IRAO OFFICE USE ONLY	
Received	1/25/17
In Banner	
MTVCOMP/Codeset	
Master Curriculum	
CIP Code	14.9999
Program Code	EE-GCER-REIS
Program Description	EE-Energy & Sustainability GCER

University of Hawai'i
Code Request Form for Academic Programs for

NEW OR MODIFY PROGRAM CODE

Reset Form

☑ **New Program Code** ☐ **Modify Program Code** Date: January 18, 2017

REQUESTOR CONTACT INFORMATION

Name: Stuart Lau
Title: University Registrar
Office/Dept: Office of the Registrar
Campus: UH Manoa
Email: stuartl@hawaii.edu
Phone: 956-5322

NEW PROGRAM CODE TO CREATE

Institution: MAN - UH Manoa
Level: GR - Graduate
Campus: MAN - UH Manoa
Effective Term: Fall 2015

	Code (Max. Characters)	Description	Check if requesting new code:
College	(2) 50	Graduate Division	☐ See Banner form STVCOLL
Department	(4) EE	Electrical Engineering	☐ See Banner form STVDEPT
Degree/Certificate	(6) GCER	Graduate Certificate	☐ See Banner form STVDEGC
~~Major~~ Concentration	(4) REIS	Energy & Sustainability	☑ See Banner form STVMAJR
~~Concentration~~ Major	(4) EE	Electrical Engineering	☐ See Banner form STVMAJR
Minor	(4)		☐ See Banner form STVMAJR

If a similar major/concentration code exists in Banner, please list the code:

Justification to warrant a new major/concentration code similar to an existing major/concentration code:

Is this major/concentration code being used the same way at the other UH campuses? ☐ Yes ☐ No

Should this program be available for applicants to select as their planned course of study on the online application? *If yes, student may select the code as their only program of study.* ☑ Yes ☐ No

RULES PERTAINING TO FINANCIAL AID AND 150% DIRECT SUBSIDIZED LOAN LIMIT LEGISLATION

Is 50% or greater of the classes in this program offered at a location other than the Home Campus? ☐ Yes ☑ No

Is this program/major/certificate financial aid eligible? ☐ Yes ☑ No

Does this certificate qualify as a Gainful Employment Program (Title IV-eligible certificate program)? ☐ Yes ☑ No
See http://www.ifap.ed.gov/GainfulEmploymentInfo/index.html

Program Length
In academic years; decimals are acceptable. The length of the program should match what is published by the campus in any online and/or written publication. 30 weeks

Special Program Designations ☐ A ☐ B ☑ N ☐ P ☐ T ☐ U
See Special Program Designations Code Definitions on IRAO Program Code Request webpage

Required Terms of Enrollment: ☑ Fall ☑ Spring ☐ Summer ☐ Extended

University of Hawai'i
Code Request Form for Academic Programs

NEW OR MODIFY PROGRAM CODE

ADDITIONAL COMMENTS

ATTACHMENTS

BOR Approved: Associate, Bachelor and Graduate Degrees, and sole credential certificates

☐ BOR Meeting Minutes & Supporting Documents ☐ Curriculum

Chancellor Approved: Certificates related to authorized BOR program & Associate in Technical Studies (ATS) Degree

☑ Memo from Chancellor to notify VPAA about new program ☐ Curriculum

For new certificates approved by the Chancellor, the related BOR authorized academic program is:
MS in Electrical Engineering

VERIFICATIONS

By signing below, I verify that I have reviewed and confirm the above information that is pertinent to my position.

Registrar:

Stuart Lau		1/18/17
Print Name	Signature	Date

Financial Aid Officer:

Jodie Kuba		1/23/2017
Print Name	Signature	Date

For Community Colleges, verification of consultation with OVPCC Academic Affairs:

Print Name	Signature	Date

UNIVERSITY of HAWAI'I SYSTEM

Stuart Lau <stuartl@hawaii.edu>

Re: Renewable Energy and Island Sustainability

1 message

Song K Choi <schoi@hawaii.edu> Fri, Dec 9, 2016 at 4:13 PM
To: Stuart Lau <stuartl@hawaii.edu>

Aloha e Stuart,

Thank you for taking care of this. I've inserted answers below. Thanks.

Mele Kalikimaka a me Hau'oli Makahiki Hou!!! God Bless.

SKC

On Tue, 6 Dec 2016, Stuart Lau wrote:

> Hi Song,
>
> Sorry, dropped the ball on getting the code created in Banner. Would you be able to assist with the following questions:
>
> 1. What department is the program assigned to?

Hmmm. It would be an EE (electrical engineering)...

> 2. Is it ok to identify the program with the code "REIS"

Yes, it would be best...

> 3. The major description is limited to 30 characters. Currently, "Renewable Energy and Island Sustainability" is 42 characters. Any preferences to shorten to 30 characters.

Energy & Sustainability (how's this?)

> 4. How long is the program in semesters?

The REIS certificate program is generally no longer than two semesters, but it depends on the students pace in taking the recommended courses. As it needs both ME (mechanical) and EE (electrical) courses to broaden the knowledge-base for the students, it may be more tedious than people perceive a certificate to encompass.

> 5. On the transcript, a comment is printed on the transcript indicating that the certificate is awarded. The comment is limited to 50 characters and is printed in the format "GCERT in Renewable Energy & Island Sustainability mm/dd/yy". 8 characters would need to be removed.

GCERT in Renewable Energy, Sustainability

> Your assistance with these questions are appreciated.
>
> Thanks,
> Stuart

--
****
Stuart Lau
University Registrar
Office of the Registrar

University of Hawaii at Manoa
Ph: 808 956-8010
****

c: Stuart Lau (Registrar), Lisa Imai (Banner), Diane Nakshima (Catalog) DT 6274

Office of the Vice Chancellor for Academic Affairs

UNIVERSITY of HAWAI'I® MĀNOA

March 11, 2015

MEMORANDUM

TO: Robert Bley-Vroman
Chancellor

FROM: Reed Dasenbrock
Vice Chancellor for Academic Affairs

SUBJECT: REQUEST TO APPROVE THE GRADUATE CERTIFICATE IN RENEWABLE ENERGY AND ISLAND SUSTAINABILITY

SPECIFIC ACTION REQUESTED:
It is requested that the Chancellor approve the interdisciplinary Graduate Certificate in Renewable Energy and Island Sustainability, to be administered by the College of Engineering (lead), with support from the Colleges and Schools of Social Sciences, Natural Sciences, Ocean and Earth Science and Technology, Architecture, and Tropical Agriculture and Human Resources.

EFFECTIVE DATE:
Fall 2015.

ADDITIONAL COST:
None.

PURPOSE:
The proposed Graduate Certificate in Renewable Energy and Island Sustainability (REIS) is designed to provide responsive and dynamic training coupled with foundational research-based curricula in the areas of clean energy technologies, renewable energy production, storage, integration, smart grid technologies, and renewable energy policy issues.

BACKGROUND INFORMATION:
UH Executive Policy E5.205 grants the Chancellor the authority to approve certificate programs in specific subjects that represent recognition of work taken within (or among) existing Board-authorized programs.

The proposed Graduate Certificate in REIS will train students to have a broad, cross-disciplinary knowledge of clean energy and related sustainability issues. The multi-disciplinary REIS faculty are drawn from the Colleges and Schools of Engineering,

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Honolulu, Hawai'i 96822
Telephone: (808) 956-8447
Fax: (808) 956-7115

Social Sciences, Natural Sciences, Architecture, Ocean and Earth Science and Technology, Tropical Agriculture and Human Resources, Law, and Business.

The 15-credit program includes formal and foundational coursework, labs, and group research projects. Students will also have opportunities to support and interact with a broad base of clean energy industry personnel (from utilities, Department of Defense, transportation, and tourism industries) via information exchanges, internships with industry and government laboratories, and outreach with the community. It is anticipated that through this program, a large number of students will be exposed to clean energy opportunities, thereby generating a sustainable pool of graduates to provide a much-needed workforce for Hawai'i and the U.S. as the electric power sector transforms from heavy reliance on fossil-based fuels to clean energy alternatives and a smart-grid future. Information on the curriculum and learning outcomes, as well as numerous letters of industry support, may be found in the attached program proposal.

The proposed program has been reviewed and recommended for approval by the Office of Graduate Education, the Graduate Council, and the Mānoa Faculty Senate. My staff and I have also reviewed the proposal, and we recommend your approval.

ACTION RECOMMENDED:
It is requested that the Chancellor approve the Graduate Certificate in Renewable Energy and Island Sustainability, to be effective Fall 2015.

APPROVED / DISAPPROVED

Robert Bley-Vroman
Chancellor

3/13/15
Date

Attachments

c: Vice President for Academic Affairs Dickson
Interim Vice Chancellor and Dean Taylor
Dean Aune
Dean Crouch
Dean Ditto
Dean Friedman
Dean and Director Gallo
Dean Konan
Dean Roley
Dean Soifer
Professor Kuh
Program Officer Pearson

UNIVERSITY of HAWAI'I MĀNOA

MĀNOA FACULTY SENATE

February 20, 2015

MEMORANDUM VIA E-MAIL

TO: Randolph G. Moore, Chair
Board of Regents

Reed Dasenbrock, Vice Chancellor for Academic Affairs
University of Hawai`i at Mānoa

FROM: Ron Bontekoe, Chair
Mānoa Faculty Senate

RE: **Resolution for a Graduate Certificate Program in Renewable Energy and Island Sustainability (REIS)**

The Mānoa Faculty Senate approved the **Resolution for a Graduate Certificate Program in Renewable Energy and Island Sustainability (REIS)** at the February 18, 2015 Senate meeting with 34 votes in favor, 5 in opposition and 5 abstained. The resolution is attached.

The Committee on Research and Graduate Education reviewed this issue and provided a report to the Senate at the February 18, 2015 Senate meeting.

Please feel free to contact me if you have any questions or need additional information.

Ron Bontekoe

Ron Bontekoe, Ph.D., Mānoa Faculty Senate Chair

Travelling (RB)

Ashley Maynard, Ph.D., Mānoa Faculty Senate Secretary

UNIVERSITY OF HAWAI'I AT MĀNOA FACULTY SENATE
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Presented to the Mānoa Faculty Senate by the Committee on Research and Graduate Education on February 18, 2015 for a Senate vote. The resolution was approved by the Manoa Faculty Senate on February 18, 2015 with 34 votes in favor of approval, 5 votes in opposition and 5 votes abstained.

RESOLUTION ON THE PROPOSAL FOR A GRADUATE CERTIFICATE PROGRAM IN RENEWABLE ENERGY AND ISLAND SUSTAINABILITY (REIS)

Whereas, the proposed certificate program has operated as a trial program since 2009 with extramural funding to support 15 to 30 graduate students per year; and

Whereas, addressing energy issues requires a multidisciplinary approach to research and education to meet demands for clean energy solutions; and

Whereas, workforce training in the energy sector has not kept pace with emerging needs; and

Whereas, creating this new certificate program through a collaboration across colleges and departments will use existing infrastructure that currently requires no additional funding; and

Whereas, existing physical resources allocated to participating REIS faculty already support energy-related research projects and these resources will be available to the Certificate Program; and

Whereas, the REIS certificate program is aligned with the University's commitment to sustainability and research focus areas and includes faculty from five colleges and support from the public and private sector; therefore, be it

Resolved, that the Manoa Faculty Senate approves the proposal to establish a Graduate Certificate Program in Renewable Energy and Island Sustainability (REIS).

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Renewable Energy and Island Sustainability Certificate

Graduate Certificate Program

University of Hawai'i

November 6, 2014

Anthony Kuh
Professor of Electrical Engineering

Renewable Energy and Island Sustainability
Certificate Plan

Point of contact:
Prof. Anthony Kuh
Dept. of Electrical Engineering
University of Hawaii
Honolulu, HI 96822
Phone: 808-956-7527
Fax: 808-956-3427
Email: kuh@hawaii.edu

I) What are objectives of program?

A) Program Objectives

The Renewable Energy and Island Sustainability (REIS) group is developing a new cross-disciplinary certificate program in Renewable Energy and Island Sustainability at the University of Hawai'i at Manoa (UHM). The program will include responsive and dynamic training coupled with foundational research-based curricula in the areas of clean energy technologies, renewable energy production, storage, integration, smart grid technologies, and renewable energy policy issues. The program will train students to have a broad, cross-disciplinary knowledge of clean energy and related sustainability issues by addressing engineering, science, social/economic, and environmental aspects of energy issues. Students will learn through formal and foundational coursework, labs, and group research projects. At the same time, the students will be supporting and interacting with a broad base of clean energy industry personnel (from utilities, Department of Defense (DoD), transportation, and tourism industries) via information exchanges, internships with industry and government labs and outreach with the community. This initiative will expose hundreds of students to clean energy opportunities, and will generate a sustainable pool of graduates to provide a much-needed workforce for Hawai'i and the U.S. as the electric power sector transforms from heavy reliance on fossil-based fuels to clean energy alternatives and a smart grid future. Graduates will provide workforce for utility companies, government labs, and work as educators (from universities to K-12 programs). The new energy economy will also need engineers, scientists, and entrepreneurs that can develop and apply new energy technologies, communicate with consumers and provide the expertise to manage energy usage across a broad spectrum of industries. Just as the Hawai'i Clean Energy Initiative (HCEI) will rely on more local resources (renewable energy sources) to supply energy, the REIS program will allow Hawai'i to rely on more locally trained students as key players in its energy workforce.

B) Student Learning Outcomes

Students in the program should have a broad understanding of energy from engineering to technology to social science to policy issues. Students should have good knowledge about renewable energy, energy efficiency, and sustainability. In addition, each student should have in depth knowledge on some aspects of energy and sustainability. Some broad student learning outcomes are listed below.

