UNIVERSITÀ DELLA CALABRIA
DIPARTIMENTO DI **INGEGNERIA DELL'AMBIENTE**

ENERGY FROM RENEWABLE SOURCES
A.A.2020/2021

Denominazione insegnamento	ENERGY FROM RENEWABLE SOURCES	
Codice insegnamento	27000194	
Corso di Studio (CdS)	ENVIRONMENTAL AND TERRITORIAL SAFETY ENGINEERING	
Livello CdS	SECOND	
Codice CdS	0773	
Settore Scientifico Disciplinare (SSD)	ING-IND/11	
Crediti Formativi Universitari (CFU)	9	
Tipologia Attività Formativa (TAF)	Affine/Integrativa	
Tipo attività formativa	COMPULSORY	
Anno di corso	1	
Periodo didattico	SECOND SEMESTER	
Docente responsabile	MARILENA DE SIMONE	
Altri docenti coinvolti		
Organizzazione didattica*	***Ore Lezioni***	54
	Ore Esercitazioni	18
	Ore Laboratorio	---
	Ore Studio individuale	150
Lingua di insegnamento	ITALIAN	
Propedeuticità	NONE	
Prerequisiti	NONE	
Contenuti	The course provides the knowledge necessary to design systems that use renewable energy sources by considering the technical, economic, and environmental aspects. In particular, technologies for the use of solar, wind and geothermal energy are illustrated. For each energy source, the sizing methods of the main plant components, the criteria for evaluating the energy produced, and the methods of economic optimization are provided. Furthermore, some methodologies for assessing the environmental impact of the plants are illustrated.	
Obiettivi formativi (in termini di risultati di apprendimento attesi)	The general learning objective is the acquisition of knowledge and methodologies to be able to design systems for the production of energy from renewable sources considering the technical, economic and environmental aspects. Specifically, students: 1) will know the theoretical and regulatory foundations that originated the development of the renewable energy sources application. They will understand the physical phenomena that determine the operation of renewable energy plants. They will understand and distinguish the various aspects of design, from sizing to economic optimization. They will acquire knowledge about the environmental problems related to renewable sources application. 2) will be able to analyse contexts and resolve problems in which the application of methods and procedures is required. 3) will be able to collect data, apply methods, analyze results and prepare technical reports. 4) will develop the ability to describe physical phenomena and more technical problems through appropriate terminology. 5) will be able to offer research and insights to be conducted independently or in a group by using traditional and web channels. In addition, the innovative teaching approach will promote the critical and resolute spirit by giving the student the role of observer of phenomena, of formulator and	

	problem solver.
Programma	**The course is structured in seven modules divided in learning units (U):** **Module 1: Renewable energy, previsions and developments (R)** **UR1_**Introduction to energy issues **UR1_**Definition and classification of renewable sources **UR3_**European climate policies **UR4_**The national regulatory framework **Module 2: Solar thermal systems (T)** **UT1_**Introduction to the use of solar thermal systems **UT2_** Principles of operation of solar systems for residential use **UT3_**Solar radiation **UT4_**Position of the sun in the sky **UT5_**Sun path diagram **UT6_**Solar radiation on the ground **UT7_**Calculation of solar radiation on inclined surfaces **UT8_** Principles of operation of solar thermal collectors **UT9_**Efficiency of the solar collector **UT10_**Types of solar thermal collectors **UT11_**The applications of low temperature solar thermal systems **UT12_**Types of solar thermal systems **UT13_** System components **UT13_**Integration of components **UT14_**Plant schemes **UT15_**Energy need for the production of domestic hot water **UT16_**Sizing of solar collectors. Annual average method **UT17_**Sizing of solar collectors. F-Chart method **UT18_** Sizing criteria for the other system components **UT19_** Construction of the plants **UT20_**Solar air systems **UT21_**Solar power plants **UT22_**Thermal energy storage **Modulo 3: Economic evaluation (E)** **UE1_** Introduction to economic evaluation **UE2_**Actualization methods of economic evaluation **UE3_**Economic optimization of solar plants **Module 4: Photovoltaic systems (PV)** **UPV1_**Photoelectric effect **UPV2_**Characteristics of photovoltaic cells **UPV3_**Efficiency of photovoltaic cells **UPV4_**Types of photovoltaic cells **UPV5_**Structure of the panel and system components **UPV6_**Types of photovoltaic systems **UPV7_**Dimensioning of photovoltaic generators **Module 5: Wind farms (W)** **UW1_**The wind as an energy resource **UW2_**Principle of operation of a wind turbine **UW3_**Types of wind turbines **UW4_**Typologies of wind farms **UW5_** Wind farms in the world, in Europe and in Italy

