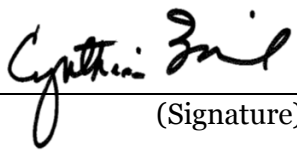
Proposing Institution:	South Carolina State University
Program Title:	M.S. in Energy and Environment
Date of Submission:	January 14, 2013
Contact Name and Information:	Stanley N. Ihekweazu, Ph.D., CMfg.E. Interim Dean, College of Science, Mathematics, Engineering and Technology South Carolina State University 300 College Street, NE Orangeburg, SC 29117 (803) 536-7132 sihekwea@scsu.edu

Cynthia Warrick, Ph.D.
Interim President, South Carolina State University



1/15/2013
(Signature)

2. Classification

Program Title:	M.S. in Energy and Environmental Science
Options:	Environmental and Energy with thesis and non-thesis
Academic Unit:	Department of Biological & Physical Sciences and Department of Civil & Mechanical Engineering Technology and Nuclear Engineering
Designation:	Master of Science
Implementation Date:	August 2013
CIP code:	30104
Site:	Main Campus, Orangeburg, SC
Qualification for Supplemental Palmetto Fellows Scholarship and LIFE Scholarship Awards:	No
Delivery Mode:	Traditional

3. Institutional Approval

The following institutional bodies have approved this proposal and their dates of approval are also indicated.

- The Vice-President of Academic Affairs (April 26, 2010), the Educational Policies Council (July 28, 2010), the Faculty Senate (September 28, 2010), the President (September 28, 2010), and the Board of Trustees (September 29, 2010).

4. Purpose

South Carolina State University (SC State) proposes an interdisciplinary-based M.S. in Energy and Environmental Science (MSEES) degree. This MSEES is designed for professionals or new graduates in the Science, Technology, Engineering & Mathematics (STEM) disciplines to fill the growing needs of the energy and environmental industries for qualified managers, technical program directors, and research associates. The program will be housed in the Department of Biological & Physical Sciences and the Department of Civil and Mechanical Engineering Technology and Nuclear Engineering within the College of Science, Mathematics, Engineering and Technology (CSMET).

The program objectives are:

- to prepare students for employment in energy industries and governmental agencies related to energy production and environmental management,
- to prepare students who will be needed to help devise ways to prevent future harm to both the environment and public health, and
- to prepare students who will craft and enforce government policies, regulations and procedures related to green-energy production and environmental protection.

5. Justification

Expansion of existing energy industries and new renewable energy enterprises is generating a crucial need for professionals trained mutually in energy and environmental sciences.

According to the US Bureau of Labor Statistics (BLS) *Occupational Outlook Quarterly, Summer 2009*, the most significant educational training for the entry-level environmental scientist position is the master's degree. This new MSEES program will enable students with undergraduate degrees in the sciences and engineering to expand their career opportunities and attain skill levels needed for career advancement. Students will gain specialized technical and management skills focused on energy development and environmental management, building upon their undergraduate science and engineering preparation. Rather than preparing students only to be academic researchers, the MSEES program will also prepare students for employment in energy industries and governmental agencies related to energy production and environmental management.

5.1 Need for Program

Projections by the Bureau of Labor Statistics (BLS)*Occupational Outlook Quarterly, Summer 2009*, forecast that employment of environmental scientists and engineers will grow at a rate that is much faster than the average for all occupations between 2006 and 2016. Further, the BLS *Occupational Outlook Handbook 2012-13 Edition* (published March 29, 2012) states: "Employment of environmental engineers is projected to grow 22 percent from 2010 to 2020, faster than the average for all occupations" (http://www.bls.gov/ooh/architecture-and-engineering/environmental-engineers.htm). The increased demand according to BLS will result from a need to comply with environmental laws and regulations and a need to develop methods for clean-up of existing hazards. Additionally, such workers will be needed to help devise ways to prevent future harm to both the environment and public health.

According to the BLS (*http://www.bls.gov/ggs/ggsoverview.htm*), green goods and services fall into one or more of five categories:

1) *Energy from renewable sources*. Electricity, heat, or fuel generated from renewable sources. These energy sources include wind, biomass, geothermal, solar, ocean, hydropower and land fill, gas, and municipal solid waste.
2) *Energy efficiency*
    - Products and services that improve energy efficiency. Included in this group are energy-efficient equipment, appliances, buildings, and vehicles, as well as products and services that improve the energy efficiency of buildings and the efficiency of energy storage and distribution, such as smart grid technologies.
3) *Pollution reduction and removal, greenhouse gas reduction, and recycling and reuse*. Those products and services that:
    - reduce or eliminate the creation or release of pollutants or toxic compounds, or remove pollutants or hazardous waste from the environment;
    - reduce greenhouse gas emissions through methods other than renewable energy generation and energy efficiency, such as electricity generated from nuclear sources; and
    - reduce or eliminate the creation of waste materials; collect, reuse, remanufacture, recycle, or compost waste material or wastewater.
4) *Natural resources conservation*. Products and services that conserve natural resources. Included in this group are products and services related to organic agriculture and sustainable forestry; land mgmt., soil, water, or wildlife conservation and storm water.
5) *Environmental compliance, education and training and public awareness*. These are products and services that:
    - enforce environmental regulations;
    - provide education and training related to green technologies and practices; and
    - increase public awareness of environmental issues.