1. Demonstrate mastery of the methodology and techniques specific to renewable energy and island sustainability. This is achieved by understanding engineering, technical, economic, environmental, and policy issues associated with energy and sustainability.
    a) Become aware of the current market structures of nonrenewable and renewable energy options as well as major positive and normative issues related to energy markets;
    b) Become aware of the engineering and technical issues associated with generating, transmitting, distributing and using renewable energy resources for electricity and transportation. Understand energy sustainability issues through integration of renewable energy with the perspectives of key criteria such as energy efficiency and energy security, and sustainability.
    c) Apply economics concepts to analyze renewable energy policies and understand related issues affecting sustainability, environment, and security.
2. Communicate both orally and in writing at a high level of proficiency on energy issues.
    a) This skill is developed through in-class oral and written communication.
    b) Students will also develop oral and written communication skills while conducting research.
3. Function as a professional in the discipline.
    This skill is developed through interactions and collaborations with students, faculty, and professionals.
4.) Develop life long learning skills.
    Learning to conduct research will help in developing life long learning skills.

The two core courses address SLO 1). Other courses reinforce the achievement of SLO 1) and address SLO 3). Other activities including conducting research also supplement SLOs 2)-4).

II) Are the objectives appropriate functions of the College and University?

Addressing energy issues requires a multidisciplinary research and education area that currently plays an important role at both the College of Engineering and the University of Hawai'i at Manoa. There is a strong need for this program because of increased demand for energy jobs in Hawai'i, US, the Pacific Rim, and beyond as economies demand more clean energy solutions.

A) Relationship to the University, campus, and college mission and development plans

This proposed certificate is unique to the state of Hawai'i. Students who have an interest in the area can remain in Hawai'i for their studies. For many students, this gives an affordable education in the energy and sustainability areas. This supports the University of Hawai'i System's values of access, affordability, and excellence; the Manoa campus' mission of

leadership, excellence and innovation in energy and sustainability; and the campus' strategic plan under the categories of economic development and technology.

In addition the University of Hawai'i Board of Regents recently came out with a memorandum on January 14, 2014 amending its policy to promote the University's commitment to sustainability. This includes goals of carbon neutrality which fits well into our REIS program and our this proposed graduate certificate.

This is also relevant to the College of Engineering as energy and sustainability were identified as one of the key research thrust areas by the College and Dean Peter Crouch.
This also supports the last three bullet items of the following four-point mission statement of the College:

- Provide an accredited program of undergraduate engineering education to students at the University of Hawai'i at Manoa.
- Assist the community in attracting students to higher educational opportunities in Science, Technology, Engineering and Mathematics (STEM) from K-12 institutions and community colleges, especially from Hawai'i.
- Provide continuing education and professional services to the engineering community in Hawai'i and wherever these services will enhance the growth of the College's overall capacity.
- Provide research and graduate education opportunities to students worldwide, within the context of a faculty driven extramurally funded research program that leverages the resources of the University of Hawai'i and its partners in Hawai'i; and participate in the growth of the technological workforce and technology-based industry in Hawai'i through student graduation and technology transfer.

This certificate program will have close ties to many other UHM programs in energy and sustainability. This complements the initiative by Hawai'i Natural Energy Institute (HNEI), which has been very successful at getting research funding for many energy projects and has been focusing on engineering and technological aspects of renewable energy implementation. The program also ties in closely with the Manoa Sustainability Corps, which is looking to coordinate sustainability activities on campus. The UHM Facilities is also proposing a more sustainable campus by relying more on renewable energy sources and becoming more energy efficient. Our program is working with Facilities Management to get students more involved in helping implement this goal.

B) Evidence of continuing need for the program

The REIS certificate program will be a unique energy and sustainability program by combining knowledge base and skills from engineering, natural science, social science, and entrepreneurship. So far the initial trial certificate program has been very successful in attracting graduate students. With the certificate we estimate that fifteen to twenty students will be initially enrolled in the program with the program growing over time. In addition, dozens of other graduate students and senior undergraduate students will take courses and participate in research projects affiliated with the program. The program fills a much-needed gap by producing

graduates with specialization in energy with a wide variety of backgrounds that are equipped to enter the workforce at different levels and in many sectors. REIS graduates will be trained in the technological, environmental, policy, and business aspects of the emerging energy issues. In particular, our program will support Hawai'i's quest for clean and renewable energy as articulated in the Hawai'i Clean Energy Initiative (HCEI).

Energy companies in Hawai'i such as our local utility, Hawaiian Electric Company, Inc. (HECO) and in other states have committed to radically reforming fossil fuel electricity generation systems based on residual fuel oil and coal to renewable technologies including biofuels, wind, solar, and ocean energy options. These rapid changes in technology base as well as high attrition/retirement and long training/apprenticeship programs typical of utilities, coupled with limited island resources, imply workforce shortage that we and the rest of the nation cannot ignore. With the HCEI and changes in national energy policy it has become critical that we build a new modern energy program meeting the important challenges that Hawai'i and the US face today. In constructing the REIS program we realize that the power and energy program must be broad in scope incorporating a wide range of disciplines including engineering, social science, environmental impacts, economics, and business development. The REIS program was also designed to partner with hotels, health services, industry and HECO. Since the start of the REIS program in June 2009 (with grants from UHM and US Department of Energy, see below for details), good relationships have been established with HECO. HECO engineers have been working closely with our team to help build our renewable energy education and research program. Our students will gain a broad education as well as in depth knowledge of clean energy and smart grid technologies. They will also learn communication skills through participating in multidisciplinary projects (e.g., presentations and teamwork). At higher levels, Ph.D. students will demonstrate significant independent thinking skills and technical leadership. Students graduating from our program will enter the workforce in a wide variety of power related sectors listed below including tourism and the military, which are the largest sectors of the Hawaiian economy.

Additional evidence can be found in Appendix A) which contains support letters from local industry including Hawaiian Electric Company and state agencies including Department of Business, Economic Development and Tourism (DBEDT). In Appendix B we list results from our survey of current REIS-funded students.

C) Projections of career opportunities for graduates

There are many career opportunities for our graduates in the energy and sustainability sector locally, nationally, and internationally. These include jobs in utility companies such as Hawaiian Electric Company, Department of Energy national energy laboratories such as Lawrence Livermore National Laboratory, local and national energy companies, and other sectors of the economy from military to tourism to help with energy conservation and sustainability.

Workforce training in the energy sector has not kept pace nor have the foundational academic programs been revamped to address emerging needs. 45% of electric, gas, and water utilities reported that at least 20% of their workforce is considering retiring in the next 1-2 years and over 60% over the next 5-10 years (January 2007 UtiliPoint International Survey, "Aging Workforce and Aging Assets 2007-2012"). However, less than 50% are undertaking programs to retain workers or stop the brain drain due to lack of resources or appropriate succession training

programs. Compounding this problem of an aging workforce is the rapid changing of clean energy technologies. Utility industries need to retool their workforce in a rapidly emerging field with limited track record compared with legacy technologies. Composed of a multi-disciplinary team of educators and industry entrepreneurs, this certificate program has been assembled to respond to this challenge.

III) How is the program organized to meet its objectives?

The REIS group is led by Anthony Kuh, Director of REIS and a professor in Electrical Engineering. He runs the REIS program and is also running the education program. He is the point of contact and this is now listed in the proposal. We also have a REIS curriculum committee that assists Prof. Kuh with educational and curriculum issues. The REIS curriculum committee is currently composed of Prof. Beei-Huan Chao in Mechanical Engineering, Prof. Reza Ghorbani in Mechanical Engineering, and Prof. Nori Tarui in Economics.

The REIS faculty members will have weekly meetings to assess the progress of the REIS program. Led by the director of the REIS group, faculty members in REIS discuss education, research, and outreach activities. These include periodic discussion of how we are meeting our objectives.

To see if we meet objectives, an evaluation plan will be established. Project goals for students, faculty, and departments will be evaluated; measurable evaluation questions and indicators based on the project goals will be devised. The following describes how this program will be implemented and the measures that will be used to perform the project evaluation and improvement. We will have an annual evaluation regarding recruitment and retention, accomplishment of student learning outcomes (measured based on well established rubrics), as well as feedbacks from third-party evaluation groups. In all evaluation areas, we will set goals for the students to make sure that students' learning objectives are fulfilled.

Goals will be set for number of applicants applying to our program, number accepted, and number of REIS students that enroll in our program. We will assess our recruitment efforts and modify them depending on how our goals are being met. Entering students will be given surveys on why they enrolled in our program. We will also look at retention of REIS students. We will carefully monitor REIS students as they move through our program. Entering students will establish a set of educational and research goals with assistance from faculty advisors. These goals will be modified every semester as they advance through our program. If the REIS students are having difficulties with attaining their goals, we will look carefully at ways we can assist the REIS students so that goals can be met or possibly be modified.

We will look at student learning outcomes (SLOs) to assess whether students are achieving their specified goals. SLOs will be evaluated directly in a variety of forms. For example, REIS graduate courses will be used to assess whether students are meeting their goals. We will also use SLOs to assess research progress. Since much of the REIS research will be group research, we can use SLO 2)to assess soft skills such as communication skills. We will also examine team projects/research for SLO 3) to assess the students' ability to function in multidisciplinary teams/projects as well as their leadership skills. For SLO 4), we will examine lifelong learning

skills through the methods and tools the students employ to accomplish their research tasks. Finally, all SLOs can be measured through the student's research oral and written progress reports as well as their final defense presentation and dissertation. Data will be gathered for both education (through the coursework and course team projects) and research, and assessed by REIS faculty members. The data will then be analyzed and interpreted, and we will then make improvements to the program based on this assessment and evaluation.

Besides evaluating REIS students we will assess the overall program. The success of the overall program depends primarily on our REIS students. We mentioned recruiting and retention, but we will also evaluate our REIS faculty funding success, outreach to the community, and scholarly achievements. Goals will be assessed for the entire program and subgroups of the program REIS team members and external evaluators will gather data, interpret data, and find ways that we can improve various aspects of program and faculty.

In addition, we have two external groups to examine our program; **1)** The Industry State Advisory Council (ISAC) is led by the Dean of the College of Engineering (COE), Peter Crouch and is also composed of representatives from the state of Hawai'i and industry working in energy. Many of our commitment letters come from companies and state agencies that are on the ISAC. The ISAC will meet at least once a year with our REIS team members giving presentations of progress of education and research and REIS students giving presentations of their research projects. **2)** Vice Chancellor for Research and Graduate Education (VCRGE) supplied the REIS team with the $1 million UHM seed funding. The REIS Director has been meeting periodically with the VCGRE to give progress reports on activities.

The external groups will also assess the performance of the program based on measurable evaluation questions and indicators on the project goals devised by the feedback from the REIS faculty members. Information gathered from various evaluation groups including program evaluation data, SLO data, recruiting and retention data, faculty data, etc. will be used for overall recommendations about the program. Assessment, evaluation, and implementing recommendations will continually occur to improve the REIS. The evaluation will be conducted, as explained in this section, on an annual basis.

A) Curriculum organization and requirements

A.1) Graduate degree requirements

Students will enroll as graduate students in their respective departments and must satisfy degree requirements (M.S., Ph.D.) for their department.

A.2) Certificate requirements

To obtain the graduate certificate in Renewable Energy and Island Sustainability (REIS), the students must fulfill the following five requirements:

1. Have passed the two Mandatory General Core Courses listed below.
2. Have passed at least one course in Technological Specialization Courses.

3. Fifteen units are required for the certificate in approved 600 and 400 level courses with at least nine units at the 600 level. For each course student should get at least a C- in that course (a Graduate Division requirement) and students should have an overall grade point average of a B in the fifteen units of approved 600 and 400 level courses.
4. Have conducted a capstone research project in the area of energy and / or sustainability under the supervision of a REIS faculty member (this faculty member should be different than student's primary thesis or dissertation advisor). The research project will result in a research paper in the area of energy or sustainability that will constitute the culminating experience for the REIS certificate. The quality of the paper should be similar to a refereed conference or journal paper or a chapter of a thesis dissertation. Note that this work is in addition to thesis / project requirements for an M.S. or Ph.D. degree.
5. Have completed at least one short course or workshop in advanced topics in renewable energy or sustainability, or attended a professional conference in renewable energy or sustainability.
6. Have passed one REIS seminar course. Note that the seminar course will expose students to different areas in renewable energy and island sustainability. The seminar course will provide students with more broad level knowledge and awareness of energy and sustainability research and education areas. This will be a one unit course that is cross-listed with a syllabus for the course shown in Appendix C.

Mandatory General Core Courses:

ECON 636: Renewable Energy Economics and Policy, (offered as Econ 699 in Spring 2011 and Spring 2012; the new course proposal for Econ 636 was approved in Spring 2011.)

ME 610: Renewable Energy and Sustainability Engineering, Spring 2011 (offered as ME 696 in Spring 2011 and Spring 2012; the new course proposal for ME 610 was approved in Spring 2011)

These two core graduate courses are intended for a broad audience of graduate students with prerequisites of math and science that are usually obtained by undergraduate students by their sophomore year or consent of instructor.

Syllabus for both core classes are shown in Appendix D.

REIS Seminar Course: Seminar: Renewable Energy and Island Sustainability (offered as CEE691/EE699/ME691 in Fall 2011, Fall 2012, Fall 2013)

Technological Specialization Courses: Below are examples of elective 400/600 level courses that will be approved on a course-by-course basis by the REIS curriculum committee based on course syllabus and content in energy and sustainability topics. Note while most of the current courses are in Engineering we anticipate that more courses in non-Engineering areas will be approved to met the needs of students from different backgrounds as they enter the program. We anticipate more courses from the Colleges of Social Sciences, Natural Sciences, Architecture, Law, Business, CTAHR, and SOEST. The intent of the REIS graduate certificate is to recruit, retain, and graduate a broad spectrum of students in a variety of disciplines interested energy and sustainability fields.

ME 491/EE 491: Solar Energy Engineering and Technology, ME 626: Viscous Flows or CEE622: Fluid Mechanics, EE 696: Renewable Energy Devices and Sensors, ME 647: Nanoscience and Nanotechnology or ME 447: Introduction to Nanotechnology, ARCH 525: Architecture Systems IV: Sustainability, BE 410: Biomass Conversion to Biofuels and Bioenergy, ECON 637: Resource Economics, ECON 638: Environmental Resource Economics, EE491I: Renewable Energy, EE491K: Power Systems, EE491K: Power Electronics, EE 693D: Smart Grid Technology, ICS 691: Smart Grid Software Engineering, ME 646: Mechanics and Design of Composites or ME 446: Advanced Materials Manufacturing, ME 696. Hybrid Electric Vehicle Dynamics and Design, ME 696. Design of Wind Turbine and Wave Energy Converter, ME 696: Renewable Energy Material and Manufacturing Technology, ME 696: Working with Industries in Renewable Energy, ORE607: Water Wave Mechanics, ORE 609: Hydrodynamics of Fluid-Body Interactions, ORE 612: Dynamics of Ocean Structures.

