology (CRESMET) contacted representatives from APS, SRP, Abengoa Solar Inc., and EnviroMission (USA) Inc. to discuss their hiring needs in solar energy. For prospective employees in this field, a particularly important need was found for training in technical and non-technical areas and in project economics, project management and development, and entrepreneurship. In response to this needs assessment, all these elements are thus incorporated into the proposed PSM program.

Finally, similar to other PSM programs the target audience is individuals with a BS in a STEM field, and who desire a graduate degree that does not necessarily lead on to a PhD, nor do they want an MBA. Rather, these students seek a technically oriented Master's Degree that includes a considerable amount of nontechnical course material. For this particular degree program, our specific target audience are those individuals with a strong interest in solar energy, and who want more than just a technical education in solar energy.

3. **IMPACT ON OTHER PROGRAMS.** List other academic units that might be impacted by the proposed program and describe the potential impact (e.g., how the implementation of this program might affect student headcount/enrollment, student recruitment, faculty participation, course content, etc. in other programs). Attach letters of collaboration/support from impacted programs.

We do not believe that the proposed PSM degree will impact any other programs. The majority of the elective courses available for the degree program are already being offered by their respective programs. Note that at the time of the submission of the NSF proposal, a total of 21 ASU faculty agreed to participate in the program. These faculty represent the Fulton Schools of Engineering, School of Sustainability, School of Geographical Sciences & Urban Planning, School of Architecture & Landscape Architecture, WP Carey School of Business, Center for Research on Education in Science, Mathematics, Engineering and Technology (CRESMET), the Consortium for Science, Policy & Outcomes (CSPO), & the Lincoln Center for Applied Ethics.

4. **PROJECTED ENROLLMENT** How many new students do you anticipate enrolling in this program each year for the next five years? Please utilize the following tabular format.

5-YEAR PROJECTED ANNUAL ENROLLMENT					
	1st Year	**2nd Year** (Yr 1 continuing + new entering)	**3rd Year** (Yr 1 & 2 continuing + new entering)	**4th Year** (Yrs 1, 2, 3 continuing + new entering)	**5th Year** (Yrs 1, 2, 3, 4 continuing + new entering)
Number of Students Majoring (Headcount)	10	20	30	30	30

5. **STUDENT LEARNING OUTCOMES AND ASSESMENT**
   A. **List the knowledge, competencies, and skills** students should have when they graduate from the proposed degree program. (You can find examples of program Learning Outcomes at (http://www.asu.edu/oue/assessment.html).

Students must have the following knowledge, competencies, and skills:
- All students must acquire a thorough understanding of the theoretical foundations for solar energy conversion, including solar electric and solar thermal processes.
- All students must acquire a thorough understanding of policy and regulatory issues that impact solar energy.
- All students must acquire skills necessary to conduct research in some aspect of solar energy.
- All students must acquire skills in effective professional communication.

   B. **Describe the plan and methods to assess** whether students have achieved the knowledge, competencies and skills identified in the Learning Outcomes. (You can find examples of assessment methods at (http://www.asu.edu/oue/assessment.html).

Students will be assessed via the following mechanisms:
- Students will receive thorough evaluations of individual assignments and exams in all required and elective courses in the degree.
- Students will be required to complete an applied research project on some aspect of solar energy, including the preparation of a written report and oral presentation.

6. **ACCREDITATION OR LICENSING REQUIREMENTS (if applicable).** Provide the names of the external agencies for accreditation, professional licensing, etc. that guide your curriculum for this program, if any. Describe any requirements for accreditation or licensing.
   None required.

7. **FACULTY, STAFF AND RESOURCE REQUIREMENTS**
   A. **Faculty**
      i. **Current Faculty.** List the name, rank, highest degree, area of specialization/expertise and estimate of the level of involvement of all current faculty who will teach in the program.

