Engineering Design & Carbon Removal

Next Generation Science Standards Covered

HS-ETS1-1, HS-ETS1-2, HS-ETS1-3, HS-ETS1-4

Grade Level
High School
Duration
3 Weeks
Related Documentary
Legion 44

Tuvalu

legion44.world

Lesson Overview

Students will explore carbon removal as a response to climate change, applying the engineering design process to develop and evaluate carbon management solutions. They will analyze real-world constraints, design a viable solution, model its impact, and critique peer proposals.

Biochar

LEGION

legion44.world

Week 1: Understanding the Problem

Objectives

1. Define the major global challenge of accumulated CO_2 in the atmosphere.
2. Identify qualitative and quantitative criteria and constraints for carbon management

Activities

Discussion & Documentary Segment (120 min)

1. Show a 15-20 min segment of Legion 44 highlighting the impacts of CO_2 accumulation.
   a. 00:00 - 18:24: Introduction to Carbon Removal and the Challenge
   b. 18:24 - 33:27: Enhanced Rock Weathering & DAC
   c. 36:55 - 1:03:37: DAC, Carbon Storage, & Biochar
   d. 1:09:39 - 1:35:40: Seaweed Sinking, Ocean Alkalinity Enhancement, Algae/Biomass Burial
2. Facilitate a class discussion using guiding questions:
   a. What are the primary sources of CO_2 emissions?
   b. Why is CO_2 accumulation a global challenge?
   c. What are potential solutions? What constraints exist (e.g., cost, energy use, land availability)?

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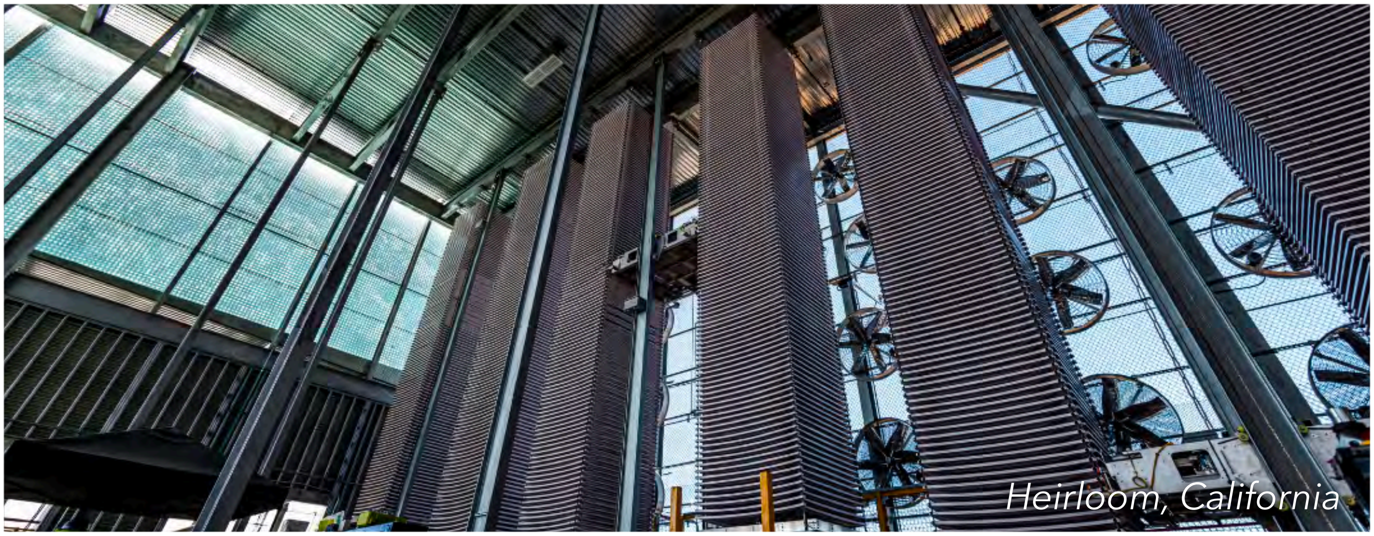
Research & Criteria Development (120 min)

- Assign students to small groups to research different carbon management approaches (e.g., Direct Air Capture, BECCS, Ocean Alkalinity Enhancement).
- Have students identify qualitative and quantitative criteria for evaluating these solutions.
- Groups present findings, and the class compiles a shared list of key constraints and trade-offs.

Week 2: Designing and Modeling Solutions (HS-ETS1-2 & HS-ETS1-4) (HS-ETS1-1)

Objectives

1. Develop a carbon removal solution based on scientific knowledge and engineering principles.
2. Use a computational or mathematical model to analyze its impact.