B) Admissions policies

Students who intend to receive the REIS certificate must be admitted to the program. All the classified graduate students in UH Manoa in good academic standing may apply for admission. The students seeking admission without a Research Assistantship shall submit a cover letter, curriculum vitae and a recommendation letter provided by a UH faculty member to the program. The cover letter shall include the student's major, research interests, and academic background. Applicants seeking a Research Assistantship shall contact a REIS faculty member for support. If admitted, the faculty member will be the student's academic adviser. After obtaining the faculty support, the applicant shall submit a cover letter and curriculum vitae to the program. The cover letter shall provide information on the student's major, degree pursued, years of graduate study, research interests, how he/she will help the program, research project to be performed under the supervision of the REIS faculty member, and the future goals in career. The REIS faculty member shall submit a supporting letter describing the student's role on the research project, how the project is related to the mission of REIS, how the project helps with future funding opportunities and how it enhances collaborations with other REIS members, external researchers and industry. All applications will be reviewed by a REIS academic committee. Admissions are awarded based on the students' academic qualifications, the relevance of the students' research interests with the goals of REIS, and the support letter.

C) Advising and counseling

Each student in the certificate program will have an advisor associated with the REIS group. The student will obtain advising and counseling from the REIS advisor along with his/ her thesis committee. In addition, each student will have access to resources associated with their respective department and college / school.

IV) Who will enroll in the program?

The program is designed for graduate students in a wide variety of disciplines—including the College of Engineering, CTAHR, SOEST, and the College of Social Sciences—who pursue a

graduate program related to renewable energy. We anticipate that graduate students from multiple disciplines will enroll in the certificate program. The mandatory courses are designed so that they attract students from various departments and units and provide them with a solid platform of natural and social science aspects of renewable energy issues. In fact, the two core courses, which were both offered as elective graduate courses in Spring 2011 and Spring 2012 and attracted graduate students from many different departments. ME691 had 21 students from Mechanical Engineering, Electrical Engineering, Civil Engineering, Economics, Computer Science, and Bioengineering. Similarly, Econ 636 "Renewable Energy Economics and Policy" (offered as Econ 699 in Spring 2011) had 17 students from Mechanical Engineering, Electrical Engineering, Civil Engineering, Economics, Political Science, and Natural Resource and Environmental Management. Many students enrolled in these courses cited the interdisciplinary nature of the course (both the course content and group projects by students from different disciplines) as an exciting aspect of the courses. In addition we are and will continue to advertise the REIS program, REIS courses, and this proposed graduate certificate to UHM faculty and graduate students in all disciplines related to energy and sustainability.

The East-West Center, which supports a large number of UHM graduate students with fellowships, requires their students to participate in a certificate program. Renewable energy, or energy in general, is an area that existing certificate programs available for EWC students does not cover. Indeed, there is a latent demand for the proposed program: several EWC fellowship students have indicated their interest in the REIS certificate program.

As a reference, the following is the enrollment in REIS Technological Specialization Courses in Spring 2011.
EE 491I: Renewable Energy (Olga Boric-Lubecke) enrollment: 11
EE 491K: Power Systems (Tao Yang, visiting instructor) enrollment: 6
EE499: Topics on the Solar Decathlon (Technical Elective + Laboratory) (David Garmire) enrollment: 4
ME 499: Solar Decathlon (Technical Elective) (Weilin Qu) enrollment: 7
Econ 637: Resource Economics (Lee Endress) enrollment: 7
EE693I: Devices for Solar Energy and Building Efficiency (David Garmire) enrollment: 11

V) What Resources are Required for Program Implementation and First Cycle Operation:

The REIS Program was started in June 2009 with support provided from internal and external funded grants (trial certificate program). One key aspect of the certificate program is that it will initially require no new resources from UHM and only require very modest resources from year three on. Resources will come from faculty working in the energy education and research areas and financial support from a Department of Energy, three year $2.5 million workforce training grant (May 2010 – June 2014) and came from an internal $1 million sustainability grant from Vice Chancellor Ostrander (June 2009 – December 2011). Additional support has come from federal grants from NSF and other funding agencies to support graduate students. The REIS faculty will continue to support the program by applying for federal and industry funds.

A. Faculty

Below is the list of faculty members involved in REIS program:

- Participants	Dept.	Expertise
Olga Boric-Lubecke	EE	Energy harvesting, RFICs, circuits & devices, biomed.
Beei-Huan Chao	ME	Energy conversion, reactive flows, heat & mass transfer
Makena Coffman	URP	RE, sustainability, energy policy
John Cusick	ENV	Sustainable tourism, env. education and history
Yingfei Dong	EE	Smart grid, network and computer security
Oceana Francis	CEE	Coastal sustainability
Matthias Fripp	EE	RE integration, power systems, smart grids
David Garmire	EE	RE devices, MEMS, CAD, computational biology
Mehrdad G. Nejhad	ME	RE Production & Storage Devices, nanotechnology
Reza Ghorbani	ME	RE, SGI, control, robotics
Jay Griffin	HNEI	RE, SGI, energy simulation models & policy analysis
Philip Johnson	ICS	Smart grid, user interfaces, software engineering
Samir Khanal	BE	Bioenergy, biofuels, biomass, sustainable engineering
Denise Konan	ECON	RE policy, international trade, computational econ.
Aleksander Kavcic	EE	SGI, information theory, communications, signal proc.
Anthony Kuh	EE	RE, SGI, signal processing, machine learning
Bor Yann Liaw	HNEI	RE, fuel cells, batteries
Jingjing Li	ME	Materials processing, manufacturing, PV cells
Dora Nakafuji	HECO	RE, SGI, field monitoring, visualization & analysis, GIS
Aaron Ohta	EE	RE devices, MEMS, biomed., microfluidics
Weilin Qu	ME	RE applications, desalination, thermal / fluid
David Rockwood	ARCH	MDS, systems integration
Prasad Santhanam	EE	SGI, information theory, communications, signal proc.
Nori Tarui	ECON	RE, environmental resource econ, micro econ, game theory
Zac Trimble	ME	Energy harvesting, energy storage
Scott Turn	HNEI	Bioenergy, biofuels, biomass
Tao Yan	CEE	Water, environmental engineering, environmental microbiology
Xiangrong Zhou	EE	Smart grids, embedded systems, computer arch.

Table 1: RE – Renewable Energy, ARCH – Architecture, BE – Biological Engineering, CEE – Civil and Environmental Engineering, ECON – Economics, EE – Electrical Engineering, HNEI – Hawai`i Natural Energy Institute, ICS – Information and Computer Science, ME – Mechanical Engineering, URP – Urban and Regional Planning, ENV - Environmental Studies, HECO – Hawaiian Electric Company, SGI – Smart Grid and Integration, MDS - Modular & Deployable Structures

No new FTE positions will be specifically requested for the REIS program, however the Departments of Electrical Engineering, Mechanical Engineering, Ocean Resources Engineering, HNEI, and Economics are all focusing on education and research in the energy area. Many of their future hires will be in the energy area that will strengthen the REIS program and is in alignment with UHM's vision of cluster hirers in the sustainability area.

B. Library resources (including an evaluation of current resources and an estimate of the cost of additional resources required)

The library resources include publications available in the University library, mainly in the UH Manoa Hamilton Library and in the University of Hawai'i databases. The present resources available in the UH library appear to be adequate for the REIS Graduate Certificate Program. The Program does not require additional library resources.

C. Physical resources (space, equipment, etc.)

The existing physical resources currently allocated to the participating faculty members will be sufficient for the Graduate Certificate Program because it already supports the energy-related research projects performed by these faculty members. The resources available to the Certificate Program are listed in the following.

Bioenergy Laboratory: St. John 203: Analytical instruments, wet labs, state-of-the-art fermenters, and equipment for bioenergy and bio-based product generation research. Lab Coordinator: Samir Khanal

Biosensing Laboratory: POST 416: Studies of devices and algorithms for human energy harvesting and physiological sensing, and for smart building occupancy sensors. Lab Coordinator: Olga Boric-Lubecke

Collaborative Software Development Laboratory: POST 307: development of software tools and technologies to support energy data collection, storage, analysis, and visualization, and design of game applications for energy literacy improvement and energy conservation. Lab coordinator: Philip Johnson

Hawaii Nanotechnology Laboratory: Holmes 140, 210, and 307: Lab Coordinator: Mehrdad Ghasemi-Nejhad

Holmes 140: Chemical Vapor Deposition furnaces are used for the development of carbon nanotubes nanoforests for inclusions in nanocomposites (for wind turbines, wave rotor blades, & electric vehicles), as well as their inclusions in fuel cells, solar cells, batteries, and supercapacitors. In addition, an automated Autoclave is used for the manufacture of nanocomposites, and an Instron machine is used for the testing of nanocomposites. In addition, this lab is also used for the development of Deployable

Disaster Devices (D^3) with Wind Turbines, Solar Panels, Batteries, Controllers, Converters, Composite Electric Cars and Airplanes.

Holmes 210: Software and hardware for the modeling and analysis of Nanocomposites.

Holmes 307: Sonicators, mixers, and vacuum ovens for the development of Nanoresin Nanocomposites for inclusions in nanocomposites (for wind turbines, wave rotor blades, & electric vehicles). In addition, there are test stations for the testing nanocomponents of fuel cells and solar cells.

Hybrid Energy and Drivetrain Laboratory: Holmes 347, Novel hybrid power systems, Simulation and experimental study, Hybrid electric vehicles, Drive and energy management of hybrid drivetrain systems. Lab Coordinator: Reza Ghorbani

Hydraulics Lab: 142 Holmes: equipped with two wave flumes, wave generators, laser velocimetries, wave gages, load cells as well as AWQA and OrcaFlex software for experimental and numerical studies on wave energy conversion devices. Lab Coordinator: Michelle Teng

Smart Campus Energy Laboratory: Holmes 493: software and hardware simulations of micro-grids with studies conducted of integration of distributed renewable energy generation and demand response. Lab Coordinator: Anthony Kuh

Energy Information Project: Housed in the University of Hawai'i Economic Research Ogranization (UHERO). Conducts experimental and empirical research to analyze policies for energy conservation and renewable energy integration. A randomized control trial in UH Faculty Housing on the effects of smart meters on energy conservation was conducted in Spring 2012. Lab Coordinator: Nori Tarui.

D. Additional resources required (staff, graduate assistantships, etc.)

The program was awarded a four year $2.5 Million grant by the Department of Energy (DOE) for a workforce training grant in the Strategic Training and Education in Power Systems (STEPS) (from May, 2010 to June 2014). Participating faculty members also have other individual or group grants funded by various federal or industrial agencies such as DOE, NSF, NASA, ONR. In addition, the program was also awarded an internal two year $1 Million grant by the Vice Chancellor for Research and Graduate Education, Gary Ostrander (from June 2009 to December 2011) as a result of winning an internal University of Hawaii at Manoa sustainability competition with the award announced in April, 2009. Currently, we have an administrative assistant supported on the DOE grant. We will continue to seek external federal funding to support the program, but will work also with the private sector and University of Hawaii administration for continued support.

E. Estimate of additional position counts and budget implementation for first five years of program

The program does not require additional faculty and graduate assistant positions. We have support through summer of 2014 and anticipate additional support through external federal funding and private support.

Funding for REIS graduate students, undergraduate students, and equipment will principally come from extramural grants. The DOE workforce training grant will expire on June 30, 2014, but in Appendix E) we also list other current funding coming mainly from NSF, but also from other government agencies and industry. Most of the students supported on these grants are in the REIS program with many of these students working towards the proposed REIS graduate certificate. The active grants excluding the DOE workforce training grant total more than $3 Million. We anticipate continued funding with efforts to increase extramural funding with more targeted attempts at larger group proposals from NSF, DOE, and DoD. The success of our REIS program and the REIS graduate certificate depends in large part with our success in obtaining sustained extramural funding.

We are also working to obtain REIS infrastructure funding from higher administration and through fund raising from industry and private foundations. This infrastructure funding will provide support for an administrative assistant and assistance with running the REIS program. While this support is not directly related to the graduate student certificate it will aid in the smoother running of the REIS program. The goal is to leverage our extramural funding to get support from higher administration and the private sector.

VI) How efficient will the program be?

The REIS Program has created an interdisciplinary program (trial certificate program) to better prepare our students to enter the workforce in the energy sector. In addition the REIS Group are working closely with HECO who will assist the program also in many ways including providing internships and helping with the development of short courses. The students will have breadth, depth, experience working in teams, and practical industry experience. All these factors will be of significant benefit to place our students in fruitful careers. Engineers and other workers already in industry will also benefit by being able to take regular and short courses in the REIS program.

The REIS program will be a self-supporting and sustainable program in renewable energy, energy efficiency, and island sustainability. The REIS group will bring more research and education funding to UHM to support our large multidisciplinary team and collaborations with HECO to retool and retrain staff in the clean energy areas. To ensure that students have proper training, experimental test beds will be further developed (e.g. the Smart Sustainable Campus consisting of renewable energy generation and storage batteries, a smart campus energy laboratory, and sensors to monitor energy usage in Holmes Hall). Other experimental laboratories including the Nano Technology Lab, Hybrid Drive lab as well as Marine Energy lab which will be developed through external funding and building a base for both fundamental and applied research in renewable energy and sustainability.

It is difficult to project graduate enrollment, but a table is added in Appendix F) to show the number of REIS students that were supported in the last five years. The numbers range from 15 to about 30 students in an academic year. These students were supported on the initial University of Hawai'i Manoa sustability grant (June 2009 to December 2011) and extramural funding (e.g. the major grant was the DOE workforce training grant from May 2010 to June 2014). We envision that future enrollment will depend on extramural funding, but that there will always be a core of graduate students interested in working in the REIS program. We also envision that the REIS program will grow as more interest and attention is paid to energy and sustainability. In the near term we would estimate that there will be between 15 to 25 graduate students per year enrolled in the REIS program. This will depend in large part on extramural funding which is current funding shown in Appendix E). All these students will be encouraged to obtain the certificate, but perhaps between 50% and 70% of enrolled REIS students will obtain the certificate.