	UW6_ Site analysis **UW6_**Energy production **Module 6: Geothermal energy (G)** **UG1_**Geothermal resources **UG2_**Thermal properties of the ground **UG3_**Classification of geothermal systems **UG4_**Geothermal probes **UG5_**Geothermal heat pumps **UG6_**Sizing criteria for a field of geothermal probes **Module 7: Effect on the environment of renewable energy plants (I)** **UI1_**Environmental impact of thermal and photovoltaic solar plants **UI2_**Environmental impact of wind power plants **UI3_**Environmental impact of geothermal plants **UI4_**Indexes of energy-environmental performances **UI5_**LCA life cycle assessment (LCA), main concept. Each learning unit is accompanied by quizzes and exercises, and preparation of reports conducted in the classroom together with the teacher or by students for self-assessment.
Modalità di erogazione	FRONTAL
Metodologie didattiche	**INNOVATIVE TEACHING – Aligned Teaching** The adopted methodology is the one promoted at European level by the EIT-InnoEnergy and is based on the "learning outcome paradigm" according to which learning outcomes are defined first and are followed by the choice of assessment methods, teaching activities, and materials that support students' efforts to achieve learning outcomes. This approach is called "aligned teaching" that is knowing things, but also knowing what to do and how to solve real life problems through creativity and innovation. The main issue of the aligned teaching is designing the evaluation before the teaching is planned, focusing on the student and what he/she should learn, instead of the teacher and on what should be taught. The application of the method requires: 1. the formulation of the contents by identification of the learning units and detailed syllabus; 2. the preparation of educational material in paper, electronic and audiovisual format. The use of international documents to promote the acquisition of scientific and technical terminology in English; 3. ongoing verification of learning level and results sharing among the students; 4. analysis of critical issues and search for solutions; 5. analysis of successes and enhancement of solution strategies.
Metodi e criteri di valutazione dell'apprendimento	The success of the training experience is based on the formulation of the contents in learning units and on the evaluation of the learning process in "course of work" by exercises conducted by the teacher and through the assignment of questions and problems to be performed in groups of students or individually to verify the effectiveness of the training process. The results of the evaluation will be discussed in the classroom so that students can be aware of their successes and gaps and can express the difficulties encountered and share the adopted resolving tools, such as: 1. memorization techniques (auditory or visual) or notation 2. individually researched support material for the self-study

