The Global Context of Clean Energy Materials
GSVS 2559 / ENGR 2595

Course details: 3 credits collab.itc.virginia.edu
Course instructor: James Groves (jgroves@virginia.edu)
Ph.D., Materials Science and Engineering
P.E., Licensed Professional Engineer, Commonwealth of Virginia

COURSE OVERVIEW

Brief Description

Clean energy systems depend upon materials sourced, refined, used, and disposed of (or recycled) globally. This course explains how material properties and selected structures deliver important clean energy device performance. It examines how the life cycles of clean energy technologies and their materials impact the environment and society. It considers how those impacts could become more sustainable and just. The course highlights geopolitical challenges sparked by the materials of the clean energy economy.

Pre- or co-requisite courses or topics

The course is open to any undergraduate. Students should be comfortable with chemistry and algebra concepts from high school.

INSTRUCTIONAL MATERIALS

Instructional materials will be provided as needed. No materials need to be purchased. Students may find the following book relevant and interesting.

McDonough, W., & Braungart, M. (2010). *Cradle to cradle: Remaking the way we make things*. North point press.

LEARNING OBJECTIVES

Students should be able to:

1. Name material properties relevant to clean energy systems and explain their scientific basis.
2. Explain how material properties and selected structures deliver clean energy device performance.
3. Discuss how the global supply chains for minerals and materials impact society and the biosphere in the era of clean energy systems.
4. Identify geopolitical challenges arising from the global supply chains of clean energy materials.
5. Explain how materials scientists and engineers research and develop device performance improvements and describe how those efforts can deliver technologies that are more sustainable and just.
6. Describe how actors like governments, investors, and corporations spur the emergence of next generation materials.

COURSE CONTENT

In each course module, relevant clean energy material properties will be introduced and their scientific basis illuminated. Clean energy devices that exploit the property will be explained. Selected life cycle stages will be examined to highlight the environmental and societal impact of clean energy materials and systems. Strategies for moderating those impacts, such as research and development of new materials solutions, will be examined. Finally, geopolitical

considerations associated with the global supply chains of clean energy materials will be discussed.

Order	Material property	Clean energy devices and applications
I.	Optoelectronic	Photovoltaics, LED lighting
II.	Magnetic	Wind turbine generators, Electric vehicle motors
III.	Mechanical	Wind turbine blades, Electric vehicle bodies
IV.	Electrical	DC converter stations and supergrids
V.	Electrochemical	Rechargeable batteries
VI.	Thermal	Concentrating solar power, Emerging nuclear fuels
VII.	Chemical	Solar fuel synthesis, H_2 storage, Carbon capture
VIII.	Optical	Atmospheric seeding

ASSESSMENT & MEASUREMENT

How course outcomes will be assessed

Homework Quizzes (15%)

Midterm exam (20%)

Individualized learning experience

- Mid-term project prospectus (7.5%)
- Final project (17.5%)

Final exam (25%)

Class discussion and participation (15%)

Late policy

All graded assignments in GSVS 2559 / ENGR 2595 will have specific due dates and times listed in the weekly handouts provided by your instructor. Untimed assignments may be turned in up to 72 hours after the assigned due date and time. When such assignments are turned in late (by any amount of time), a 10% grade penalty will be assessed. After a student misses the 72 hour “late submission” window, assignments may be turned in at any time before the official end of the semester, receiving a 30% grade penalty. If students believe they need a deadline extension, they must request and receive written approval for such an extension, prior to the original submission deadline.

Course grade scale

A+	> 97%	**B+**	87 – 90%	**C+**	77 – 80%	**D+**	67 – 70%
A	93 – 97%	**B**	83 – 87%	**C**	73 – 77%	**D**	63 – 67%
A-	90 – 93%	**B-**	80 – 83%	**C-**	70 – 73%	**D-**	60 – 63%

F <60%

LEARNING COMMUNITY INTERACTION & ENGAGEMENT

Individual student engagement

Your success in this course will depend on *your* individual efforts and on *our* ability to work together to build a cooperative learning environment. Questions and sharing of beliefs, opinions, and feelings are strongly encouraged. In order to maximize our learning, we will need to create a safe community in which we will feel comfortable sharing thoughts and ideas even when those thoughts and ideas are not in full agreement with the thoughts of others in the course. Achieving a safe learning environment requires practice and effort. It will require each of us to behave professionally and respectfully at all times, and to adhere to our course norms. As you learn in this course and learn about your classmates, you are encouraged to respect and appreciate differences.

Learning community values

Meaningful and courteous dialogue is expected in this course. Healthy dialogue will require a degree of respectful understanding and a willingness to listen to all course participants. You may not agree with another person's point-of-view, or you may already understand a concept and feel frustrated with the pace of class discussion at times. Give others a chance to contribute and learn. Encourage one another politely. Seek to understand and appreciate the ideas of others. Learn from one another. Be patient and encouraging as we *all* seek to advance our knowledge of important sustainable energy system concepts. Since every student is entitled to full participation in this course without interruption, all students are expected to come to class sessions prepared and on time. You are always expected to refrain from undertaking any activities that might be considered disruptive.

Class schedule and time commitment

This course is a 3 credit hour course at the University of Virginia. Students should understand that the U.S. federal government mandates a certain *minimum* student workload for each credit hour earned while in college. By the federal definition, each credit hour should require a minimum of two hours of out of class student work each week for approximately fifteen weeks. So, in addition to attending class regularly (as part of class participation), set aside 6+ hours per week outside of class to engage with the materials of this course. The course content is not difficult to understand, yet there is much to learn. Organize your schedule to allow you to put in the expected study time! The expectation is that you will attend class every single day. Class session recordings will be available for illness and family emergency misses.

Use of email

Your instructor will seek to minimize the number of course related messages sent to you by email. Still, email messages to the class and to individual students will be necessary from time-to-time. Your instructor expects that you will check your university email account at least one time each day, Monday – Friday during the semester. If an email includes a specific request for a response, it is your instructor's expectation that you will respond in no more than two business days from the time that the email was *sent* to you (not from the time that you read the email). Failure to read and respond to emails from your instructor in a timely manner (as defined above) will have a negative impact upon your class participation grade.

Special Needs

The University of Virginia strives to provide accessibility to all students. If you require an accommodation to fully access this course, please contact the Student Disability Access Center

(SDAC) at (434) 243-5180 or sdac@virginia.edu. If you are unsure if you require an accommodation, or to learn more about their services, you may contact the SDAC at the number above or by visiting their website at http://studenthealth.virginia.edu/student-disability-access-center/faculty-staff.

Honor code

The University of Virginia relies upon and cherishes its community of trust. Your instructor firmly endorses, upholds, and embraces the University of Virginia's Honor principle that students will not lie, cheat, or steal, and we expect all students to take responsibility for the System and the privileges that it provides. I recognize that even one Honor infraction can destroy an exemplary reputation that has taken years to build. Acting in a manner consistent with the principles of Honor will benefit every member of the community both while enrolled in this course and in the future.

If you have questions about the Honor System or would like to report suspicions of an Honor offense, please contact your instructor. For more information on the UVA Honor System, please visit the following web resource: http://www.virginia.edu/honor/