There will also be additional students not supported including undergraduate students taking REIS energy and sustainability courses. Through the curricula and short course series, all these students will become "teachers" of tomorrow. Within this timeframe, the developed curricula would not only support REIS students, but would have exposed hundreds of others to clean energy concepts and technologies. (Curricula: five courses x 15 students/class x 3 yrs = 225; short course offering: 2 courses x 20 students/class x 3 years = 120; UG RE course: 20 students x taught twice = 40). Each graduate student will publish on average two articles in high ranked journals and / or conferences. This will improve the portfolio of UHM as a research institute.

The program will continue to be supported through external grants from government and industry contracts and endowments. We are encouraging REIS members to write proposals and collaborate with industry partners such as HECO. We group proposals into three areas: large proposals involving most or all REIS members with proposal addressing most facets of the REIS program, medium proposals involving a focused research and education areas involving three to six REIS members, and small proposals involving one or two REIS faculty members with the proposal being more narrow in scope and targeted at a specific area. The program will continue to produce trained workforce at the B.S., M.S. and Ph.D. As the program develops we anticipate that the number of REIS students will grow as the demands for workforce in the energy sector increase. We also envision that the REIS program will continue to change as we add new faculty members to the REIS team and work with more companies.

VII) How will effectiveness of program be demonstrated?

The REIS Certificate program will be evaluated using the assessments used by the Faculty of Graduate Studies with appropriate modifications for the REIS Certificate program. The following assessments will be performed to REIS Certificate program:

• Core and Technical Elective Course assessments: Every semester, the Program administers a student survey of all REIS courses to determine the effectiveness of the course and its instructor. It also administers a student survey to determine the effectiveness of the course in achieving educational program outcomes. We will also

conduct an annual survey to REIS students asking about the effectiveness of the REIS program. Results from the first survey are shown in Appendix B.

• Industrial State Advisory Council: The REIS Program has an Industrial State Advisory Council made up of representatives from industry. Internally, Vice Chancellor for Research and Graduate Education meets with REIS director and PI Prof. Anthony Kuh periodically to assess the progress of the program. The Dean of the College of Engineering, Peter Crouch with assistance from Prof. Anthony Kuh, Director of REIS has formed an Industrial Advisory Council (ISAC) consisting of industry members (e.g. HECO, Blue Planet, Sopogy) and representatives from state agencies (DBEDT, HREDV). The ISAC will meet at least once a year to evaluate education and research activities.

• Alumni Surveys: The Department will begin administering an alumni survey to assess if the graduates have achieved the educational objectives. The survey will be conducted every couple of years.

• Thesis Report Assessments: The REIS Certificate program requires a thesis in renewable energy and sustainability. The REIS program requires a REIS member to be in the committee to assess the quality of projects and its relevancy.

We will also survey our graduates to determine where they get their initial employment after graduation.

So far, we placed several REIS-supported graduate students in private energy companies (e.g. Schneider Electronics, a smart grid company in Houston; Archionetics, a local IT company in, Honolulu; Rockwell Automation in Ohio) and as a postdoc at UH. A few M.S. students moved on to pursue Ph.D. in other universities (e.g. UC Berkeley, UW Madison). The Certificate Program will allow us to further improve the placement of REIS-funded graduate students.

Appendix A

Attached are support letters from industry and the state. They include letters from Estrella Seese of DBEDT, Maurice Kaya from HREDV, Scott Seu from Hawaiian Electric Company, Mark Duda from RevoluSun, Kekoa Kaluhiwa from First Wind, Leslie Wilkens of MDEB and WIT, and Joshua Kaakua of NHSEMP. We also have a letter of support from the Chair of the Economics Department, Prof. Byron Gangnes and the Chair of Mechanical Engineering, Prof. Mehrdad Ghasemi Nejhad.

NEIL ABERCROMBIE
GOVERNOR

RICHARD C. LIM
DIRECTOR

MARY ALICE EVANS
DEPUTY DIRECTOR

DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM

STRATEGIC INDUSTRIES DIVISION
235 South Beretania Street, Leiopapa A Kamehameha Bldg., 5th Floor, Honolulu, Hawaii 96813
Mailing Address: P.O. Box 2359, Honolulu, Hawaii 96804
Web site: www.hawaii.gov/dbedt/info/energy

Telephone: (808) 587-3807
Fax: (808) 586-2536

December 5, 2011

To Whom It May Concern:

The Hawaii State Energy Office, under the Department of Business, Economic Development and Tourism, strongly supports the proposal for a graduate certificate in Renewable Energy and Island Sustainability (REIS).

Hawaii is the most oil-dependent state in the nation, relying on imported petroleum for about 90% of its primary energy, making Hawaii vulnerable to fluctuations in oil prices and availability. To create a new course toward energy independence, the Hawaii Clean Energy Initiative was formed in 2008. This partnership between the U.S. Department of Energy and the State of Hawaii has set goals and a developed a roadmap to achieve 70% clean energy by 2030, with 30% from efficiency measures and 40% from locally generated renewable sources. An energy transformation is required, with research, education, workforce development and collaboration critical to achieving these goals. Additionally, growth of the innovation sector - engineering, science and technology - is essential for economic stability in Hawaii, and renewable energy is the fastest growing segment of this sector.

The Hawaii State Energy Office works closely with the University of Hawaii (UH) and relies on UH as a key partner in achieving these aggressive goals, with strongly interactive, multidisciplinary collaboration. We believe this unique team from UH provides the expertise, integrated approach and high level of collaboration to successfully develop the REIS graduate certificate program.

The Hawaii State Energy Office will support Professor Kuh's team by facilitating industry, government and public interaction, outreach, mentorship and internship opportunities. We expect graduates of this graduate certificate program to become future leaders in Hawaii's progress toward food and fuel independence.

The Hawaii State Energy Office offers its wholehearted support for this proposal, building on Hawaii's leadership in renewable energy, efficiency, innovation and water technologies.

Sincerely,

Estrella A. Seese
Manager, Energy Planning and Policy Branch

HAWAII RENEWABLE ENERGY DEVELOPMENT VENTURE
2800 Woodlawn Drive, Suite 132 | Honolulu, Hawaii 96822 U.S.A.
P: (808) 237-5050 | F: (808) 237-5059 | hredv@pichtr.org | www.hawaiirenewable.com

November 28, 2011

To Whom It May Concern:

The Hawaii Renewable Energy Development Venture (HREDV) is a U.S. Department of Energy program to help accelerate the development and application of innovative renewable energy technologies in Hawaii. HREDV supports State of Hawaii efforts to proactively transform Hawaii's energy system from heavy reliance on imported petroleum to one based on energy efficiency and renewable energy. The Hawaii Clean Energy Initiative envisions Hawaii obtaining 70% of its energy from clean energy sources by 2030.

HREDV's and Hawaii's successes are very dependent on having a strong relationship with the University of Hawaii at Manoa College of Engineering. I currently serve on Dean Peter Crouch's advisory council and have consulted with Professor and Chair Tony Kuh about the strong benefits of developing a power and energy program in the College of Engineering. HREDV supports the College's efforts to build an interdisciplinary program at the University of Hawaii in renewable energy and island sustainability.

We are very excited that Dr. Kuh has assembled a multidisciplinary team from the University of Hawaii's College of Engineering, the Hawaii Natural Energy Institute (HNEI), the College of Natural Science, the College of Tropical Agriculture and Human Resources, and the College of Social Science to form a graduate Ph.D. program in renewable energy, water, and island sustainability. We expect that many of the graduates from this program will become the future leaders in sustainable development in Hawaii.

The Hawaii Renewable Energy Development Venture recognizes the importance of the proposed program to the future of Hawaii. HREDV will support Professor Kuh's team by providing the needed interface with stakeholders in renewable energy in the State of Hawaii and with Hawaii's energy companies; facilitating internship programs, mentoring, and business partnering; and assisting with funding applied research. We have developed ties with industry to jointly address workforce issues as we anticipate the transformation of Hawaii's energy system. We strongly endorse the Renewable Energy and Island Sustainability graduate certificate.

Sincerely,

Maurice H. Kaya, P.E.
Project Director

Hawaiian Electric Company, Inc. • PO Box 2750 • Honolulu, HI 96840-0001

November 18, 2011

Scott W. H. Seu
Vice President
Energy Resources

To Whom It May Concern:

We are pleased to provide a letter in support of the Renewable Energy and Island Sustainability (REIS) graduate certificate program at the University of Hawaii, Manoa. With aggressive renewable energy policy targets, Hawaii will need a solid pipeline of knowledgeable, energy savvy workforce and leaders across multi-disciplines. A key component to building this pipeline for Hawaii and for the nation is a strong educational foundation but also one that is closely linked to real world energy and sustainability issues.

As Hawaii and Hawaiian Electric Company endeavors to utilize more indigenous renewable resources, we also must support developing local talent, educated and informed about energy issues, technologies, policies and markets. Hawaiian Electric staff is working closely with REIS faculty to support building lasting industry-academia partnerships, to develop both academic and working knowledge related to energy and renewable integration needs and to train the next generation workforce through internships and other hands-on opportunities. Current efforts include the REIS seminars, collaboration on the $2.5M DOE workforce training effort and efforts to develop a smart grid laboratory and infrastructure on the UH campus.

Successful integration of significant renewables on the Hawaiian grids will take collaboration and understanding of complex issues. Offering a REIS graduate certificate, in addition to a traditional graduate degree, will offer broad perspective for the students and support continuing partnerships with Hawaii industries, such as Hawaiian Electric to develop more locally trained talent and leaders with insight on clean energy transformation needs. We encourage and support the REIS faculty in this endeavor and look forward to building capabilities for our future.

Should there be additional questions or needs, please feel free to contact myself or Dora Nakafuji (dora.nakafuji@heco.com, 808-543-7597), our Director for Renewable Energy Planning, who is also serving as an adjunct faculty at UH Manoa supporting REIS initiatives.

Regards,

REVOLUSUN

December 13, 2011

To whom it may concern:

I am writing to strongly endorse the graduate certificate in Renewable Energy and Island Sustainability (REIS). I believe that this program will help the Hawaii achieve the energy future we so desperately need by helping train the state's renewable energy workforce. Having locally trained talent to apply to the challenges that Hawaii faces, such as a high penetration of distributed generation on small island grids is essential, because such training does not exist in a systematic way anywhere else that I am familiar with.

In my roles as an owner of a solar integration company, a renewable energy project developer, and as the solar industry's lead for policy in the state, I am acutely aware of the limitations that our current workforce has in confronting the problems that threaten to hold our industry back. We literally cannot find workers that understand PV system design, DG integration, solar forecasting, and power electronics at the level required to implement all of the renewable energy projects that are currently striving to be built. It is my sincere hope that the University of Hawaii College of Engineering can be the institution that trains the labor force that makes these projects possible.

To this end, I am working with Dean Peter Crouch from the College of Engineering and Professor Anthony Kuh to help guide the the Renewable Energy and Island Sustainability (REIS) program to become maximally useful to the renewable energy industry in Hawaii. I have assisted the REIS program by serving on their REIS industry advisory council, giving a seminar in their seminar series to REIS supported students and faculty, and assisting Professor Kuh by introducing him to key industry players and government energy policymakers at the state level. I will continue to help out in various ways as the program grows.

I look forward to continued collaborations with Professor Kuh and the REIS program and strongly support the approval of the REIS graduate certificate.

Sincerely,

Mark Duda
Principal/Founder
RevoluSun, LLC

1600 Kapiolani Blvd, Suite 1700 | Honolulu, HI 96814 | 808.532.4401 (ph) | 808.532.4402 (f) | www.dephawaii.com

firstwind
CLEAN ENERGY MADE HERE

January 15, 2012

To whom it may concern,

This letter is in support of the Renewable Energy and Island Sustainability (REIS) graduate certificate program at the University of Hawai'i at Mānoa. First Wind strongly supports this certificate as we all work toward creating an economy with a workforce that relies more on clean energy solutions.

As Hawai'i increases its renewable energy sources in the coming years, we need to prepare a locally trained workforce in the energy sector. First Wind believes that the University of Hawai'i at Mānoa can provide this critical need. Our development and operations staff work closely with REIS faculty members and students by participating in the REIS seminar series and hosting tours of our Kahuku wind farm on O'ahu.

As developer, owner and operator of utility scale wind energy projects, First Wind seeks to be a positive, long term member of the communities in which our projects are located. We currently own and operate 11 wind projects in the Northeast, West and Hawai'i with a total generating capacity of 735 MW. First Wind is proud of the fact that the first project we built was in 2006 on the island of Maui.

The REIS graduate certificate will be a strong vehicle in getting graduate students interested in working in the clean energy sector. First Wind strongly supports the education and research efforts by the REIS faculty in developing this program, as we believe it will provide innovative training in the areas of clean energy and sustainability that will prove beneficial to the State of Hawai'i and beyond.

Should you have any questions about our company, please do not hesitate to contact me or visit our website at www.firstwind.com. Mahalo for this opportunity to express First Wind's strong support of the REIS program at the University of Hawai'i at Mānoa.

Sincerely,

Kekoa Kaluhiwa

Kekoa Kaluhiwa
Director of External Affairs
First Wind

810 Richards St., SUITE 650 Honolulu, HI 96813 808 695 3300 WWW.FIRSTWIND.COM

medb

maui economic development board, inc.

December 13, 2011

RE: In strong support of the University of Hawaii Renewable Energy and Island Sustainability (REIS) graduate certificate plan

To whom it may concern:

The Women in Technology (WIT) Project of Maui Economic Development Board, Inc. is pleased to send our letter of strong support for Professor Kuh's proposed graduate REIS certificate. The proposed REIS certificate focuses on education and research in sustainability with an emphasis on clean energy. This is in complete alignment with current WIT initiatives to strengthen the K-20 educational pipeline and workforce development in Hawaii, particularly for women, Native Hawaiians, and other underrepresented minorities exploring STEM (i.e. science, technology, engineering, mathematics) pathways.