Patrick Phelan (Mechanical, Aerospace, Chemical & Materials Engineering and Affiliate Faculty, School of Sustainability), Professor & Graduate Program Chair, PhD, thermofluid sciences and sustainable energy, full participant

Rimjhim Aggarwal (Global Institute of Sustainability), Assistant Professor, PhD, economics and sustainability, full participant

Harvey Bryan (Architecture & Landscape Architecture & Affiliate Faculty, School of Sustainability), Professor, PhD, solar energy and the built environment, full participant

Susan Haag (Center for Research on Education in Science, Mathematics, Engineering, and Technology), Associate Research Professional, PhD, performance assessment and project evaluation, full participant

Christiana Honsberg (Electrical, Computer, & Energy Engineering), Professor, PhD, solar photovoltaics, full participant

Tim James (L. William Seidman Research Institute, WP Carey School of Business), Research Professor, Economics and Director of Research and Consulting, PhD, economics and renewable energy, full participant

George Maracas (Electrical, Computer, & Energy Engineering & School of Sustainability), Research Professor, PhD, solar energy systems

Clark Miller (School of Politics and Global Studies), Associate Professor, Associate Director, Consortium for Science, Policy & Outcomes, & Director, PSM in Science and Technology Policy, PhD, science, technology, & globalization, full participant

David Nielsen (Mechanical, Aerospace, Chemical, & Materials Engineering), Assistant Professor, PhD, bio-based fuels from renewable resources, full participant

Martin (Mike) Pasqualetti (School of Geographical Sciences & Urban Planning), Professor, PhD, renewable energy policy

Jonathan Posner (Mechanical, Aerospace, Chemical & Materials Engineering), Assistant Professor, PhD, micro/nanofluids and science policy, full participant

T. Agami Reddy (Architecture & Landscape Architecture & School of Sustainability), Professor, PhD, thermofluids and sustainable energy, full participant

Ron Roedel (Electrical, Computer, & Energy Engineering), Professor, PhD, solar photovoltaics, full participant

G. (Mani) Tamizhmani (CTI Electronic Systems), Clinical Professor & President, TÜV Photovoltaic Testing Laboratory, PhD, solar photovoltaics testing, full participant

Steve Trimble (Mechanical, Aerospace, Chemical, & Materials Engineering), Professor of Practice, PhD, technology & business of sustainable energy systems, full participant

Jameson Wetmore (School of Human Evolution & Social Change & the Consortium for Science, Policy and Outcomes), Assistant Professor, PhD, science, technology, ethics and public policy, full participant

Yong-Hang Zhang (Electrical, Computer, & Energy Engineering), Professor, PhD, optoelectronic devices, full participant

Stephen Goodnick (Electrical, Computer, & Energy Engineering), Professor & Director, Arizona Institute for Renewable Energy, PhD, solid-state devices, partial participant

Jeffrey Goss (Ira A. Fulton Schools of Engineering Global Outreach & Extended Education), Assistant Dean, MA, professional and executive education, partial participant

Joseph Herkert (School of Applied Arts and Sciences), Lincoln Associate Professor of Ethics and Technology, PhD, social, ethical & policy implications of engineering, partial participant

Kyle Squires (Mechanical, Aerospace, Chemical, & Materials Engineering), Professor and Director, PhD, fluid mechanics, partial participant

ii. **New Faculty.** Describe the new faculty hiring needed during the next three years to sustain the program. List the anticipated hiring schedule and financial sources for supporting the addition of these faculty.

One non-tenure research faculty member, the Program Manager, will be hired to administer the day-to-day operations of the program. This faculty member will be supported initially by the NSF grant (if awarded), and afterwards by the program fees.

iii. **Administration of the program.** Explain how the program will be administered for the purposes of admissions, advising, course offerings, etc. Discuss the available staff support. As described above, day-to-day operations of the program will be administered by the Program Manager, with overall direction provided by the MACME Graduate Program Chair. Admissions decisions, advising, and the coordination of course offerings will be done by these two faculty members, in consultation with the other participating faculty. An administrative assistant and a part-time program evaluator will be supported by the program fees.