Project Launch & Proposal Development (60 min)

1. Students (individually or in teams) select a specific carbon management solution to design.
   a. Provide a structured project outline:
      i. Problem definition and constraints
      ii. Proposed solution description
      iii. Expected impact and feasibility
      iv. Trade-off considerations

Solution Design & Computational Modeling (180 min)

1. Students refine their designs and run simulations to predict their impact. Suggested tools:
   a. En-ROADS Climate Solutions Simulator - works for afforestation, biochar, BECCS, soil carbon, DAC, ERW
   b. Road to 10 Gigatons - works for afforestation/reforestation, BECCS, soil carbon, DAC, ERW,
   c. PhET Interactive Simulations - Greenhouse effect
2. Students document assumptions, model results, and limitations of their approach.

Week 3: Evaluation and Peer Review (HS-ETS1-3)

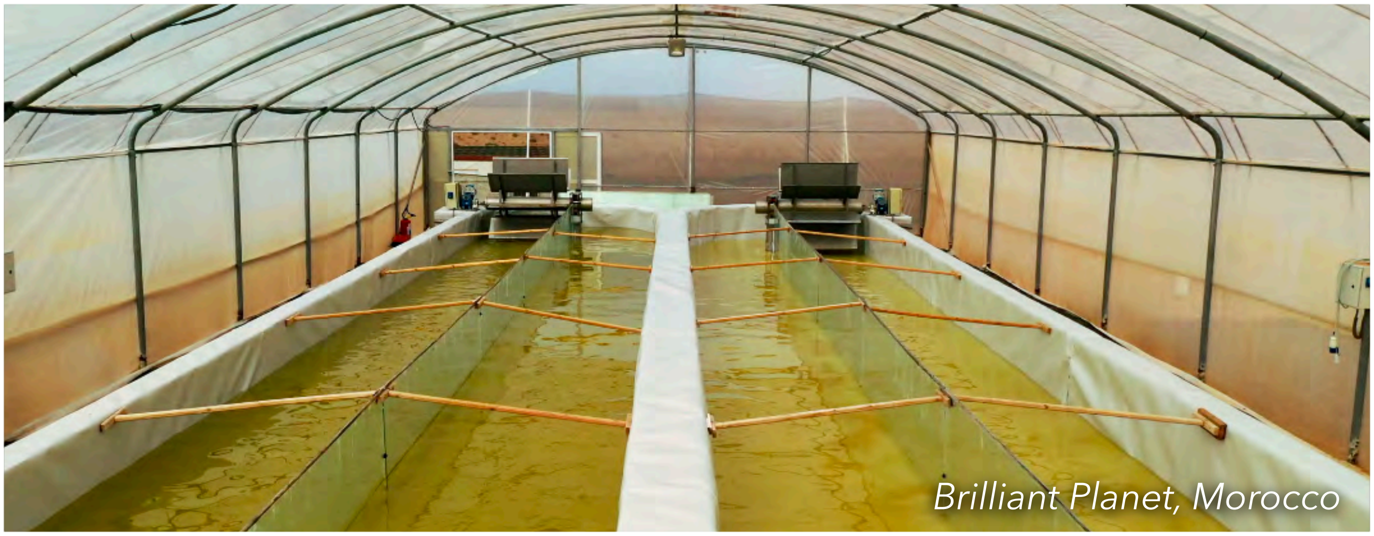
Objectives

- Critically evaluate proposed solutions using engineering criteria.
- Provide constructive feedback on design trade-offs and feasibility.

Activities

Peer Review & Debate (10-15 min presentation per group)

1. Students present their projects in small groups or to the class.
2. Peer evaluation using structured criteria:
   a. Clarity of problem definition
   b. Strength of proposed solution
   c. Consideration of trade-offs and constraints
   d. Use of models/simulations to support conclusions
3. Organize a debate where teams advocate for different solutions and challenge each other's approaches.



Final Reflection & Improvement Plan (1 Class Period)

1. Students reflect on peer feedback and document changes they would make to improve their design.
2. Exit Ticket: What was the most important trade-off you had to consider in your design?

Assessment and Grading

- Participation in Discussions (15%) – Engagement in class discussions and research activities.
- Project Proposal (20%) – Clear problem definition, realistic constraints, and well-defined criteria.
- Final Project & Model (40%) – Depth of analysis, use of simulations, and creativity of the solution.
- Peer Review & Reflection (25%) – Thoughtfulness in evaluating peers and applying feedback.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