Also, according to the BLS, the average annual salaries of professionals (environmental scientists, environmental engineers, operational managers, geoscientists and mechanical engineers) in the above-mentioned professional categories range from $67,000 to $133,000. (http://www.bls.gov/news.release/ggsocc.t06.htm)

A unique partnership at the federal level is merging policy objectives of the U.S. Department of Energy (DOE) and the Environmental Protection Agency (EPA) to achieve goals reflected in SC State's MSEES degree program. The MSEES graduates would have degree credentials and skills essential for employment in industry and governmental agencies targeted by DOE/EPA initiatives. In February 2010, Energy Secretary Dr. Steven Chu and EPA Administrator Lisa P. Jackson announced the creation of the State Energy Efficiency Action Network (SEEAN) (*http://yosemite.epa.gov/opa/admpress.nsf/0/FF27F659FB5DE64C852576BE005FE8DC*). EPA Administrator Jackson stated: "In the clean energy future, energy efficiency is action number one. We can cut greenhouse gases and protect our environment while we save money for homeowners, schools and businesses." The Energy Secretary stated: "Expanding energy efficiency is one of the quickest, most cost-effective ways we can address climate change and grow America's economy." He also explained President Obama's $28.4 billion Fiscal Year 2011 budget request, highlighting the Administration's commitment to create jobs with the development of a clean energy economy, invest in advanced science, research and innovation, maintain a strong nuclear deterrent and secure nuclear materials, and improve energy efficiency to help curb greenhouse gas emissions that contribute to climate change.

By providing MSEES graduate students with training in both the fields of energy development and environmental management, SC State will be educating graduates who are prepared to enter these developing job markets For decades, energy production operations (along with major transportation projects) have been the biggest generators of federally required Environmental Impact Statements (EIS), and SC State's graduates would be prime candidates to oversee these efforts through employment in the industry as well as by the government agencies reviewing the EIS. By securing a major training and research grant from the DOE Headquarters Office of Environmental Management during 2010 to 2013, SC State achieved an important new milestone in its efforts to expand training for undergraduates to enter the employment pipeline into the energy and environmental fields.

Energy industries already play a prominent role in South Carolina's economy and DOE Savannah River Site (SRS) companies have been among the single biggest employers in the State over the past decades. (http://www.srs.gov/general/news/factsheets/srs.pdf) All facets of the nuclear industry are active in South Carolina. The State is ranked among the top five states with regards to the number of active nuclear reactors; namely Oconee 1, Oconee 2, and Oconee 3, all administered by Duke Energy Power Company, LLC; Robinson 2, administered by Progress Energy; and V.C. Summer, administered by South Carolina Electric & Gas Co. SC State is in a unique position to train managers needed to address energy production and environmental concerns in the nuclear industry in South Carolina and in the nation. SC State has the only undergraduate degree program in nuclear engineering in the State and collaborates with SRS to conduct environmental remediation monitoring of SRS waste sites as well as to provide undergraduate internships at the Savannah River Environmental Sciences Field Station (SRESFS). All of these attributes will support an industry-relevant, high quality MSEES Program.

5.2 Consistency with South Carolina State University's Mission

South Carolina State University's proposed MSEES degree is entirely consistent with the University's mission statement. These new efforts in energy and environmental science

described above would merge University goals with twenty-first century technology needs. The MSEES degree will advance the overall mission of outreach and economic development as is referenced in the University's mission statement, in part:

> *"SC State University prepares highly skilled, competent and socially aware graduates to enable them to work and live productively in a dynamic, global society. Through technology and traditional methods of teaching and learning, research and service, the University enhances the quality of life of citizens and contributes to the economic development of the state and nation."*

By expanding South Carolina's economy and employment opportunities with developing energy industries, while enhancing the State's environmental quality, SC State's MSEES graduates would contribute to the achievement of the University's mission. Additionally, as a Historically Black College and University (HBCU), SC State would be producing graduates for employment fields that have traditionally been underrepresented by minority professionals. Minority managers and researchers are underrepresented at federal and state agencies involved in energy and environmental management and regulation. (http://www.nsf.gov/statistic/infbrief/nsf09312/nsf09312.pdf) SC State's MSEES graduates would be well-qualified to bring a more diverse workforce in these professions.

5.3 Relationship to Other Programs at S.C. State University

One of the strengths of the MSEES program is its collaborative nature. Although this degree will be located within the College of Science, Mathematics, Engineering and Technology (CSMET), it will also be building upon an established relationships with the SRESFS, (Savannah River Environmental Sciences Field Station) the Nuclear Engineering Program (NEP), the College of Business & Applied Professional Sciences (CBAPS), and the James E. Clyburn University Transportation Center (UTC). Existing courses and faculty in collaborating departments will facilitate an efficient start for this new MSEES degree because faculty in those units will teach courses in the program. The University through the SRESFS offers graduate environmental courses leading to a certificate during the summer in Environmental Monitoring and Restoration. A certificate course such as *ENV550 Environmental Policy and Law* would also be a part of the proposed MSEES degree. Existing graduate courses in the UTC that will be a part of the new MSEES program include: *TRP633 Transportation, Energy and Air Quality, TRP640 Transportation and Land Use Planning, TRP642 Environmental Transportation Policy,* and *TRP641 Application of GIS and GPS in Transportation*. Advanced nuclear and other engineering undergraduate courses that would also be a part of this MSEES Program include: *NE405 Nuclear Reactor Theory, NE397 Nuclear Energy,* and *ENGR421 Thermodynamics*. Collaboration with CBAPS will provide MSEES students with coursework addressing management and business aspects of the energy and environmental professions. The existing graduate courses will be a part of the MSEES Program would include: *AGBU561 Advanced Statistics, ECON515 Advanced Managerial Economics, MGT575 Management Information Systems,* and *MGT526, Seminar in Leadership*. Two of the required core courses will be new courses, *MET594 Energy Economic Analysis* and *ENV690 Seminar in Energy and Environmental Science*. The remaining core course, *ENV510 Patterns and Processes in Environmental Pollution and Remediation,* already exists.