WIT's established statewide network (which includes government agencies, pre-college and postsecondary educational institutions, industry groups, labor and other like-minded organizations) can provide the proposed project with recruitment, outreach and program assistance at various levels including but not limited to:

- Partnering with local energy and sustainability companies for internship opportunities

- K-12 outreach (members of Dr. Kuh's team have assisted WIT in outreach events focused on Ron Ho <rho@rnsha.com>middle school girls)

- Recruitment and marketing promotional assistance

- Equity-based and culturally relevant content

I enthusiastically support approval of the University of Hawaii REIS graduate certificate and look forward to partnering with them on this program.

Sincerely,

Leslie Wilkins
Vice President, Maui Economic Development Board, Inc.
Founder and Director, Women in Technology Project
Cell: (808) 280-0376
Email: leslie@medb.org

1305 N Holopono Street, Suite 1
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UNIVERSITY of HAWAI'I MĀNOA

College of Engineering
Native Hawaiian Science & Engineering Mentorship Program

Dr. Anthony Kuh
Department of Electrical Engineering
University of Hawaii at Manoa
2540 Dole St,
Honolulu, HI 96822

Aloha Dr. Kuh,

This letter is to solidify our enthusiastic support for the proposed certificate program in Renewable Energy and Island Sustainability (REIS) at the University of Hawaii at Manoa.

The proposed research and teaching activities focuses on issues of great importance for our global community and especially for Native Hawaiian, Pacific Islander, and developing communities. This cross-disciplinary area is relevant and attractive to Native Hawaiians considering graduate education and research pathways. I consider it a great opportunity for the College of Engineering to develop further partnerships with other units such as the Hawaiinuiakea School of Hawaiian Knowledge, the Hawaiian Natural Energy Institute, and the College of Natural Sciences. The proposal also aims at promoting interdisciplinary teaching and research activities. As such, our office, the Native Hawaiian Science & Engineering Mentorship Program (NHSEMP), will utilize and commit our resources to enhance the program in K-12 outreach, recruitment, and retention activities to provide community outreach to give 1,000 K-12 student from underrepresented groups a vision of careers in the fields of science, technology, engineering, and mathematics (STEM) annually, and recruit our best and brightest undergraduate and graduate STEM students for the REIS graduate certificate program.

As the project director for NSF LSAMP program, you will have the support of our staff and networks at the 17 educational institutions across the Pacific which comprises our LSAMP alliance to increase the numbers of students from underrepresented students on career paths to leadership in industry and academia. We can assist with the recruitment of our best and brightest STEM students from Manoa, Hilo, American Samoa, Palau, Guam, Micronesia, the Marshall Islands, Chaminade, Hawaii Pacific University, and the seven community colleges of the UH system. Additionally, I believe we can offer collaborative opportunities such as as co-sponsored workshops, faculty training, and community projects to meet our shared goals.

I believe the Pacific region hosts an untapped talent pool, unique environment, and potential for collaboration in the areas of renewable energy and energy efficiency. I look forward to supporting the REIS certificate program on this exciting work in the years to come.

Sincerely,

Joshua Kaakua

2540 Dole Street, Holmes Hall 207C
Honolulu, Hawai'i 96822
Telephone: (808) 956-7945
Fax: (808) 956-2291

Department of Economics

UNIVERSITY of HAWAI'I MĀNOA

Dr. Anthony Kuh
Department of Electrical Engineering University of Hawaii at Manoa
2540 Dole St,
Honolulu, HI 96822

Dear Dr. Kuh:

I am writing to express our Department's enthusiastic support for the proposed Renewable Energy and Island Sustainability (REIS) Graduate Certificate Program at UH Manoa.

As stated in the application, our graduate program offers one of the two core required courses in the program (Econ 636, Renewable Energy and Island Sustainability). The course, offered this semester (Spring 2012), has 10 students enrolled as of January 17, 2012. It was also offered as Econ 699 in Spring 2011 (enrollment: 17). Both sections have attracted graduate students from a variety of disciplines, including among others mechanical engineering, electrical engineering, civil engineering, natural resource and environmental management, and the Shidler School. The course is central to the REIS certificate program, ensuring that REIS students are exposed not only to technological and engineering aspects of renewable energy issues, but also to the social-science aspects and policy challenges that renewable energy development faces. The Department is committed to offering the class regularly for the REIS program, which I believe will benefit future graduate students in REIS and beyond.

The REIS certificate also concords well with our Department's existing and anticipated strengths. The general area of "Energy, Resource, and Environment" has been one of the key research and teaching areas for our Department. We have several faculty members active in this area, including James Roumasset, Denise Konan, Nori Tarui, John Lynham, Lee Endress (affiliate graduate faculty), and Kimberly Burnett (UHERO). As one example, Professor Konan's Energy and Greenhouse Gas Solutions (EGGS) Project focuses on energy and greenhouse gas policy and management issues in the State of Hawaii, and the project has delivered influential research reports and peer-reviewed academic publications. With another cluster hire in environmental economics to be based in our Department (20% in the Sea Grant Program, 80% in Economics), our Department's strength in energy policy analysis will continue to grow.

To date, two graduate students in economics have been funded through REIS, and they have been working on cutting-edge research related to renewable energy and energy conservation. In addition, a number of other graduate students have taken REIS courses.

Every year we attract graduate applicants who are interested in pursuing energy-related research. The REIS program will help us attract top applicants interested in energy and sustainability issues.

Many contemporary issues require interdisciplinary approaches for effective solutions. Renewable energy development and policy is one such area. REIS will provide a unique opportunity for our faculty members and graduate students to pursue interdisciplinary research on renewable energy, while advancing the University's initiative on sustainability and the State's overarching goals for developing appropriate energy and environmental policy.

Please contact me if you have any further questions regarding our Department's involvement with REIS.

Sincerely,

Byron Gangnes
Professor and Chair
Department of Economics
gangnes@hawaii.edu
808-956-8730

College of Engineering
Department of Mechanical Engineering

UNIVERSITY of HAWAI'I MĀNOA

Mehrdad N. Ghasemi Nejhad
Professor & Chair
ASME & Boeing Welliver Fellow

March 5, 2012

MEMORANDUM

TO: Dr. Kenneth Tokuno, Associate Dean of UH-Manoa Graduate Studies

FROM: Dr. Mehrdad Ghasemi Nejhad, Prof. & Chair

SUBJECT: ME Support Letter for the REIS Graduate Certificate

I am documenting my full support for the Renewable Energy and Island Sustainability (REIS) Graduate Certificate Program. The REIS Program is an interdisciplinary program within the College of Engineering (COE) including all three Departments of Electrical, Mechanical, and Civil & Environmental Engineering. REIS program is also a cross-disciplinary program within the Manoa Campus including many colleges and schools such as COE, HNEI, ICS, Biological Engineering, Architecture, Economics, and the College of Business. Finally, the REIS Program is a trans-disciplinary program in that it has collaborations among UH-Manoa, the Renewable Energy Industry such as HECO, and international institutions overseas such as Japanese institutions. These activities make the REIS Program a true multi-disciplinary program. In addition, REIS program collaborates with the Community Colleges on Oahu and Maui such as KCC, LCC, HCC, & MCC on an NSF Funded Program called PEEC/IKE, where the community college students are trained on REIS projects with the participation of our REIS undergraduate research students. This is also intended to encourage the PEEC/IKE students to join UH and REIS program after their graduation. It should be mentioned that the PEEC/IKE program is also active in attracting K-12 students and engaging them in STEM studies to recruit these students into PEEC/IKE. I am the link between the REIS & PEEC/IKE programs.

In order to educate our graduate students and give them the required background so that they a) obtain necessary inter-disciplinary and cross-disciplinary backgrounds, b) are successful in their REIS research activities, and c) are equipped with life-long learning tools and are successful in their future career, the REIS program takes them through the Graduate Certificate Program to equip them with necessary tools they need to achieve the above-mentioned goals, which are a part of the REIS Program overall goals. The success of our REIS graduates in their career, be it in academia or industry, is important to the overall goals of the nation in its quest towards replacing fossil fuels by renewable

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energy, and hence moving towards nation's energy independency. REIS Program while addresses the needs of Hawaiian Islands in its energy independency, it has broader goals of developing novel renewable production and storage devices with contributions in the area of smart grid, disaster mitigation, and sustainable tourism.

Mechanical Engineering (ME) Department and many of its faculty are participants and integrated part of the REIS Program. For example the following ME Faculty are Co-PIs and Senior Investigators in the REIS Research Program:

Table 1. REIS related research in the ME Department

ME Faculty (& Their Labs)	Research Areas
1. Dr. Mehrdad Ghasemi Nejhad, Prof. & Chair (Holmes Hall 307, 210, & 140)	1. Nanotechnology in Renewable Energy Production and Storage Devices; 2. Deployable Disaster Devices 3. Electric Vehicle Students Projects 4. Collaboration between REIS & PEEC/IKE
2. Dr. Beei-Huan Chao, Prof. & Grad. Chair (Holmes Hall 310A)	1. Efficiency in Combustion
3. Dr. Weilin Qu, Associate Prof. (Holmes Hall 355)	1. Water Desalination
4. Dr. Reza Ghorbani, Assistant Prof. (Holmes Hall 347)	1. Marine/Wave Energy 2. Hybrid Drivetrain

Table 1 shows that we have seven research laboratories, in the ME Department, where the ME Faculty conduct various REIS related research.

In addition, two of our ME Faculty (Dr. Beei-Huan Chao and Dr. Reza Ghorbani) are on REIS Education and Certificate Committee. Dr. Ghorbani has taught the first REIS related graduate course required by the REIS Certificate as a Core Course. He has already developed a graduate course in ME named ME 610 (Renewable Energy Engineering and Sustainability) and is working towards the development of the second course. Also, Drs. Nejhad & Ghorbani have taught ME 691 as REIS related Seminar Course, once each, over the past few years. Other ME Faculty affiliated with REIS (see Table 1) will teach other courses related to the REIS Graduate Certificate as outlines in the REIS Graduate Certificate Program Proposal.

In closing, the ME Department and ME Faculty are integrated part of the REIS Program, and I am committed to make the REIS Program and its Graduate Certificate a success and a venue to train and educate our students in this important area of renewable energy and energy efficiency.

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Please do not hesitate to contact me if you have any questions or need further information.

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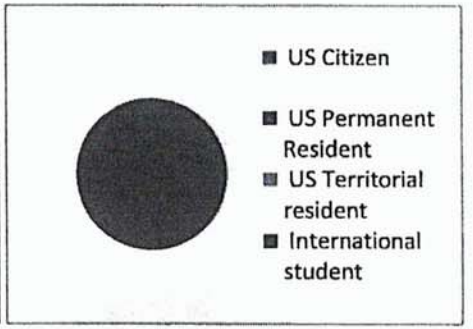
Appendix B

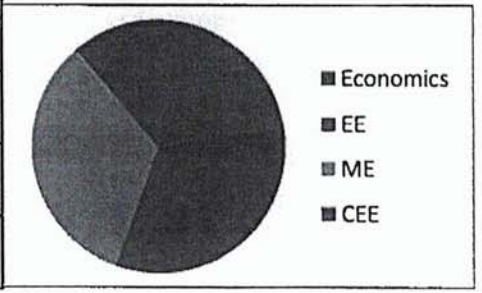
Attached are results from REIS student survey. The surveys show that the students are supportive of the REIS program. The survey also shows areas where the program is strong and where we can make improvements on the program. The surveys will be continued to be distributed to students on a regular basis so we can get feedback on our program and look at ways of improving the program.

SURVEY OF GRADUATE STUDENTS FOR REIS CERTIFICATE PROGRAM

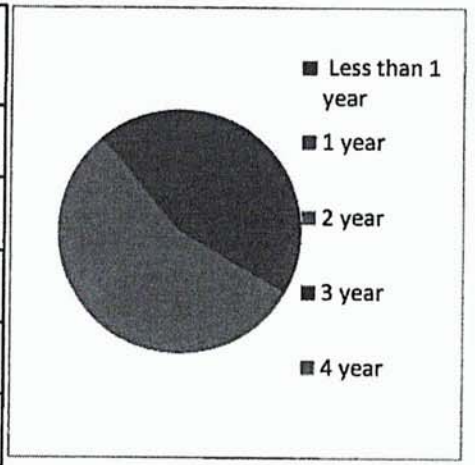
	Question	Answer	No. of Responses
1	Residency Status	US Citizen	6
		US Permanent Resident	0
		US Territorial resident	0
		International student	3



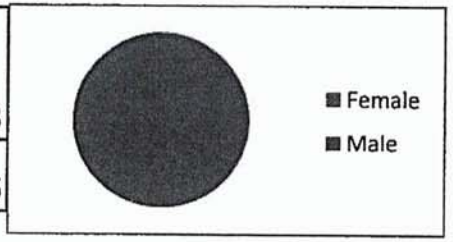
2	Department/College	Economics	2
		EE	3
		ME	3
		CEE	1



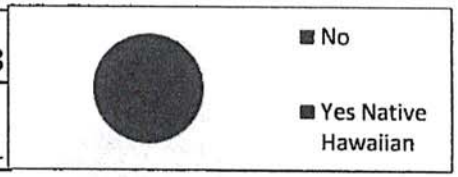
3	Number of Years in the program:	Less than 1 year	2
		1 year	1
		2 year	5
		3 year	1
		4 year	0
		5 or more years	0



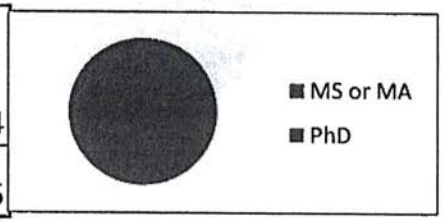
4	Gender	Female	3
		Male	6



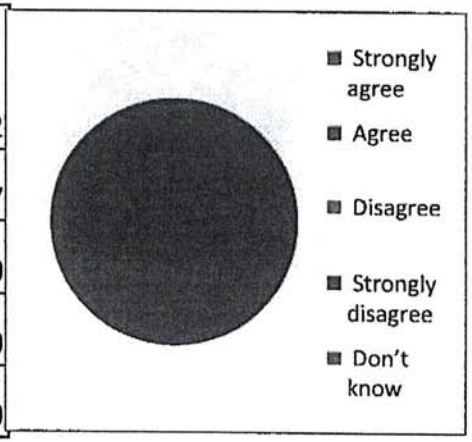
5	Minority?/Specify if Yes	No	8
		Yes Native Hawaiian	1



