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

RENEWABLE SOURCES AND ENERGY ENHANCEMENT PROCESSES

A.A. 2021/2022

Denominazione insegnamento	Renewable Sources and Energy Enhancement Processes	
Codice insegnamento		
Corso di Studio (CdS)	ENVIRONMENTAL AND TERRITORIAL SAFETY ENGINEERING	
Livello CdS	MASTER Degree	
Codice CdS		
Settore Scientifico Disciplinare (SSD)	ING-IND/27	
Crediti Formativi Universitari (CFU)	9	
Tipologia Attività Formativa (TAF)		
Tipo attività formativa	COMPULSORY	
Anno di corso	2 Year	
Periodo didattico	SECOND SEMESTER	
Docente responsabile	Girolamo Giordano	
Altri docenti coinvolti		
Organizzazione didattica*	***Ore Lezioni***	54
	Ore Esercitazioni	18
	Ore Laboratorio	---
	Ore Studio individuale	153
Lingua di insegnamento	English	
Propedeuticità	NONE	
Prerequisiti	Basics in Chemistry, Physic, Thermodynamic and Transport Phenomena	
Contenuti	The lectures focuses on the sector of energy production from renewable sources. The class is divided into two parts. The first one will deal with issues relating to traditional and renewable primary energy sources together with the analysis of climate change and greenhouse gas emissions. In the second part the processes of energy production from renewable sources will be analyzed.	
Obiettivi formativi (in termini di risultati di apprendimento attesi)	The aim of the course are: - Primary energy sources (consumption, reserves and production) - Green house gas emission - Energy from renewable sources, conversion of biomass, syngas from renewable sources, biorefineries and bio-methane Transversal skills: Critical and decisional skills achieved through the analysis of the processes that are analyzed during the course, enhancing the "problem solving" skills and the interpretation of data and	

	the process choices. Consolidated communication skills to present and discuss the topics during the oral test.
Programma	Lecture topics: • Primary energy sources (production, reserves, consumption and per-capita consumption). • Greenhouse gas emissions (historical data and future perspectives). • Carbon dioxide capture, and use of CO2 as carbon source. • Energy production from renewable sources and biomass conversion: gasification, pyrolysis, fast pyrolysis and catalytic pyrolysis. • Hydrogen production and storage. • Fuel cells. • Fermentation, aerobic and anaerobic digestion of waste and biomass. • Bio-refineries, bio-ethanol, bio-oils, bio-diesel and bio-gas. • Bio-methane production from the organic fraction of Municipal Waste. Practice (18 h) Practice Topics: • Material and energy balances. • Main reaction to transform CO2. • Unit operation in industrial hydrogen production. • Hydrogen purification for PEMFC. • Hydrogen balance in bio-fuels production. • Bio-methane separation from CO2.
Modalità di erogazione	FRONTAL
Metodologie didattiche	Traditional lecture format with blackboard and slides projection
Metodi e criteri di valutazione dell'apprendimento	For each exam session, the learning assessment method is done on a single stage, based on an oral exam concerning the course topics. The assessment methods of learning will take place through the traditional and consolidated method, almost millennial, applied from the Italian Academy for examination. Learning Evaluation Criteria The oral exam aims to verify and evaluate the level of achievement of the specific and transversal skills provided by the course. In particular, the following is verified: • if the ability to motivate the choices of industrial processes has been acquired.

	To pass the test with sufficient level it is necessary to: • frame the process / treatment discussed, • describe and motivate the proposed methodological approach, • argue the technological solutions adopted, • analyze the main advantages and (if any) disadvantages of the process. Learning Measurement Criteria and Final Mark Attribution The assessment of learning is measured with a mark expressed in thirtieths.
Testi di riferimento ed eventuali letture consigliate	BP Statistical Review of World Energy, 2021,) World Oil Review 2020 (Vol 1), ENI World Gas and Renewables Review 2020 (Vol. 2), ENI Biofuels Production by Biomass Gasification: A Review; by A. Molino et al. Energies 2018, 11, 811. A review of biomass gasification modelling; by S. Safarian et al. Renewable and Suistenable Energy Review 2019, 110, pp. 378-391. Fuels from waste plastics by thermal and catalytic processes: a review; by J. Aguado et al. Industrial & Engineering Chemistry Research 2008, 47(21), pp 7982-7992. Developing advanced catalysts for the conversion of polyolefinic waste plastics into fuels and chemicals; by D. Serrano et al. ACS Catalysis 2012, 2 (9), pp. 1924-1941. Waste biorefinery models towards sustainable circular bioeconomy: Critical review and future perspectives; by S. Venkata Mohan et al. Bioresource Technology 2016, 21, pp. 2-12. Other review articles will be provided during the course.
Peer review	Review of course content and workloads with other Professors working in the same field.
Orario delle lezioni	http://diam.unical.it
Calendario degli esami	http://diam.unical.it
Commissione d'esame	http://diam.unical.it

* Organizzazione didattica

STIMA DEL CARICO DI LAVORO PER LO STUDENTE				
	Lezioni [Ore]	Esercitazioni [Ore]	Laboratorio [Ore]	Studio individuale [Ore]
Descrizione blocco argomenti 1 **Primary energy sources (production, reserves, consumption and per-capita consumption).**	7			18
Descrizione blocco argomenti 2 **Renewable energy sources (production).**	4			5
Descrizione blocco argomenti 3 **Greenhouse gas emissions (historical data and future perspectives).**	4			5
Descrizione blocco argomenti 4 **Carbon dioxide capture, and use of CO2 as carbon source.**	6			16
Descrizione blocco argomenti 5 **Material and energy balances. Main reaction to transform CO2.**	-	6		16
Descrizione blocco argomenti 6 **Energy production from renewable sources and biomass conversion: gasification, pyrolysis, fast pyrolysis and catalytic pyrolysis.**	6	3		18
Descrizione blocco argomenti 7 **Hydrogen production and storage and Fuel cells.**	6	3		18
Descrizione blocco argomenti 8 **Fermentation, aerobic and anaerobic digestion of waste and biomass.**	6			15
Descrizione blocco argomenti 9 **Bio-refineries, bio-ethanol, bio-oils, bio-diesel and bio-gas.**	8	3		22
Descrizione blocco argomenti 10 **Bio-methane production from the organic fraction of Municipal Waste.**	7	3		20
Ore riservate allo sviluppo delle competenze trasversali *(possono essere previste anche ore di lezione frontale)*				
Tesine/altri homework				
Ulteriori ore da dedicare alla preparazione dell'esame *(es. ore che gli studenti dedicano allo svolgimento di precedenti tracce d'esame)*				
TOTALE *(Attenzione: i totali devono coincidere con le ore inserire dall'ufficio)*	**54**	**18**		**153**
ORE COMPLESSIVE	✓ **250**			