B . Resource requirements to launch and sustain the program. Describe any new resources required for this program's success such as new staff, new facilities, new library resources, new technology resources, etc The program requires significant new resources to be successful, therefore a program fee has been requested. These resources include the Program Manager, administrative assistant, and part-time program evaluator described above. Two graduate teaching assistants will be hired to work with faculty to offer the highest-quality courses, including online courses, and to develop and maintain the program website. The program also requires resources to support visitors from the solar energy community, who will give guest lectures and interact with the students in their courses and in their applied research projects, materials and supplies for teaching, and travel to support recruiting of the highest caliber students. The program will require resources to support the required summer travel to Washington DC, organized to allow the students to engage with solar energy policymakers. Finally, additional resources are necessary for the applied research projects, in the form of experimental equipment, materials, supplies, software, etc. These requirements are described in greater detail in the request for a special program fee for program students that would cover all of these additional resources.

8. CURRICULAR STRUCTURE OF THE PROPOSED PROGRAM

A. Admission Requirements The requirements listed below are Graduate College requirements. Please modify and/or expand if the proposed degree has additional admissions requirements.

i. **Degree.** Minimum of a bachelor's degree (*or equivalent*) or a graduate degree from a regionally accredited College or University of recognized standing in a related field such as science, technology, engineering, or mathematics (STEM).

Modify or expand, if applicable: Students are expected to enter the program with a strong technical foundation, as measured by holding a bachelor's degree in any physical science, technology, engineering or mathematics field.

ii. **GPA.** Minimum of a 3.00 cumulative GPA (scale is 4.0=A) in the last 60 hours of a student's first bachelor's degree program Modify or expand, if applicable:

iii. **English Proficiency Requirement for International Applicants.** If applicable list any English proficiency requirements that are higher than and/or in addition to the Graduate College requirement. (See Graduate College policy and procedures http://graduate.asu.edu/admissions/international.html#proficiency):

iv. **Required Admission Examinations.**

☒GRE ☐GMAT ☐Millers Analogies ☐None Required

v. **Application Review Terms.** Indicate all terms for which applications for admissions are accepted and the corresponding application deadline dates, if any:

☒ Fall Deadline (month/year): Jan 31

☒ Spring Deadline (month/year): Oct 30

☐ Summer Deadline (month/year):

B. Degree Requirements. Below provide the curricular requirements for the proposed degree program.

i. ***Total credit hours (cr hrs) required for the degree program**:* 30

ii. **Core courses.** List all required core courses and total credit hours for the core (required courses other than internships, thesis, dissertation, capstone course, etc)**.** Omnibus number courses can not be used as core courses. Permanent numbers must be requested by submitting course proposal to ACRES for approval.

***Total cr hrs for required core courses**:* 9

Course prefix & number	Course title	Credit hours	New course?
EEE 565	Solar Cells	3	Y ☒ N ☐
MAE 580	Solar Energy Colloquium	3	Y ☒ N ☐
GCU/ PUP 549	Solar Energy & Public Policy	3	Y ☒ N ☐

(Please expand table as needed. Right click in white space of last cell. Select "Insert Rows Below")

iii. **Elective Courses**

***Total cr hrs for program electives**:* 15

Provide a sample list of elective courses:

Course prefix & number	Course title	Credit hours	New course?
EEE 598	Advanced Solar Cells	3	Y ☐ N ☒
ALT 535	Applied Photovoltaics	3	Y ☐ N ☒
MAE 598	Solar Thermal Engineering	3	Y ☐ N ☒
SOS 516	Science, Technology & Public Affairs	3	Y ☐ N ☒
EEE 591	Fundamentals of Solid State Devices	3	Y ☐ N ☒
ATE 550	Passive Heating and Cooling	3	Y ☐ N ☒
ALT 507	Evaluations of Photovoltaic and Fuel Cell Systems	3	Y ☐ N ☒
ALT 598	Reliability, Standards and Codes of Alternative Energy Technologies	3	Y ☐ N ☒
EEE 537	Fundamentals of Optoelectronics	3	Y ☐ N ☒
FSE 501	Technology Entrepreneurship	3	Y ☐ N ☒
SOS 516	Science, Technology, and Public Affairs	3	Y ☐ N ☒
GPH 598	Energy and the Environment	3	Y ☐ N ☒

GCU 598	Solar Energy and Sustainability	3	Y ☐ N ☒
HSD 598	Ethical Issues in Science and Technology	3	Y ☐ N ☒
HSD 610	Human and Social Dimensions of Science and Technology Colloquium	3	Y ☐ N ☒
SCM 587	Project Management	3	Y ☐ N ☒
MKT 591	Business to Business Marketing	3	Y ☐ N ☒
MGT 590	Adv. Entrepreneurship: Business Plan Creation	3	Y ☐ N ☒
LES 591	Intellectual Property	3	Y ☐ N ☒
ECN 591	Globalization, Business, & Economic Policy	3	Y ☐ N ☒

(Please expand table as needed. Right click in white space of last cell. Select "Insert Rows Below")

iv. **400-Level Courses.** No more than 6 credit hours of 400-level coursework can be included on graduate student program of study.