5.4 Comprehensive List of Similar Programs in the State

- M.S. in Plant and Environmental Sciences at Clemson University.
- Master's in Earth and Environmental Resource Management at the University of South Carolina.

Institution	Degree	Institution Program Name	CIP CODE
Clemson University	MS	Plant and Environmental Science	11101

College of Charleston	MS	Environmental Studies	30103
Clemson University	MS	Environmental Engineering and Science	141401
Clemson University	MEngr	Environmental Engineering and Science	141401
Clemson University	MS	Environmental Toxicology	261004
U.S.C. - Columbia	MEERM	Earth & Environmental Resources Management	400601
U.S.C. - Columbia	MPH	Environmental Health Sciences	512202
U.S.C. - Columbia	MS	Environmental Health Sciences	512202

5.4.1 Comparison with similar programs In-State

Currently, no other university in South Carolina offers an M.S. degree in Energy and Environmental Science. The closest graduate degree majors to the MSEES degree would be the M.S. in Plant and Environmental Sciences at Clemson University and the Master's in Earth and Environmental Resource Management at the University of South Carolina. The focus of the Clemson University M.S. in Plant and Environmental Sciences (Clemson Graduate School Catalog, 2011-2012) is more related to plant production in the fields of "biological sciences/botany, crop science, genetics, horticulture, plant pathology, plant physiology and soil science," without an energy focus. In contrast, the University of South Carolina Master's in Earth and Environmental Resource Management (M.E.E.R.M.) has a more general environmental policy scope and does not overlap with SC State's energy thrust. The M.E.E.R.M.'s focus is not directly linked to energy, but has a broader emphasis. As stated in the USC Graduate Catalog, 2011-2012: "This master's degree program is focus-based on students' backgrounds and interests. Electives are available in geological, biological, marine, and environmental health sciences; geography; chemistry and biochemistry; chemical, civil, and environmental engineering; environmental law; policy; and business administration, based on the background and needs of the student." Regarding non-State supported institutions, no current M.S. degree programs in Energy and Environmental Sciences exist in SC private colleges or universities. Furman University does offer a B.S. degree in Earth and Environmental Sciences. Existing degrees in South Carolina are not duplicative of SC State's proposal. (from the ACAP minutes on January 2011, Dr. Blackwell "informed the committee that the program is a unique one for the state, comb[in]ing study of alternative methods of energy with the study of the environmental impact." And none of the programs listed in the Table in Section 5.4 has such focus.) For these reasons, the SC State MSEES degree is uniquely positioned to provide South Carolina residents with the opportunity to be trained for leadership advancement into a key twenty-first century job market.

5.4.2 Similar Programs Out-of-State

Outside South Carolina, there are a few graduate programs specifically with SC State's proposed major of Energy and Environmental Science. Other American universities with similar graduate degree program titles are Duke University's Masters of Environmental Management with an Energy and Environment Program option; George Washington University's M.S. in Environmental and Energy Management; and the University of Texas at Austin's Master of Arts in Energy and Earth Resources**.** Duke University's program has similar employment markets and goals as SC State; however, Duke's graduates are more specifically trained for policy/management positions with less of the technological, analytical focus of SC State's proposed degree.

6.0 Admissions Criteria for the MS degree in Energy and Environmental Science

To gain admission to the MSEES degree, all applicants must meet the requirements for entrance into SC State's Graduate School. These requirements are detailed in the SC State Graduate Catalog, 2010-2012. In addition to general Graduate School admission requirements, the MSEES Program requires the following:

- a Bachelor's degree in the sciences, mathematics, engineering, or engineering technology from a regionally accredited institution in the United States or proof of equivalent training in a foreign institution. Applicants from undergraduate majors other than the sciences and engineering may receive conditional acceptance, but must complete additional undergraduate courses in
  math and science determined by their advisor before receiving full admission.
- an undergraduate grade point average of at least 3.00 on a 4.00 scale.
- A total score on both the verbal and quantitative portions of the Graduate Record Examination General Test (GRE) that is 1000 and above.**7.0 Enrollment**

. Most initial students will constitute new enrollment (Table 7.1). It is expected that one or two students may transfer from existing graduate programs. The total program enrollment is projected to start with 6-8 students and grow to about 18 after five years.

Table 7.1. Projected student headcount and credit hours in the MSEES

PROJECTED TOTAL ENROLLMENT						
YEAR	**FALL**		**SPRING**		**SUMMER**	
	Headcount	Credit Hours	Headcount	Credit Hours	Headcount	Credit Hours
2013-14	6	54	6	54		
2014-15*	14	126	14	126		
2015-16*	16	144	16	144		
2016-17*	16	144	16	144		
2017-18*	18	162	18	162		

*Assuming all new students from previous year graduate after 2 years.

The numbers in Table 7.1 (Projected student headcount and credit hours in the MSEES) were estimated based on the experience gathered for our MS Degree in Transportation program. The MS Degree in Transportation program started with 9 students and has grown to a total of 31 students in 8 years. The majority of the students that will populate the MSEES program are expected to come from the state of South Carolina.

8.0 Curriculum

All MSEES students will take 18 credit hours of required courses (the "core") and a 12 credit hour option in energy or environment). Figure 8.1 shows the series of core and elective courses. Thirteen new courses will be needed, highlighted yellow below. All but two of these new courses will be a graduate expansion of existing undergraduate course titles. Thesis students will complete 31 credit hours of coursework including *ENV690 Seminar* and 6 credit hours of *ENV699 (Thesis Preparation)* for a total of 36 credit hours. Non-thesis students will complete 36 credit hours of coursework including *ENV690 Seminar*.