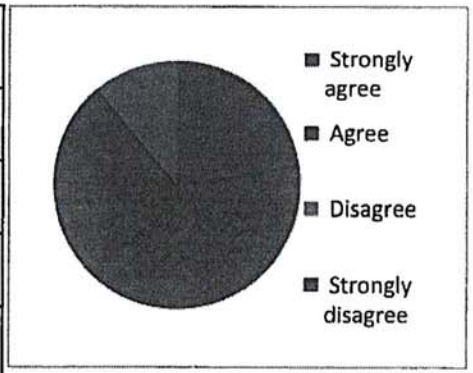
6	In which degree program are you enrolled?	MS or MA	4
		PhD	5



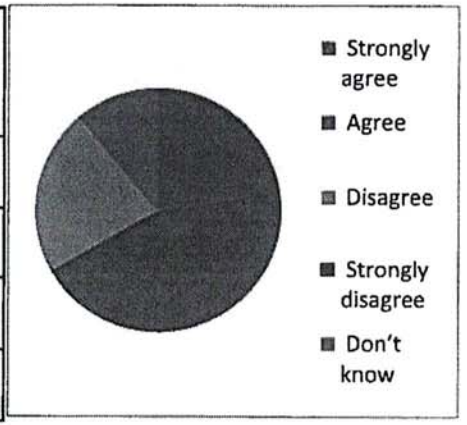
7	The program informs students of its learning outcomes/objectives.	Strongly agree	2
		Agree	7
		Disagree	0
		Strongly disagree	0
		Don't know	0



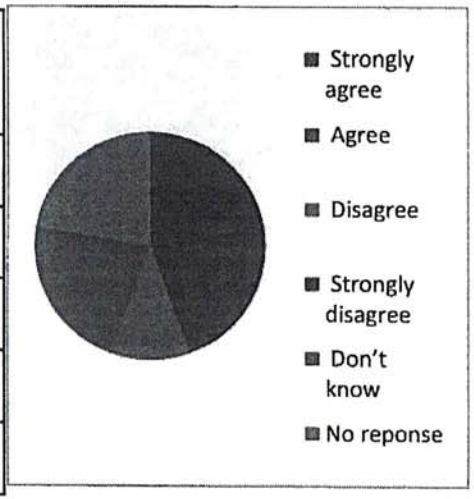
8	In general, students are well prepared to handle the program requirements.	Strongly agree	2
		Agree	6
		Disagree	0
		Strongly disagree	0
		Don't know	1



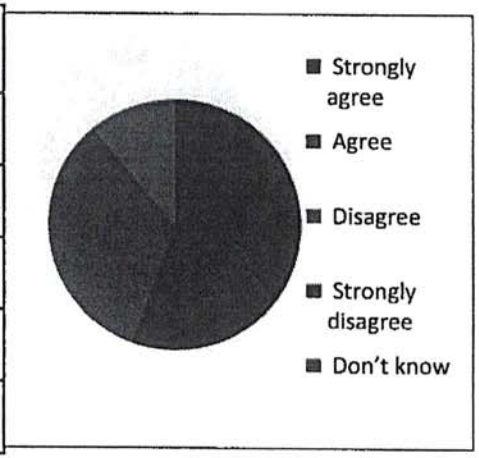
9	Students are provided with adequate information regarding program requirements.	Strongly agree	2
		Agree	4
		Disagree	2
		Strongly disagree	0
		Don't know	1



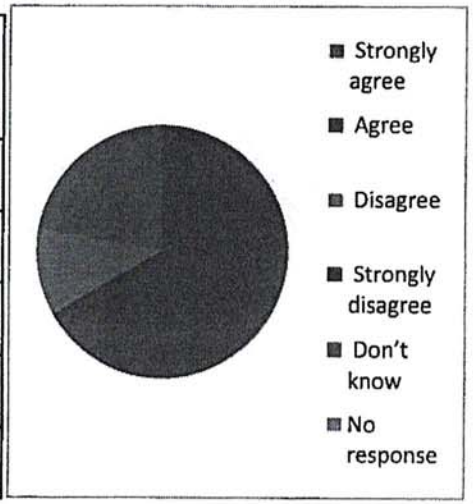
10	The program requirements are clearly stated by director at the beginning of your study.	Strongly agree	2
		Agree	2
		Disagree	1
		Strongly disagree	0
		Don't know	2
		No reponse	2



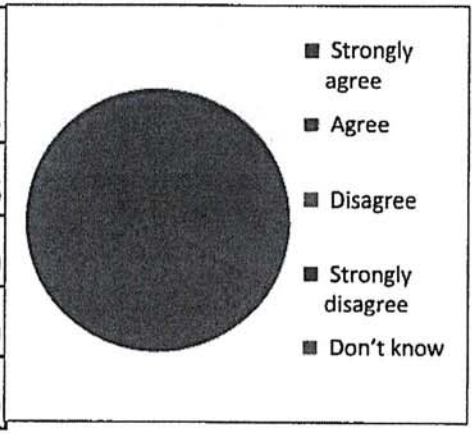
11	The program requirements are adequate.	Strongly agree	3
		Agree	2
		Disagree	0
		Strongly disagree	0
		Don't know	3
		No reponse	1



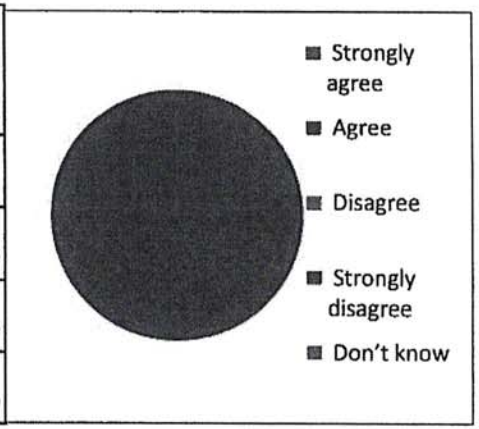
12	The quality of the program is sufficiently high to attract students.	Strongly agree	2
		Agree	4
		Disagree	1
		Strongly disagree	0
		Don't know	2
		No response	0



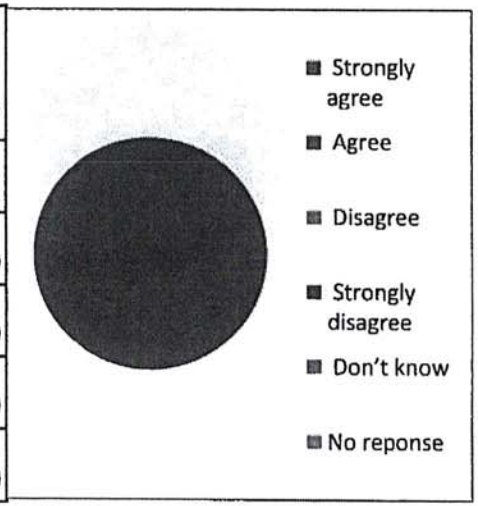
13	The quality of teaching the core courses in the program is high.	Strongly agree	3
		Agree	6
		Disagree	0
		Strongly disagree	0
		Don't know	0



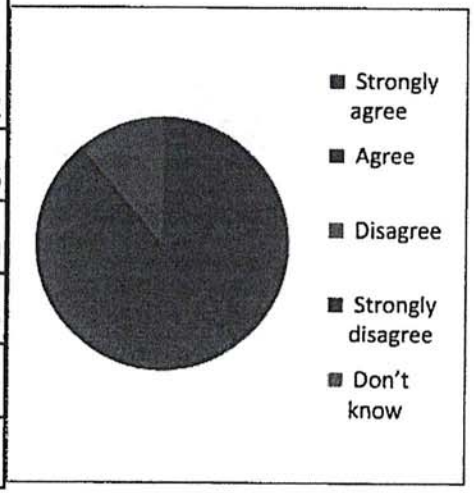
14	The quality of research and supervisor in the program is high.	Strongly agree	4
		Agree	5
		Disagree	0
		Strongly disagree	0
		Don't know	0



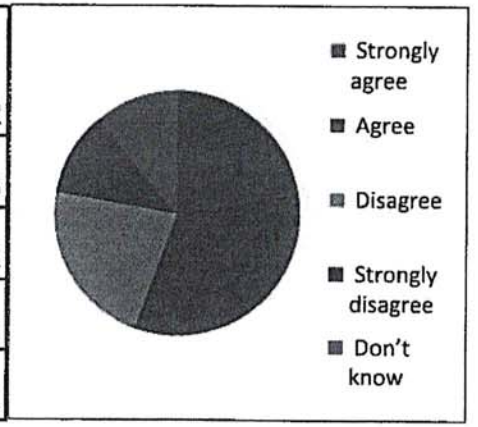
15	I learned a lot about Renewable Energy and Sustainability in this program.	Strongly agree	7
		Agree	2
		Disagree	0
		Strongly disagree	0
		Don't know	0
		No reponse	0



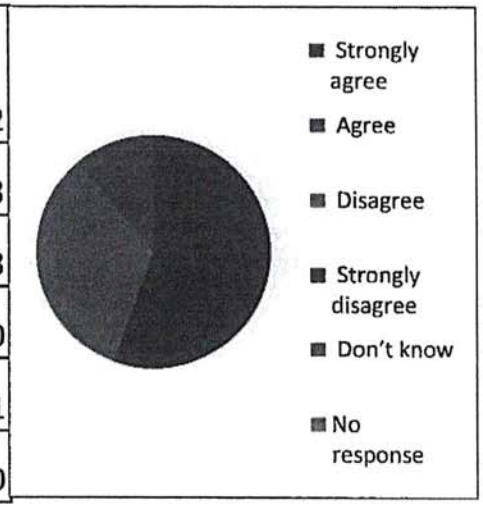
16	The quality of the research facilities is adequate to meet the needs of the thesis.	Strongly agree	2
		Agree	6
		Disagree	0
		Strongly disagree	0
		Don't know	1
		No response	0



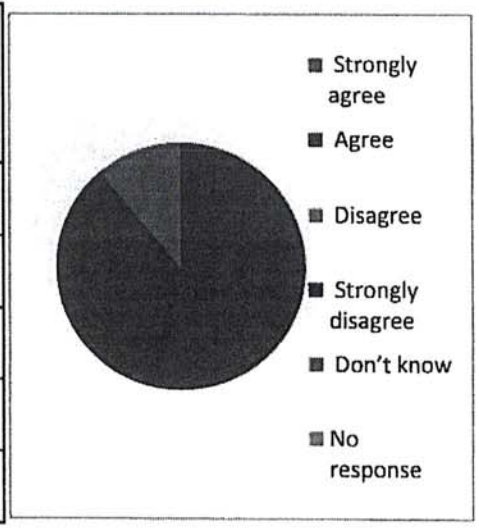
17	The program encourages students to participate in internships, service learning, exhibitions, performances, or	Strongly agree	2
		Agree	3
		Disagree	2
		Strongly disagree	1
		Don't know	1



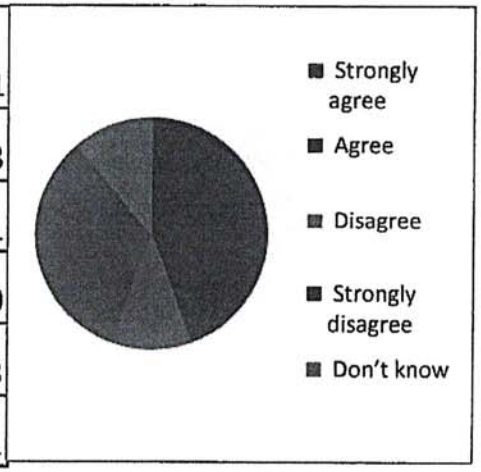
18	The program prepares students for careers in Renewable Energy and Sustainability.	Strongly agree	2
		Agree	3
		Disagree	3
		Strongly disagree	0
		Don't know	1
		No response	0



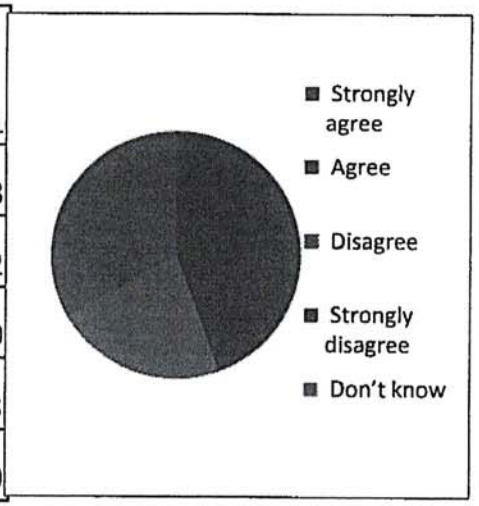
19	Faculty mentoring is helpful to students to attain their degree certificate and future career goals.	Strongly agree	3
		Agree	5
		Disagree	0
		Strongly disagree	0
		Don't know	0
		No response	1



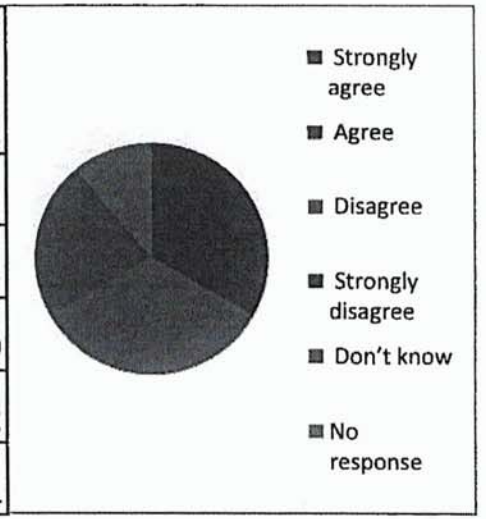
20	The program ensures that its students finish in a timely manner.	Strongly agree	1
		Agree	3
		Disagree	1
		Strongly disagree	0
		Don't know	3
		No response	1



