

Introduction

- The rapid deployment of clean energy technologies demands large amounts of “critical” raw materials associated with supply chain complexities and energy-intensive extraction and manufacturing processes
- Ensuring that these materials are available in the required capacities and at their highest value and function will dictate a robust circular economy
- At ISEE, we aim to train a qualified workforce to effectively design, promote, and implement sustainable critical materials development and green manufacturing concepts to advance next-generation technologies focused on energy production, transmission, and storage.
- Focus:** Building on existing curricula in the VCU College of Engineering & School of Business, a series of stand-alone **Micro-credential Courses** will be developed.

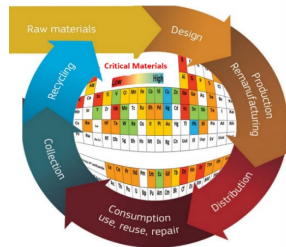
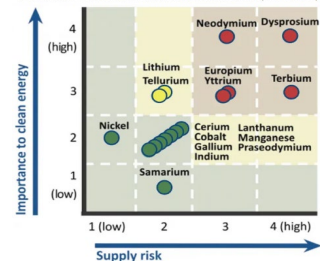
Methods

- VCU has partnered with Credly to provide participating students with Continuing Education Units (CEUs) and a Digital Badge.
- The courses will offer students a flexible way to supplement their core degree from any discipline, a facile platform for “green” upskilling
- Content:** Series of short videos (30 mins) focused on
 - Embodied Energy in Materials
 - Life Cycle Analysis LCA (OpenLCA*)
 - Carbon Accounting in Manufacturing Processes (GREET*)
 - Basic Concepts of Supply Chain Resiliency
 - Basic Concepts of Circular Business Models
- Project-based Assessment:** Unique Design Canvas to evaluate the sustainability of a “critical material” in the context of a specific energy technology (e.g., Nd in wind powder technology, Co in batteries, etc.)

Progress

- The scope of the micro-credential courses was assessed via a detailed survey conducted in the Fall 2024 semester (Sample size: 135 students)
 - Sustainable Materials & Green Manufacturing (EGMN 591);
 - Senior Capstone Design (EGNR 492);
 - Supply Chain Analytics (SCMA- 691)
- The suitability of the Sustainable Design Canvas as an assessment tool was piloted in EGMN 591.
- Examples of select student projects will be made publicly available via a website supported by ISEE.
- Content and script for the micro-credential course have been developed (Video recordings are in progress)
- Course will be expanded into an Energy Innovation Certificate, in collaboration with Dominion Energy Innovation Center (DEIC).

MATERIALS CRITICALITY MATRIX, MEDIUM TERM (2015-2025)

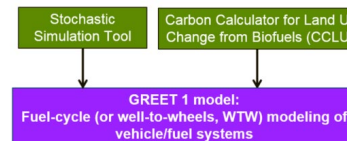


■ Critical ■ Near-Critical ■ Not Critical

Source: <https://www.energy.gov/science/doe-explainscritical-materials>

The GREET® (Greenhouse gases, Regulated Emissions, and Energy use in Transportation) model

- Freely available at www.greet.es.anl.gov
- Updated and released annually
- Support DOE R&D programs



GREET 2 model: Vehicle cycle modeling for vehicles



Source: <https://www.energy.gov/eere/bioenergy/articles/greet-greenhouse-gases-regulated-emissions-and-energy-use-transportation>



Skills

| | |
|---------------------------|--------------------------|
| Critical Materials | Measuring Sustainability |
| Life Cycle Analysis | User Design |
| Whole System Mapping | Supply Chain Basics |
| Circular Economy Concepts | Design Thinking |

Learning Project-based

20 hrs \$ Free

*Nominal fee for students not affiliated with VCU
Fee structure to be determined



Integrating sustainability into engineering education to protect and improve our planet and lives