Figure 8.1 Flow chart of core courses with environmental and energy options. (New Courses highlighted in Yellow)

Core Courses (Thesis & Non-thesis students 7 of 9 courses =18 (ENV 690 = 0 credit)
Credits *=(required)
P531 Atmospheric Physics and Climatic Impacts (3)
*ENV550 Environmental Policy and Law (3)

TRP633 Transportation, Energy and Air Quality (3)
*MET 594 Energy Economic Analysis (3)
MET 591 Energy Production Systems (3)
ENV 610 Environmental Restoration Technology (3)
*ENV 510 Patterns and Processes in Environmental Pollution and Remediation (3)
*AGBU561 Advanced Statistics (3)
*ENV690 Seminar in Energy and Environmental Science (0) New Course
**ENV699 Thesis Preparation (6)
** = Required for Thesis Students only

Environmental Option
(Thesis students: 4 courses =12 Credits) (Non-thesis students; 6 courses (1)Energy Option course may be included) =18 Credits)
ENV 600 Ground Water Monitoring and Remediation (3)
ENV 610 Environmental Restoration Technology (3)
P531 Atmospheric Physics and Climatic Impacts (3)
TRP 642 Environmental Transportation Policy(3)
ENV698 Special topics in Environmental Science (3)
TRP 641 Application of GIS and GPS in Transportation (3)
MET 530. Introduction to Air Pollution Control(3)
MASC501 Marine and Estuarine Ecology (3)

Energy Option
(Thesis students: 4 courses =12 Credits) (Non-thesis students; 6 courses (1) Environmental Option course may be included) =18 Credits)
NE 597 Nuclear Energy (3)
TRP633 Transportation, Energy and Air Quality, (3)
TRP 634 Hazard Material Transportation and Risk Analysis (3)
MET 591 Energy Production Systems (3)
MET 596 Electrical Controls in Energy (3)
NE 511 Nuclear Reactor Engineering (3)

8.1 Curriculum Sheets for MS in Energy and Environmental Science
Figures 8.1.1 to 8.1.4 show the curricula for MSEES with thesis and non-thesis options.

Figure 8.1.1: Curriculum Leading to the Degree of Master of Science in Energy and Environmental Science
Thesis with Environmental Option
(36 Credits)

FIRST YEAR

First Semester	**Credits**	**Second Semester**	**Credits**
* ENV 510 Patterns & Processes in Env. Pollution & Remed.	3	*ENV550 Environmental Policy & Law	3
* AGBU561 Advanced Statistics	3	*MET 594 Energy Economic Analysis	3
and <u>one</u> of the following four courses:		*and <u>one</u> of the following four courses:*	
TRP633 Transport, Energy & Air Quality	3	TRP633 Transport., Energy & Air Quality	3
MET 591 Energy Prod Systems	3	MET 591 Energy Production Sys	3
ENV 610 Env. Restoration Tech.	3	ENV 610 Env. Restoration Technology	3

or		or	
P531 Atmospheric Physics & Climatic Impacts	3	P531 Atmospheric Physics & Climatic Impacts	3
	9		9

SECOND YEAR

First Semester	**Credits**	**Second Semester**	**Credits**
*ENV690 Seminar in Energy & Env. Science	o	*ENV699 Thesis Preparation	3
*ENV699 Thesis Preparation	3	*and <u>two</u> of the following four courses:*	
and <u>two</u> of the following four courses:		TRP 642 Env. Transportation Policy	3
MET 530 Introduction to Air Pollution Control	3	TRP 641 Application of GIS & GPS in Transportation	3
MASC501 Marine & Estuarine Ecology	3	ENV 600 Ground Water Monitoring & Remediation	3
P531 Atmospheric Physics & Climatic Impacts	3	ENV 610 Environmental Restoration Technology	3
ENV698 Sp.topics in Env. Sci	3		
	9		9

* = Required

Figure 8.1.2: Curriculum Leading to the Degree of Master of Science in Energy and Environmental Science
Non-Thesis with Environmental Option
(36 Credits)

FIRST YEAR

First Semester	**Credits**	**Second Semester**	**Credits**
* ENV 510 Patterns & Processes in Env. Pollution & Remed.	3	*ENV550 Environmental Policy & Law	3
* AGBU561 Advanced Statistics	3	*MET 594 Energy Economic Analysis	3
and <u>one</u> of the following four courses:		*and <u>one</u> of the following four courses:*	
TRP633 Transport, Energy & Air Quality	3	TRP633 Transport., Energy & Air Quality	3
MET 591 Energy Prod. Systems	3	MET 591 Energy Production Systems	3
ENV 610 Env. Restoration Tech.	3	ENV 610 Env. Restoration Technology	3
or		or	
P531 Atmospheric Physics & Climatic Impacts	3	P531 Atmospheric Physics & Climatic Impacts	3
	9		9

SECOND YEAR

First Semester	**Credits**	**Second Semester**	**Credits**
*ENV690 Seminar in Energy & Env.Science	o	*<u>Three</u> of the following four courses:* (one Energy Option Course may be *substituted for one of the three)*	
and <u>three</u> of the following four courses: (one Energy Option Course may be *substituted for one of the three)*		TRP 642 Env. Transportation Policy	3

MET 530. Introduction to Air Pollution Control	3	TRP 641 Application of GIS & GPS in Transportation	3
MASC501 Marine & Estuarine Ecology	3	ENV 600 Ground Water Monitoring & Remediation	3
P531 Atmospheric Physics & Climatic Impacts	3	ENV 610 Environmental Restoration Technology	3
ENV698 Special topics in Env. Science	3		
(Energy Option course electives include: NE597, TRP633, TRP634, MET591, MET596, and NE511)			
	9		9