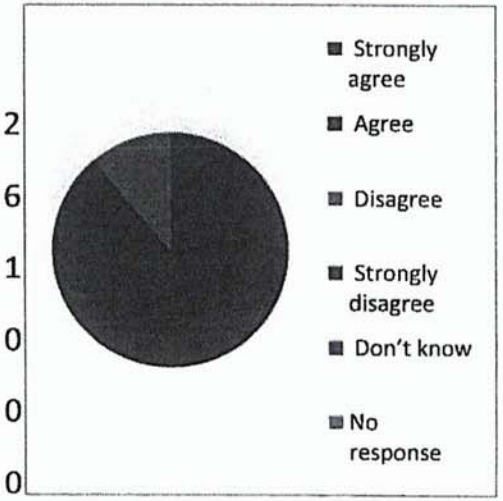
21	The program invites student feedback on important decisions that affect them.	Strongly agree	1
		Agree	3
		Disagree	2
		Strongly disagree	0
		Don't know	3
		No response	0



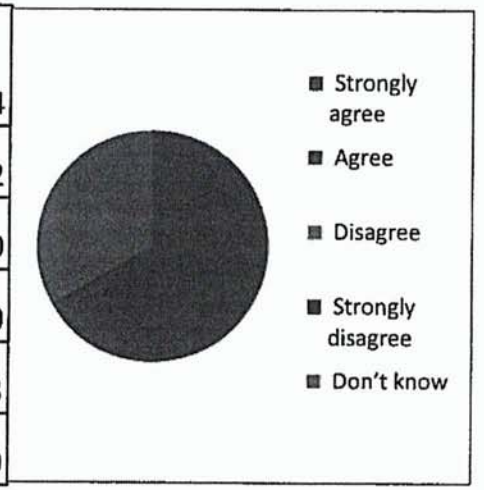
22	The program provides an open environment for addressing legitimate student concerns.	Strongly agree	1
		Agree	2
		Disagree	3
		Strongly disagree	0
		Don't know	2
		No response	1



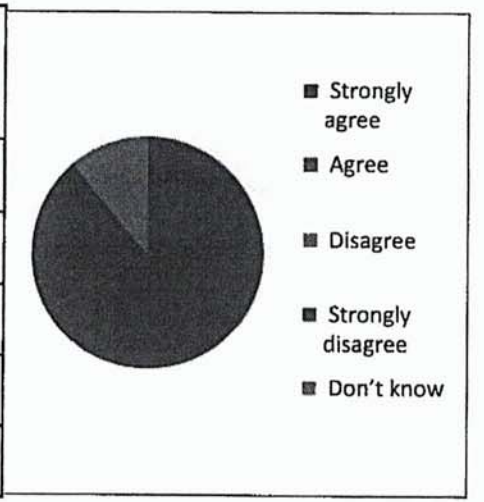
23	The program fosters a climate of respect for diversity of backgrounds, ideas, and perspectives.	
	Strongly agree	2
	Agree	6
	Disagree	1
	Strongly disagree	0
	Don't know	0
	No response	0



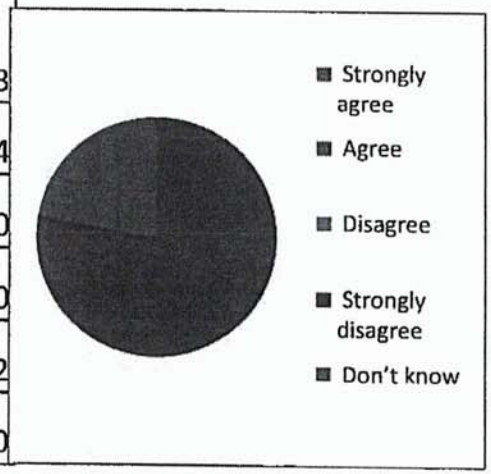
24	Student morale in the program is high.	Strongly agree	4
		Agree	2
		Disagree	0
		Strongly disagree	0
		Don't know	3
		No response	0



25	The program provides a safe learning environment free from harassment or coercion.	Strongly agree	6
		Agree	2
		Disagree	0
		Strongly disagree	0
		Don't know	0
		No response	1



26	If I could start over, I would choose this program again.	Strongly agree	3
		Agree	4
		Disagree	0
		Strongly disagree	0
		Don't know	2
		No response	0



Appendix C

Renewable Energy and Island Sustainability Seminar Syllabus

Catalog Description

Course Number (CEE691, ME 691, EE 699): One unit seminar course on current topics in energy and sustainability. This class will meet one hour per week with seminars given by industry, government, and academic experts in energy and sustainability. Topics include renewable energy (wind, solar, wave, biofuels, geothermal), energy efficiency, smart grids, and sustainability issues (energy, water, food, environment). At the end of the semester students will give short presentations on energy and sustainability issues.

Credits: 1 unit

Pre- and Co-requisites: None

Class schedule: 1 hour per week

Class will consist of seminars given by industry, government, and academic experts in energy and sustainability. 12 to 13 seminars will be given. The last one to two weeks will be devoted to students giving short presentations on energy and sustainability topics. The seminar class has been given the last three years with seminar schedule for Fall, 2011 shown on the succeeding pages.

Grading will be credit/ no credit with grade determined by attendance, filling out summaries of seminar speakers, and giving seminar presentations.

Fall 2011

ME691/EE699 Seminars in Renewable Energy and Island Sustainability (REIS)

1 credit graduate course in the College of Engineering, UHM

Thursdays, 4:30 – 5:30 pm, Holmes Hall 244

Instructors: Reza Ghorbani (ME691) and Xiangrong Zhou and Tony Kuh (EE699)

Date	Speaker	Tentative Topic
08/25	Tony Kuh Prof. and Chair EE Director REIS, UHM kuh@hawaii.edu	Introduction to the REIS Program
09/01	Jeff Mikulina Executive Director, Blue Planet Foundation jeff@blueplanetfoundation.org	Hawaii clean energy challenge: innovating out of adversity
09/08	Jennifer Yoshimura Renewable Energy Planning Engineer Hawaiian Electric Company jennifer.yoshimura@heco.com	Forming the Renewable Community
09/15	Dr. Jay Griffin Assistant Specialist, HNEI, UHM griffin4@hawaii.edu	Maui Smart Grid Project
09/22	Dr. Mark Duda Principal and founder, RevoluSun mark@dephawaii.com	Hawaii's Solar Future
09/29	Maria Tome Renewable Energy Program Manager, DBEDT mtome@dbedt.hawaii.gov	Transportation Energy and Electric Vehicles
10/06	Michael Champley PUC champleym@hotmail.com	Technology and Policy Issues Related to Hawaii's Transition to Clean Energy
10/13	Dawn Lippert Project Manager, HREDV dawn.lippert@pichtr.org	Innovation in Hawaii's Clean Tech Sector
10/20	Joshua Strickler PUC Joshua.B.Strickler@hawaii.gov	Renewable Energy Development
10/27	Prof. Tao Yan Civil and Environmental Engineering, UHM taoyan@hawaii.edu	Water and Energy Nexus: The Wastewater Component
11/03	David Hafner	University of Hawaii Smart

	Asst. Vice Chancellor Office of Facilities and Grounds UHM hafner@hawaii.edu	Microgrid
11/10	Wren Wescoatt Manager First Wind wwescoatt@firstwind.com	Developing Wind Energy in Hawaii
11/17	Prof. Maxine Burkett Law School, UHM burkettm@hawaii.edu	Climate Change Adaptation, Migration, and the Law
12/01	Student speakers	Each student gives a 10 min oral presentation on a topic related to REIS

Fall 2012

CEE691/ME691/EE699 Seminars in Renewable Energy and Island Sustainability (REIS)

1 credit graduate course in the College of Engineering, UHM

Thursdays, 4:30 – 5:30 pm, Holmes Hall 244

Instructors: Michelle Teng (CE691), Zac Trimble (ME691), and Tony Kuh (EE699)

Date	Speaker	Tentative Topic	Instructor in Charge
08/30	Tony Kuh Prof. and Chair EE Director REIS, UHM kuh@hawaii.edu	Introduction to the REIS Program	Zac
09/6	Mehrdad Ghasemi Nejhad Chair, ME, UHM nejhad@hawaii.edu	Nanotechnology in Renewable Energy Production and Storage Devices	Zac
09/13	Matthias Fripp Assistant Professor, EE, UHM mfripp@hawaii.edu	Optimal Design of Power Systems with Large Shares of Renewable Energy	Tony
09/20	Dr. William Flanagan Director, Ecoassessment Center, GE Company, GE Global Research Niskayuna, NY	Life Cycle Assessment at GE: An overview of GE's Environmental Life Cycle Assessment Efforts	Tony
09/27	Steve Meder, ARCH	Sustainable architectural design	Zac
10/4	Leon Roose, HNEI lroose@hawaii.edu	Maui Smart Grid	Tony
10/11	Yue Qi and Xingcheng Xiao General Motors R&D Center Warren, MI	Lithium ion batteries; modeling, experimentation, and materials	Zac
10/18	Gordon Grau Professor and Director of Sea Grant UHM	Sustainability programs at Sea Grant	Michelle
10/25	Oceana Francis Assistant Professor, CEE, UHM oceanaf@hawaii.edu	Sea level changes and coastal sustainability	Michelle

11/1	Scott Turn, HNEI	Research in Support of Bioenergy/Biofuel Development	Tony
11/8	Mark Ambler Weston Solutions, Inc. Mark.Ambler@westonsolutions.com	Green roof technology	Michelle
11/15	Dora Nakafuji HECO dora.nakafuji@heco.com	Renewable energy program at HECO	Tony
11/29	Nori Tarui, ECON	Economics of renewable energy	Zac
12/6	Student speakers	Each student gives a 10 min oral presentation on a topic related to REIS	Michelle

Appendix D

Syllabi of two core REIS courses;

Econ 636 and ME 610

These two courses were both taught Spring 2011 and Spring 2012 semesters.

Ver. November 21, 2011

University of Hawaii at Manoa
Department of Economics

ECON 636 Spring 2012
Renewable Energy Economics and Policy
MW 1:30-02:45PM SAUNDERS 541

Instructor: Nori Tarui Office: Saunders 518
Phone: 956-8427 Email: nori@hawaii.edu
Office Hours: MW 10:30-11:30

***Upon approval of Renewable Energy and Island Sustainability (REIS) Graduate Certificate Program, this course will satisfy a core-course requirement for the certificate. The course will not count as a field course for Economics PhD students. The course could satisfy the area of concentration requirement for Economics MA students. The instructor's approval is required for registration.**

Learning Objectives and Course Content:
This course reviews economic and policy aspects of renewable energy issues. In order to help students see renewable energy issues in perspective, the course will also review non-renewable, conventional energy sources including fossil fuel and nuclear power. Topics include the economics of major renewable energy options (e.g. bioenergy, wind, solar, and geothermal energy) as well as the energy mix between various fossil-fuel and renewable energy options. Students will learn about:

1. Basic economic concepts for analyzing renewable energy development;
2. Major criteria used in policy discussions (e.g. efficiency, energy security, sustainability);
3. Major positive and normative issues and analytical tools in renewable energy economics and policy.
4. The current market structures of nonrenewable and renewable energy options;
5. How to analyze the effects of alternative renewable-energy policies, with applications to renewable energy development in Hawaii.

Prerequisites:
College calculus and principles of economics, or consent.

Course Requirements:

Problem Sets	20%
Midterm	20%
Final exam	30%
Group project, presentation, participation:	30%

There will be periodic problem sets to understand the theory of energy economics and policy and to apply the theory in the context of renewable energy. The problem sets consist of (i) analytical exercises that involve calculus in order to understand decision making by energy producers, consumers, and regulators as well as market allocations of energy; (ii) cost-benefit analysis

exercises of renewable energy policies, and (iii) short-essay questions on renewable energy policies.

In class, you will be asked to present an overview of a selected renewable energy option from an economics point of view. The instructor will guide you in terms of the references and the content of your presentations.

You will also participate in a group project addressing the policy aspects of renewable energy options in Hawaii, where you apply cost-benefit analysis and/or other research tools.

Textbooks

The following is a required textbook.

Moselle, Boas, Jorge Padilla and Richard Schmalensee, eds. *Harnessing Renewable Energy in Electric Power Systems* RFF Press/Earthscan, 2010.

The lectures will also draw on several references including the following optional textbooks:

Bosselman, Eisen, Rossi, Spence and Weaver *Energy, Economics and the Environment*, Third Edition, West Academic, 2010. **(BERSW)**

Dahl, Carol A. *International Energy Markets: Understanding Pricing, Policies, and Profits,* Pennwell Corporation, 2004. **(Dahl)**

Peirce, William Spangar *Economics of the Energy Industries*, Second Edition, Praeger, 1996. **(Peirce)**

Viscusi, W. Kip, Harrington, Joseph E., Vernon, John M. *Economics of Regulation and Antitrust.* Fourth Edition, MIT Press, 2005. (**VHV**; electronic version available at UHM Library)

Most of the readings for the course are journal articles, and will be (mostly) available at Laulima.

Upon request, I will suggest additional technical readings for economics graduate students.

Topics to be covered

***Classes will be mostly lectures and student presentations. Occasionally we will have in-class exercise and group-project discussions.**

0. Introduction: why economics and policy for energy?
    a. Energy use in historical perspective
    b. Why economics
    c. Measurements and key concepts of energy

    Readings:
    Dahl Ch 1
    OECD/IEA *World Energy Outlook* 2010
    US Energy Information Agency (EIA) Energy Basics 101
    Smil, Vaclav. *Energy in World History* Westview, 1994, Ch 6, 7.
    Maddison, Angus. The World Economy: A Millennial Perspective. OECD, 2007.

1. Basics of energy economics and policy
    a. Supply, demand, market equilibrium, price elasticity

b. Market power
c. Natural monopoly and utility regulation
d. Externality
e. Discounting and project finance
f. Gains from trade, energy-import dependence, energy security, opportunity cost
g. Sustainability

Readings:
Pindyck, R. and D. Rubinfeld *Microeconomics*, 7th edition, Pearson, 2007, Ch 2, 9, and 18.
Tietenberg, Tom and Lynne Lewis. *Environmental and Natural Resource Economics*, Eighth Edition, Pearson, 2008, Ch. 4, 5.
Pascual, Carlos and Jonathan Elkind, eds. *Energy Security: Economics, Politics, Strategies, and Implications*. Brookings Institution Press, 2010, Ch. 4 and 5.