	3. methods for the schematization and reorganization of contents. Each student becomes an added value in the "community class". The final assessment consists of an oral test on at least three macro-topics of the course. The test is passed if the score obtained is not less than 18/30. To verify the acquisition of essential operational skills, students will have to discuss a report prepared during the exercises.
Testi di riferimento ed eventuali letture consigliate	• M.A. Cucumo, V. Marinelli, G. Oliveti - Ingegneria solare, Principi e Applicazioni - Pitagora editrice Bologna, 1994. • G. Oliveti, L. Marletta, N. Arcuri, R. Bruno, M. De Simone, G. Evola – Tecnologie solari negli edifici esistenti, Criteri di progetto e metodologie di calcolo – EPC Editore, 2013. • R. Pallabazzer - Sistemi di Conversione Eolica – Hoepli editore Milano, 2011. • R. Lazzarin, F. Busato, F. Minchio, M. Noro - Sorgenti Termiche delle Pompe di Calore - Collana AICARR Delfino editore Milano, 2012. • Saccardi -Progettare e gestire l'efficienza energetica - McGraw Hill, 2012. • A. Singh. D. Pant, S.I. Olsen - Life Cycle Assessment of Renewable Energy Sources (Green Energy and Technology) – Springer Nature, 2013. • Collection of National and International technical reports and scientific publications. • Learning material prepared by the teacher.
Peer review	The lecturer, as a member for several national and international networks, is in continuous dialogue with lecturers and scientists that conduct activities in the field of Applied Environmental Physics and Renewable Energy
Orario delle lezioni	http://diam.unical.it
Calendario degli esami	http://diam.unical.it
Commissione d'esame	http://diam.unical.it

* Organizzazione didattica

WORKLOAD ESTIMATION FOR THE STUDENT				
	Lessons [Hours]	Exercises [Hours]	Laboratory [Hours]	Self-study [Hours]
Module 1: Renewable energy, previsions and developments *References* • Saccardi -Progettare e gestire l'efficienza energetica - McGraw Hill, 2012. • Collection of National and International technical reports and scientific publications. • Learning material prepared by the teacher	3	1	0	7
Module 2: Thermal solar systems *References* • M.A. Cucumo, V. Marinelli, G. Oliveti - Ingegneria solare, Principi e Applicazioni - Pitagora editrice Bologna, 1994. • G. Oliveti, L. Marletta, N. Arcuri, R. Bruno, M. De Simone, G. Evola – Tecnologie solari negli edifici esistenti, Criteri di progetto e metodologie di calcolo – EPC Editore, 2013. • Collection of National and International technical reports and scientific publications. • Learning material prepared by the teacher	16	6	0	40
Module 3: Economic evalutations *References* • M.A. Cucumo, V. Marinelli, G. Oliveti - Ingegneria solare, Principi e Applicazioni - Pitagora editrice Bologna, 1994. • G. Oliveti, L. Marletta, N. Arcuri, R. Bruno, M. De Simone, G. Evola – Tecnologie solari negli edifici esistenti, Criteri di progetto e metodologie di calcolo – EPC Editore, 2013.	3	1	0	8
Module 4: PV plants *References* • M.A. Cucumo, V. Marinelli, G. Oliveti - Ingegneria solare, Principi e Applicazioni - Pitagora editrice Bologna, 1994. • G. Oliveti, L. Marletta, N. Arcuri, R. Bruno, M. De Simone, G. Evola – Tecnologie solari negli edifici esistenti, Criteri di progetto e metodologie di calcolo – EPC Editore, 2013. • Collection of National and International technical reports and scientific publications. • Learning material prepared by the teacher	10	4	0	30
Module 5: Wind farms. *References*	8	2	0	20

• R. Pallabazzer - Sistemi di Conversione Eolica – Hoepli editore Milano, 2011. • Collection of National and International technical reports and scientific publications. • Learning material prepared by the teacher				
Module 6: Geothermal energy. *References* • R. Lazzarin, F. Busato, F. Minchio, M. Noro - Sorgenti Termiche delle Pompe di Calore - Collana AICARR Delfino editore Milano, 2012. • Collection of National and International technical reports and scientific publications. • Learning material prepared by the teacher	8	2	0	20
Module 7: Effect on the environment of renewable energy plants *References* • A. Singh. D. Pant, S.I. Olsen - Life Cycle Assessment of Renewable Energy Sources (Green Energy and Technology) – Springer Nature, 2013. • Collection of National and International technical reports and scientific publications. • Learning material prepared by the teacher	6	2	0	15
Soft skills	0	0	0	0
Homework	0	0	0	10
Preparation of the final assessment	0	0	0	0
TOTAL	**54**	**18**	**0**	**150**
TOTAL HOURS	✓ **222**			