* = Required

Figure 8.1.3: Curriculum Leading to the Degree of Master of Science in Energy and Environmental Science
Thesis with Energy Option
(36 Credits)

FIRST YEAR

First Semester	**Credits**	**Second Semester**	**Credits**
* ENV 510 Patterns & Processes in Env. Pollution & Remed.	3	*ENV550 Environmental Policy & Law	3
* AGBU561 Advanced Statistics	3	*MET 594 Energy Economic Analysis	3
and <u>one</u> of the following four courses:		*and <u>one</u> of the following four courses:*	
TRP633 Transport, Energy & Air Quality	3	TRP633 Transport., Energy & Air Quality	3
MET 591 Energy Prod. Systems	3	MET 591 Energy Production Systems	3
ENV 610 Env. Restoration Tech.	3	ENV 610 Env. Restoration Technology	3
<u>or</u>		<u>or</u>	
P531 Atmospheric Physics & Climatic Impacts	3	P531 Atmospheric Physics & Climatic Impacts	3
	9		9

SECOND YEAR

First Semester	**Credits**	**Second Semester**	**Credits**
*ENV690 Seminar in Energy & Env.Science	0	*ENV699 Thesis Preparation	3
*ENV699 Thesis Preparation	3	*and <u>two</u> of the following four courses:*	
and <u>two</u> of the following four courses:		TRP633 Transportation, Energy & Air Quality	3
NE 597 Nuclear Energy	3	TRP 634 Hazard Material Transportation & Risk Anal.	3
MET 591 Energy Prod. Systems	3	NE 511 Nuclear Reactor Eng.	3
MET 596 Electrical Controls in Energy	3		
	9		9

* = Required

Figure 8.1.4: Curriculum Leading to the Degree of Masters of Science in Energy and Environmental Science

Non-Thesis with Energy Option
(36 Credits)

FIRST YEAR

First Semester	**Credits**	**Second Semester**	**Credits**
* ENV 510 Patterns & Processes in Env. Pollution & Remed.	3	*ENV550 Environmental Policy & Law	3
* AGBU561 Advanced Statistics	3	*MET 594 Energy Economic Analysis	3
and one of the following four courses:		*and one of the following four courses:*	
TRP633 Transport, Energy & Air Quality	3	TRP633 Transport., Energy & Air Quality	3
MET 591 Energy Prod. Systems	3	MET 591 Energy Production Systems	3
ENV 610 Env.Restoration Tech.	3	ENV 610 Env. Restoration Technology	3
or		or	
P531 Atmospheric Physics & Climatic Impacts	3	P531 Atmospheric Physics & Climatic Impacts	3
	9		9

SECOND YEAR

First Semester	**Credits**	**Second Semester**	**Credits**
*ENV690 Seminar in Energy & Env. Science	0	*three of the following courses:*	
and three of the following courses:		(one Environmental Option Course may be *substituted for one of the three)*	
(one Environmental Option Course may be *substituted for one of the three)*			
NE 597 Nuclear Energy	3	TRP633 Transportation, Energy &Air Quality	3
MET 591 Energy Prod. Systems	3	TRP 634 Hazard Material Transportation & Risk Anal.	3
MET 596 Electrical Controls in Energy	3	NE 511 Nuclear Reactor Eng.	3
(Envimt'l Option course electives: ENV600, ENV610, ENV698, P531, TRP641,TRP642, MET530, MASC501)			
	9		9

* = Required

8.2 Course Descriptions

***ENV 510 Patterns and Processes in Environmental Pollution and Remediation**
This course provides an overview of environmental contamination and pollution. Students will define contamination and pollution issues including sources, spread, and hazards to living and non-living entities.

***ENV 550 Environmental Policy and Law**

An introductory course focusing on the key federal environmental laws, regulatory structures and environmental policies in the United States.

ENV 600 Ground Water Monitoring and Remediation
This course will introduce the theory of groundwater flow and role in geological processes,.

ENV 610 Environmental Restoration Technology
This course reviews the scientific foundations and principles of environmental restoration and research and includes hands-on experience with practical restoration techniques, etc.

***ENV 690 Seminar in Energy and Environmental Science (0)** Through seminars presented by experts in the field, the course teaches about developments and issues in energy and related environmental management. Students.

ENV 698 Special Topics in Environmental Science Special topics in advanced disciplines of environmental science and energy production will be studied and related to current energy and environmental issues.

***ENV 699 Thesis Preparation** (6) Two semesters of thesis research work and thesis manuscript preparation.

MASC 501 Marine and Estuarine Ecology This course introduces students to a wide variety of ocean and estuarine environments and how physical and chemical forces structure them ecologically.
MET 530 Introduction to Air Pollution Control This is a course in the study of the sources of air pollution and characteristics of source emissions; atmospheric reactions; effects of pollutants; sampling, analysis, measurement, and control of pollutants. *Prerequisite:* C 150 General Chemistry I.

MET 591 Energy Production Systems This course is a study of processes and equipment used to convert energy resources (such as geothermal and the sun) and fuels (such as coal and natural gas) into useful energy forms, such as electricity, heat and motion or light.

***MET 594 Energy Economic Analysis** This course emphasizes the techniques necessary to evaluate the economic impact and advantages of energy production. Quantitative measures of profitability of alternative energy investment proposals as well as energy conservation techniques are analyzed.

MET 596 Electrical Power Systems This course is a study of the concepts and principles of Electrical Power Systems. It covers a review on the balanced 3 phase circuits and per phase method of analysis; one-line diagram; per power system basics, important components, generation and transmission/distribution of Electrical Energy.
NE 511. Nuclear Reactor Engineering This course is the study of reactor heat generation and removal, steady-state and non-steady-state conduction in reactor elements, single phase, two phase, liquid metal cooling, and core thermal design. Prerequisite: ENGR 421 Thermodynamics

NE 597 Nuclear Energy This course stresses the fission process and reactor theory.