1. Are 400-level ASU courses allowed on student program of study for this degree? . ☐ Yes ☒ No

2. If yes, how many credit hours?

v. **Additional Requirements (if applicable).** Provide a brief description of any additional requirements (e.g. internships, clinicals, field study, etc.**)** not applicable

Total cr hrs for other required courses: 0

List course info for any additional requirements (e.g. internships, clinicals, field study, etc.)

Course prefix & number	Course title	Credit hours	New course?
			Y ☐ N ☐
			Y ☐ N ☐
			Y ☐ N ☐

(Please expand table as needed. Right click in white space of last cell. Select "Insert Rows Below")

vi. ***Total cr hrs required for research and/or other elective courses per student's research area (if applicable)***: 0

vii. **Culminating experience** for the proposed program (please check all that apply and provide requested information):

	Required?	Brief description of the applied project or the capstone course, as applicable.	Course prefix and number	Credit hours
Thesis **(master's only)**	☐			
Applied Project **(master's only)**	☒	Research project on solar energy, leading to a short written report and oral presentation	MAE 593	6
Capstone course **(master's only)**	☐			
Dissertation **(doctoral only)**	☐			

(Please expand table as needed. Right click in white space of last cell. Select "Insert Rows Below")

viii. **If applicable, provide the following information about any concentration(s) associated with this degree program**. Please attach a sample program of study with timeline for each concentration listed below.

I. **Concentration name**: not applicable,

Total cr hrs for the courses required for the proposed concentration: 0

List all required concentration courses:

Course prefix & number	Course title	Credit hours	New Course?
			Y ☐ N ☐

ix. Master's program comprehensive exams, please check all that apply (Please note: for doctoral programs, a written and an oral comprehensive exam are required.)

☐ Written comprehensive exam required

☐ Oral comprehensive exam required

☒ No comprehensive exam required

x. For Doctoral Degrees, indicate the Master's Degree Credit Allowance: If approved by the student's supervisory committee, does the program allow up to 30 credit hours from a previously awarded master's degree to count towards the degree requirements for this doctoral program? ☐Yes or ☐No

xi. Committee: Required Number of Thesis or Dissertation Committee Members (must be at least 3 including chair or co-chairs): not applicable

xii. Foreign Language Exam.

Foreign Language Examination(s) required? ☐Yes ☒No

If yes, list all foreign languages required:

xiii. Course Prefix(es) Provide the following information for the proposed graduate program.

a. Will a new course prefix(es) be required for this degree program?
Yes ☐ No ☒

b. If yes:

- Complete the New Prefix Request Form for each new prefix. This form can be located on the Office of the Executive Vice President and Provost of the University Curriculum Development website at <http://provost.asu.edu/curriculum>.
- Submit the completed form to Nancy Kiernan at <nkiernan@asu.edu> in the Office of the Executive Vice President and Provost of the University.

xiv. New Courses Required for Proposed Degree Program. Provide course prefix, number, title, and credit hours and description for any new courses required for this degree program.
MAE 580 Solar Energy Colloquium (3) Discussion-oriented class focusing on topical issues in solar energy. Pre-requisites: undergraduate course in thermodynamics, or instructor approval.

GCU 549/PUP 549 Solar Energy & Public Policy (3) The relationships between research and development of a broad spectrum of solar energy resources, concentrating on the interplay between technology and society in the formation and success of public policy in the US and abroad. Field Trip. Fee.

EEE 565 Solar Cells (3) Introduction to the generation and utilization of electricity from solar energy. Exploration of the science and engineering of direct conversion (photovoltaics), including the design, fabrication, and operation of solar cells, and the construction and performance of solar cell modules.