2. Overview of major fossil-fuel energy options and nuclear power
   a. Coal: market structure, "clean coal," carbon capture and sequestration
      MIT The Future of Coa.l http://web.mit.edu/coal/
      US EIA on coal US EIA on
      coal http://www.eia.gov/energyexplained/index.cfm?page=coal_home
   b. Oil: world oil market, energy security, the price trend in the past and the future
      US EIA on oil http://www.eia.gov/energyexplained/?page=oil_home
      On global oil market structure:
      Nordhaus, W. (2009) "The Economics of an Integrated World Oil Market," http://nordhaus.econ.yale.edu/recent_stuff.htm
      Smith, J.L. (2009) "World Oil: Market or Mayhem?" *Journal of Economic Perspectives*, 23(3): 145–64. (Available on laulima)
   c. Natural Gas: regulation, deregulation, and markets
      US EIA on natural
      gas http://www.eia.gov/energyexplained/index.cfm?page=natural_gas_home
      MIT The Future of Natural
      Gas http://web.mit.edu/ceepr/www/publications/index.html
      http://web.mit.edu/ceepr/www/publications/Natural_Gas_Study.pdf
   d. Nuclear power: energy security and waste management)
      US EIA on nuclear
      energy http://www.eia.gov/energyexplained/index.cfm?page=nuclear_home
      MIT The Future of Nuclear Power http://web.mit.edu/nuclearpower/

   Other readings: BERSW Ch. 5, 6, 7, 8, 14, Dahl Ch. 3, 6, 7.

3. Economic and policy aspects of electricity generation
   a. Generation, transmission and distribution
   b. Public utility regulation, rates-of-return regulation, and electricity pricing
   c. Smart grid and information security
   d. Energy efficiency and energy conservation

   Readings:
   VHV Ch. 11, Ch. 12

Griffin, James M. and Steven L. Puller eds. *Electricity Deregulation.* The University of Chicago Press, 2005, Introduction, pp. 1-28.
Gillingham,K., R. G. Newell, K. Palmer "Energy Efficiency Economics and Policy" *Annual Review of Resource Economics*, Vol. 1: 597 -620, 2009.

4. Overview of major renewable energy options
    a. Hydropower
    b. Solar power (thermal and photovoltaic, decentralized vs centralized)
    c. Wind power
    d. Biofuels
    e. Geothermal, ocean thermal energy conversion, energy storage technology, and other options

   Readings: OECD/IEA *World Energy Outlook* 2010.
   MPS Ch 4, 5.

5. Policies of renewable energy
    a. Price-based instruments including feed-in tariffs
    b. Quantity-based instruments including renewable portfolio standards
    c. Subsidies and tax credit for energy development

   Readings:
   MPS Ch 11.
   Heal, G. (2010) Reflections—The Economics of Renewable Energy in the United States. *Review of Environmental Economics and Policy* 4(1) 139-154.
   Palmer, Karen L., Richard Sweeney, Maura Allaire. Modeling Policies to Promote Renewable and Low-Carbon Sources of Electricity. RFF Backgrounder, June 2010. http://www.rff.org/Publications/Pages/PublicationDetails.aspx?PublicationID=21281.
   Fischer, Carolyn, Louis Preonas. Combining Policies for Renewable Energy: Is the Whole Less than the Sum of Its Parts? RFF Discussion Paper 10-19, March 2010, http://www.rff.org/Publications/Pages/PublicationDetails.aspx?PublicationID=21041.
   DSIRE: Database of State Incentives for Renewables & Efficiency. http://www.dsireusa.org.

6. Energy use and renewable energy potential in Hawaii
    a. Application: Hawaii Clean Energy Initiative (HCEI) http://www.hawaiicleanenergyinitiative.org/
    b. Hawaii Act 234 (Greenhouse gas emission reduction) http://hawaii.gov/dbedt/info/energy/policy/

7. Topics: US national aspects and global aspects of renewable energy
    a. Energy demand and supply in the long run
    b. Climate change and other environmental constraints

   Reading: OECD/IEA *World Energy Outlook* 2010.

8. Topics: Renewable energy in the context of climate-change policies

a. Economics of climate change: how much greenhouse gas emissions should be controlled, and how fast?
b. Policies to reduce GHG emissions and their implications to renewable energy development: emissions tax, emissions trading, voluntary approaches, carbon credits and offsets
c. International agreements on climate change mitigation
d. Renewable energy policies in the context: renewable energy certificates REC, climate registries

Readings:
Stern Review and discussions by William Nordhaus, Martin Weitzman, Partha Dasgupta, Geoffrey Heal, etc.

Disability Access
If you feel you need reasonable accommodations because of the impact of a disability, please: (1) contact the KOKUA Program (V/T) at 956-7511 or 956-7612 in room 013 of the QLCSS (Queen Lili'uokalani Center for Student Services); (2) speak with me privately to discuss your specific needs. I will be happy to work with you and the KOKUA Program to meet access needs related to a documented disability.

ME 610: Renewable Energy Engineering and Sustainability

(Principles of renewable energy technologies, production and distribution, solar, biomass, hydro, wind, wave, tidal, geothermal as well as smart grid and storage.)

This course covers the theoretical and technological background of renewable energy generation and distribution and its interactions with sustainability. Students from different disciplines are the general audience of the course. However basic knowledge of physics, biology, dynamics and thermal science are required. The emphasize of the course is on solar, biomass, hydro, wind, wave, tidal, geothermal as well as smart grid and storage. The goal of the course is to review both the scientific background and technological potential of renewable energy generation and distribution. Teamwork, communication and problem solving on class projects and discussions are required. Students may be involved in completing an industrial project on renewable energy in Hawaii.

Instructor: Reza Ghorbani, Assistant Professor
Office: Holmes 201, Mechanical Engineering, University of Hawaii at Manoa
Phone: 808-956-2292
Email: Rezag@hawaii.edu

Textbook: Godfrey Boyle, "Renewable Energy", 2004, Oxford University Press, in association with The Open University.

Prerequisite: Basic knowledge in physics, biology, dynamics, and thermodynamics; or Consent.

Expected course outcomes:
At the successful completion of the course, the student is expected to have/be able to:

- List and generally explain the main sources of energy and their primary applications in the world.
- Describe the challenges and problems associated with the use of various energy sources, including fossil fuels, with regard to future supply and the environment.
- Describe/illustrate basic scientific/technological concepts of the main renewable energy generation techniques such as solar, biomass, hydro, wind, wave, tidal and geothermal.
- Thoroughly study a specific topic on renewable energy related to student's field of study.
- Work in a team setting project.

Exams and quizzes: Your grade is based on the assignments, final written exam, and quality of the final project, as well as the written and oral presentation. Extra time involvement for the project is required. The breakdown of grading is as follows:

Class participation and discussion	20%
Homework assignments	20%
Renewable energy project	40%
Final exam (comprehensive)	20%
TOTAL	100%

Tentative outline of the topics:

Syllabus Introduction
Energy: Past, Today, and Future
- A brief history of energy consumption

Energy & Environment
- Climate change and climate modeling
- Current US and other major government policies and incentives
- Power needs, base load, reliability, energy storage and smart grid
- Non-renewable Energies. A basic comparison or fossil, nuclear and renewable alternatives

Solar Energy
- Sun and its energy
- Basics of solar energy
- Solar energy in the past
- Solar thermal energy
  - Basic science
  - Technology, Active and Passive
- Solar Photovoltaic
  - Basic science
  - Technology and manufacturing process
  - Economy

Biomass
- Biomass energy
- Conversion technologies
- Biomass boilers
- Plant design

Geothermal Energy and Stationary Combustion Systems
- Fundamental of combustion cycle calculation
  - Rankine Vapor Cycle
  - Brayton Gas Cycle
- Advanced Combustion Cycles for Maximum Efficiency
  - Supercritical Cycle
  - Combined Cycle
  - Cogeneration and Combined Heat and Power (CHP)

Hydro
- Hydro power
- Turbine classification
- Impulse turbine theory

- Impulse turbine design
- Environmental impact

Wind Energy
- Historical background
- Wind resources
- Wind turbines
  - Horizontal and vertical
  - Aerodynamics of blades
    - Airfoils
    - Relative velocity of wind
    - Rotor disc theory
    - Lift force
    - Drag based turbines
  - Structure
  - Subsystems
- Electrical machines
  - Principles of electromagnetism
  - Alternating current
  - Conversion of mechanical to electrical power
  - Synchronous generators
  - Variable speed permanent magnet
  - Asynchronous generators
- Environmental impact

Introduction to Marine Energy
- Wave energy
- Tidal energy

Water-Energy Nexus
- Water to generate energy
- Energy to use water
- Co-management

Tentative Timeline:

Tuesday	**Thursday**
Jan 10 Energy: Past, Today, and Future. A brief history of energy consumption	**Jan 12 (No Class!)** **MINI Project**
Jan 17 (No Class!) **MINI Project**	**Jan 19** Energy & Environment, Climate
Jan 24 Intro to Thermal Science	**Jan 26** Sun and Basics of Solar Energy, Solar Heat
Jan 31 Solar Thermal Technologies, Solar Photovoltaic Introduction	**Feb 2** Solar Photovoltaic Science

Feb 7 Solar Photovoltaic, Manufacturing, Market	**Feb 9** Biomass Energy, Market and feedstock
Feb 14 Biomass Energy Technologies	**Feb 16** Biomass Energy Technologies
Feb 21 Project Discussion/First Presentation	**Feb 23** Hydro Power, Turbines
Feb 28 Geothermal	**March 1** Wind Energy, Historical Background
March 6 Wind Turbines Aerodynamics	**March 8** Wind Resources, Electrical Generators
March 13 Wing Turbine and Grid	**March 15** Wind Energy Open Discussion
March 20 **PROJECT WEEK**	**March 22** **PROJECT WEEK**
March 27 **NO Class:** Spring Recess	**March 29** **NO Class:** Spring Recess
April 3 Wave Energy, Resources	**April 5** Wave Energy Convertors
April 10 Tidal Energy	**April 12** Smart Grid and Control
April 17 Energy Storage	**April 19** Transportation
April 24 Energy-Water Nexus	**April 26** **Class Project (RE Planning)**
May 1 **Final Project Presentation**	**May 3** **Final Project Presentation** **(Final Exam Posted)**
May 8 **Final Exam Due**	

Appendix E

Current Support by REIS faculty

Investigator: Anthony Kuh
Project/Proposal Title: Workforce Training, Integrated Education and Research in Clean Energy and Island Sustainability
Source of Support: Department of Energy
Total Award Amount: $2,500,000
Total Award Period Covered: 5/04/2010 – 06/30/2014
Location of Project: University of Hawaii

Investigator: Anthony Kuh
Project/Proposal Title: Hawaii Energy and Environmental Technologies
Source of Support: ONR
Total Award Amount: $200,000
Total Award Period Covered: 12/01/2009 – 06/30/14
Location of Project: University of Hawaii

Investigator: Anthony Kuh
Project/Proposal Title: Sensing, Modeling, and Control of Smart Sustainable Microgrids
Source of Support: NSF
Total Award Amount: $360,000
Total Award Period Covered: 07/01/2013 – 06/30/2016
Location of Project: University of Hawaii

Investigator: Anthony Kuh
Project/Proposal Title: JST/NSF Cooperative Distributed Energy Management Systems
Source of Support: NSF
Total Award Amount: $89,511
Total Award Period Covered: 12/15/2013 – 11/30/2014
Location of Project: University of Hawaii

Investigator: Philip Johnson
Project/Proposal Title: Human-centered information integration for the smart grid
Source of Support: NSF
Total Award Amount: $417,000
Total Award Period Covered: 2010 – 2014
Location of Project: University of Hawaii

Investigator: Beei-Huan Chao
Project/Proposal Title: A Novel Approach to Clean, Efficient Flames
Source of Support: NASA
Total Award Amount: $39,000
Total Award Period Covered: 2011 – 2014
Location of Project: University of Hawaii

Investigator: Mehrdad N. Ghasemi Nejhad
Project/Proposal Title: Nanotechnology Initiative in Composites and Energy, NICE
Source of Support: Adama Materials, Inc.
Total Award Amount: $475,000
Total Award Period Covered: 2010 – 2014
Location of Project: University of Hawaii

Investigator: Mehrdad N. Ghasemi Nejhad
Project/Proposal Title: Development of High Performance SiC-SiC Composites-Phase III
Source of Support: TREX Enterprises Corporation
Total Award Amount: $125,000
Total Award Period Covered: 2012– 2014
Location of Project: University of Hawaii

Investigator: Mehrdad N. Ghasemi Nejhad
Project/Proposal Title: Friction Stir Blind Riveting for Dissimilar Materials
Source of Support: NSF
Total Award Amount: $296,113
Total Award Period Covered: 2014– 2017
Location of Project: University of Hawaii

Investigator: Michelle Teng
Project/Proposal Title: Numerical modeling and wave tank studies on wave energy conversion devices
Source of Support: DOE
Total Award Amount: $97,194
Total Award Period Covered: 2008– 2014
Location of Project: University of Hawaii

Investigator: Reza Ghorbani
Project/Proposal Title: AIS: Collaborative Research: A Novel Intelligent Grid Optimization Architecture Using Hierarchical Multi-Agent Framework for Modern Sustainable Power Grid
Source of Support: NSF
Total Award Amount: $315,508
Total Award Period Covered: 2013– 2016
Location of Project: University of Hawaii

Investigator: Reza Ghorbani
Project/Proposal Title: Electric Vehicle Transportation Center
Source of Support: US DOT
Total Award Amount: $500,000
Total Award Period Covered: 2014– 2018
Location of Project: University of Hawaii

Investigator: Reza Ghorbani
Project/Proposal Title: Advanced education modules for renewable energy integration to the grid
Source of Support: DOE
Total Award Amount: $513,590
Total Award Period Covered: 2014– 2018
Location of Project: University of Hawaii

Appendix F
REIS students supported on grants