P 531 Atmospheric Physics and Climatic Impacts An overview of the local, regional, and global impact of the atmosphere on the Earth System.

9. *Assessment*

The following Student Learning Outcomes have been developed for the program:

1) By the time of graduation, the student is expected to be able to conduct research to improve the processes of carbon foot-print in the environment.
2) By the time of graduation, the student is expected to know the principles underlying green-energy production and environmental management.
3) By the time of graduation, the student is expected to be familiar with government policies, regulations, and procedures related to green-energy production and environmental protection.
4) By the time of graduation, the student will have the know how to use statistical methods in the analysis of green-energy and environmental processes.

The assessment of the above student learning outcomes will be measured using a multiplicity of instruments including:

- Projects (individual and group), tests, exams, and/ or reports. Details of each of these tools will be outlined in the syllabus.
- For students in the thesis track, a thesis which includes the collection of data, observation of data, analysis of data, and conclusion from analysis.

The program will be assessed through the following metrics:

- a yearly graduation rate of 30%.
- a yearly rate of enrollment increase of 30%.
- At least one publication or presentation per year.

10.0 Faculty

Table 10.1 Faculty List

List staff by Rank (e.g. Professor #1, Professor #2, Associate Professor #1, etc.)	Highest Degree Earned	Field of study	Teaching in Field (Yes/No)
Professor 1	Ph.D.	Physics	Yes
Professor 2	Ph.D.	Marine Science	Yes
Associate Professor 1	D. Eng.	Nuclear Engineering	Yes
Associate Professor 2	Ph.D.	Engineering	Yes
Associate Professor 3	Ph.D.	Engineering	Yes
Associate Professor 4	Ph.D.	Engineering	Yes
Assistant Professor 1	Ph.D.	Engineering	Yes
Assistant Professor 2	M.S.	Engineering	Yes
Associate Professor *	Ph.D.	Chemical Oceanography	Yes
Associate Professor *	Ph.D.	Ecology	Yes
Associate Professor *	Ph.D.	Ecology / Environmental Sci.	Yes

* Visiting Professor/Adjunct Faculty at Field Station & SC State

As indicated in Table 10.1, additional faculty will be visiting professors/adjuncts. These adjuncts will have earned doctorates in environmental sciences, ecology or related fields. For the faculty

members involved in the MSEES program, an FTE will teach two undergraduate courses and one graduate course. In order to avoid faculty overload, the excess courses will be assigned to Adjunct faculty or visiting professors. The same explanation for overload applies to individuals who must now serve in administrative positions (Department Chair or Academic Program Coordinator) for the program. Existing graduate courses will be taught by faculty who are currently teaching them. Excluding the new *ENV690 **S**eminar* course, and the new *P531 Atmospheric Physics and Climatic Impacts* course, the other new courses are graduate level versions of undergraduate subject titles and will be taught by the same existing faculty. With the exception of ENV 690 and ENV 699, all other ENV courses will be taught by adjunct faculty from the University of Georgia Savannah River Ecology Lab.

For the graduate faculty teaching currently offered graduate courses, there are no anticipated changes in their current assignments. As is currently applicable to faculty in all existing programs at the university, the MSEES faculty will be required to attend annual conferences, topical meetings, participate in research, consulting, and in curriculum development. Travel funds are provided for faculty to attend conferences. Release time is given to faculty with funded grants. Academic Program Coordinators or Department Chairs have a 25%-50% release time respectively in their administrative capacities.

The institutional definition of the full-time equivalent (FTE) for a faculty member per semester in the undergraduate level is as follows:

4 – Course -load = 1 FTE **2 – Course -load = 0.50 FTE**
3 – Course -load = 0.75 FTE **1 – Course -load = 0.25 FTE**

For the graduate level, the full-time equivalent (FTE) is:
Graduate level:
3 – Course-load = 1 FTE 2 -Course-load = 0.67 FTE
1-Course-load = 0.33 FTE

Table 10.2a: Number and full time equivalent of administrators in the MS degree in Energy and Environmental Science.

UNIT ADMINISTRATORS, FACULTY AND STAFF SUPPORT						
YEAR	**NEW**		**EXISTING**		**TOTAL**	
	Headcount	FTE	Headcount	FTE	Headcount	FTE
ADMINISTRATION						
2013-14	1	0.25	0	0	1	0.25
2014-15	0	0	1	0.25	1	0.25
2015-16	0	0	1	0.25	1	0.25
2016-17	0	0	1	0.25	1	0.25

2017-18	0	0	1	0.25	1	0.25
FACULTY						
2013-14	3	2.0*	8	8.67	11	10.65
2014-15	0	0	11	10.67	11	10.65
2015-16	0	0	11	10.67	11	10.65
2016-17	0	0	11	10.67	11	10.65
2017-18	0	0	11	10.67	11	10.65
STAFF						
2013-14	2	0.5	0	0	2	0.5
2014-15	0	0	1	0.5	2	0.5
2015-16	0	0	1	0.5	2	0.5
2016-17	0	0	1	0.5	2	0.5
2017-18	0	0	1	0.5	2	0.5

*2 course-load per adjunct

11.0 Physical Plant

No modifications are required to the existing building or facilities as a result of the new MSEES program. The MSEES program will be jointly housed in the departments of Biological & Physical Sciences and the Department of Civil & Mechanical Engineering Technology and Nuclear Engineering.

The Biological & Physical Sciences Department is located in Hodge Hall. However, a new Hodge Hall Annex, the Leroy Davis Annex, has been completed and is in use. The new annex facilities include offices, smart classrooms, an auditorium, teaching laboratories with prep rooms, and research laboratories. The Civil and Mechanical Engineering Technology & Nuclear Engineering Department has now moved to the Engineering and Computer Science Complex This three-story building has a net area of about 55,000 square feet of space and includes 87 offices, 10 classrooms, and 28 laboratories. Additional office and classrooms will be located at the Savannah River Environmental Field Station (SREFS) in Aiken, SC.

12.0 Equipment

The Applied Radiation Sciences Laboratory is equipped with nine sets of Sain-Gobain Crystals N210/NBC Geiger-Muller tubes coupled with spectrum ST360 radiation counters and nine sets of Canberra NaI(Tl) detectors operated with Genie 2000 spectrum analysis software. These detectors are connected to nine PC computers, providing each student in every training course

with sufficient opportunity to operate the instruments and obtain his/her own experimental data.

In addition, the Applied Radiation Sciences Lab has one Canberra high-purity germanium detector for gamma-spectrometry with a higher energy resolution than that provided by the NaI(Tl) detectors; one Canberra alpha analyzer for alpha-spectrometry; two triathler 425-034 liquid scintillation counters that are small in size and are suitable for field investigations of environmental radioactivity and one PerkinElmer Tri-Carb 2900TR Liquid Scintillation Analyzer (LSA) that can conduct more precise liquid scintillation analysis and can automatically analyze a hundred samples at one time. These advanced instruments provide the lab with the capability of carrying out scientific investigations in various fields such as radiochemistry, environmental chemistry, biology and medical sciences.

The lab is also equipped with various health physics instruments, some of which are shown in Table 12.1.

Table 12.1 Radiation and Health Physics Instruments

Type of instrument	**QTY**	**Brand**	**Comments**
G-M Counters	9	SainGobain Crystal	Coupled with ST360 radiation counters
NaI(TI) detectors	9	Canberra	Use Genie 2000 spectrum analysis software
Alpha analyzer	1	Canberra	
Liquid scintillation Counters	2	Triathler 425-034	Small and suitable for field Investigation
Radiation monitors	9	Eberline and Ludium	They are pancake-style
Radiagem 400 portable dose r Meters	5	Canberra	
Personal contamination monit	1	Eberline	For whole-body radiation survey

The Engineering and Engineering Technology programs maintain a computer laboratory in Room 209 of the Crawford Engineering Technology building. The laboratory currently has 45 Dell computers with associated software. The computers have standard software packages needed for word processing, spreadsheet and database manipulation. These contain specialized engineering and mathematics packages that the students use in their coursework and research. Packages available to students include MAPLE, MATLAB, MCNP, SCALE, MICRO-SHIELD and MICRO-SKYSHINE. The Miller Whittaker Library has a state-of-the-art Smartclass Room facility which is always accessible to students.

Currently, some of the software (MCNP, SCALE, MICRO-SHIELD & MICRO-SKYSHINE) are used primarily in the Special Topics course (NE 499). This course exposes students at the junior and senior levels to current industry-based computer codes. The version of MCNP at SC State is a PC-based version which can be loaded onto multiple PCs. In the near future, the software will be made accessible through a network of PCs connected to a dedicated workstation, which is already in place. Other nuclear engineering application codes include MICRO-SHIELD for design analyses in radiation shielding and RASCEL for emergency planning. The SCALE, MICR-SKYSHINE AND MICRO-SHIELD software are also PC based versions.

New instrumentation in the Leroy Davis Annex includes a Gas Chromatography-Mass Spectrometer (GC-MS), Fourier Transform-Infrared (FT-IR) spectroscopy. Other equipment that will be used for the new program are listed in Tables 12.2 & 12.3. The new program will also take advantage of the laboratory at the SREFS.

Table 12.2: Laboratory Equipment for Energy and Environmental Studies

Type of instrument	QTY	Brand	Comments
Bio310 Bioreactor	1	New Brunswick Scier	Conducting controlled fermenta experiment
Liquid Chromatograph-TCD	1	Hitachi	Analyzing non-volatile organics
Gas Chromatography	1	Varian	Analyzing permanent gas mixtures
Total organic carbon analyzer	1	Shimadzu	Determining total carbon

Table 12.3: Sample Laboratory Equipment for Biological and Physical Sciences

Type of instrument	QT	Brand	Comments
Biology GC-Chromatograph	2	Varian	Analyzing permanent mixtures
Environmental growth Chambers	3	Percival	Controlled environment plant and insect maintenance
Microscopes	15		Stereo microscopes dissection

13.0 Library Resources

The Miller F. Whittaker Library is the main library at SC State. The library contains 7% (see Table 13.1) of energy related collection (energy use; energy conservation; renewable energy sources - biomass, hydrogen, solar power; and fuel, fuel cells, and energy options) and contains 10% (see Table 13.2) environmental studies (hazardous waste remediation, pollution, pollutants, pollution control industry, radioactivity, soil pollution, solid waste recycling, water and wastewater treatment, toxic waste, toxicology, and environmental movement). Data are based on the 2012 online Bowker Book Analysis system, trademark of R.R. Bowker LLC "Information from Resources for College Libraries (RCL), the American Library Association."

Table 13.1: Qualitative Holdings: Energy Related Resources

Bibliographies Checked	Number of Entries Searched	Library Holdings	Percentage
Lord, Charles R. *Guide to Information Sources In*	77	35	46%

Engineering Englewood, CO 2000			
Bowker. Book analysis System, 2010. Retrieved from http://www.bbanalysis.com/Pages/Login.aspx?ReturnUrl=%2fPages%2fIndex.aspx	298	22	7%

Table 13.2: Qualitative Holdings: Environmental Engineering Resources

Bibliographies Checked	Number of Entries Searched	Library Holdings	Percentage
Lord, Charles R. *Guide to Information Sources In Engineering* Englewood, CO 2000	58	19	33%
Bowker. Book analysis System, 2010. Retrieved from http://www.bbanalysis.com/Pages/Login.aspx?ReturnUrl=%2fPages%2fIndex.aspx	119	12	10%

The library provides subscriptions to six major full-texts and one bibliographic electronic database for current and retrospective information in energy and environmental engineering. These databases include millions of peer-reviewed journals and other reference sources for research and study. The databases include:

- Omni File, ACM Digital Library, Academic Search Premier, Dialog, Academic Library, Complete E-Book Collection, JSTOR, ProQuest, and ACM Digital Library.

The databases:

a) supplement the existing print materials for currency;
b) enhance the acquisition of new materials;
c) provide on-site and Internet access; and) improve the overall quality areas of the energy and environmental engineering collection.

The library uses the following resources and services to support access to quality energy and environmental engineering collections:

- Statewide library borrowing available to students and faculty allows individual check-out privileges at more than 55 public, private, and technical college and university libraries in South Carolina.

- PASCAL Delivers allows users to request rapid book delivery using interlibrary loan services from any member library within the state of South Carolina by submitting an electronic request for delivery of a book to their home institution, and receive the books within a 48 hour period.

- Interlibrary loan services are available from more than 58,000 libraries of all types in 115 countries and more than 88 million bibliographic records when materials are not owned by the library.

- Community Higher Education Council (CHEC) agreement with Claflin University and Orangeburg-Calhoun Technical College provides interlibrary loan services among the three Orangeburg institutions.

The core collection for the Master of Science in Energy and Environmental Sciences has an estimated initial cost of $155,000 based on the *Bowker's Book Analysis System*; this averages to $31,000 per year for five years. The College of Engineering, Science, Mathematics and Technology is committed to securing funds to support the library's collection through grants.

The formula below serves as a guide to the collection development process. It provides a foundation on which other formats can be developed. The following is the quantitative comparison of the library's current holdings with a standard guide in relation to the new program being proposed (Association College and Research Libraries, "Standards for Libraries in Higher Education," 2004). Over the next five years the expected number of faculty for the program is 11, and the anticipated student enrollment is 18.

Volumes needed for the MSEES program
Faculty - 11 x 100 volumes each = 1,100 per year x 5 years = 5,500
Students - 18 x 15 volumes each = 270 per year x 5 years = 1,350

14.0 Accreditation, Approval, Licensure, or certification

The MSEES is not subject to any specialized or professional accreditation or approved by any state agency other than the Commission on Higher Education (CHE). Also, the graduates of the program are not subject to licensure or certification by any public or private agency.

15.0 Articulation

No articulation agreements exist for the proposed program since no other university in South Carolina offers an MSEES degree. At present, SC State has an ongoing Memorandum of Understanding (MOU) with Savannah River Site (SRS) to operate and manage the only Environmental Field Station in the nation. Students from the University of Georgia also participate in the operation of the SRS field station.

16.0 Estimated New Costs

Table 16.1 shows the distribution of the estimated new costs required to start and sustain the program by year, over a five-year period.

Table 16.1: Estimated New Costs by Year for the First Five Years and Sources of Financing by Year

ESTIMATED NEW COSTS BY YEAR						
CATEGORY	**1st**	**2nd**	**3rd**	**4th**	**5th**	**TOTALS**
Program Administration	0	0	0	0	0	**0**
Faculty Salaries	0	18,000	18,000	18,000	18,000	**72,000**
Graduate Assistants	0	0	0	0	0	**0**
Clerical/Support Personnel	0	0	0	0	0	**0**

Supplies and Materials	1,000	1,000	1,000	1,000	1,000	**5,000**
Library Resources	31,000	31,000	31,000	31,000	31,000	**155,000**
Equipment	0	3,000	0	0	0	**3,000**
Facilities	0	0	0	0	0	**0**
Other (identify)	0	0	0	0	0	**0**
TOTALS	**32,000**	**53,000**	**50,000**	**50,000**	**50,000**	**235,000**
SOURCES OF FINANCING BY YEAR						
Tuition Funding	55,548	129,612	148,128	148,128	166,644	**648,060**
Program-Specific Fees	0	0	0	0	0	**0**
State Funding	0	0	0	0	0	**0**
Federal Funding	50,000	50,000	0	0	0	**100,000**
Reallocation of Existing Funds**	0	0	0	0	0	**0**
Other Funding (Specify)	0	0	0	0	0	**0**
TOTALS	**105,548**	**179,612**	**148,128**	**148,128**	**166,644**	**798,060**

In generating Table 16.1 above, the following assumptions were made:

i) Three Adjunct Professors will be hired from the second year at the rate of $2700. However, this amount can be raised per semester to $3000 in certain circumstances.

ii) An amount of $31,000 per year is projected for the first five years for additional library resources.

iii) An amount of $3,000 is projected for the purchase of computers and associated equipment for the three adjunct professors starting from the second year (offices and classroom spaces will be available).

iv) No new state funds are anticipated. No special or unique funding is anticipated or required.

v) Tuition revenues are based on six new students during the first year, and additional eight new students for the next three years (2nd, 3rd, & 4th years) and 10 new students in the fifth year. The tuition rate is based on a conservative in-state cost (out-of-state will generate more revenue) which is $4,629 per semester, for a total yearly rate of $9,258 per student.

vi) An existing grant (HBCU UP funded through 2015) will be used to supplement the tuition revenues to the rate of $50,000 per year for the first two years of the program.