Alternative Energy

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Background

- IMSA offers an “Engineering” class—a one-semester, project-based class, in which students apply concepts and principles of science in constructing their projects.
- One of the projects traditionally required for all students was a wind turbine project. Students optimized the design with the goal of producing maximum sustained power.

Motivation

- Create an alternative energy module which could address global issues such as energy supply and demand, climate change, and CO_2 emissions.
- Expand the wind-turbine project to an alternative energy project which addresses the four Engineering NGSS standards.
- Break project into two phases (alpha and beta) to show students how engineering projects are phased into process development and scale-up, with optimization occurring all along the way.

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NGSS Engineering Standards

HS-ETS1-1 (Analysis)	Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
HS-ETS1-2 (Design)	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
HS-ETS1-3 (Evaluation)	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
HS-ETS1-4 (Modelling)	Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

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Benefits

- Students are exposed to:
  - Wide variety of concepts (power vs energy, Ohm's law, electromagnetic induction, galvanic cells, how solar panels work)
  - Assessing environmental impact (CO_2 emissions, ecological and community impacts, etc.)
  - Test equipment (voltmeters, ammeters)
  - 2 phase projects (alpha and beta)
  - Written and oral reports

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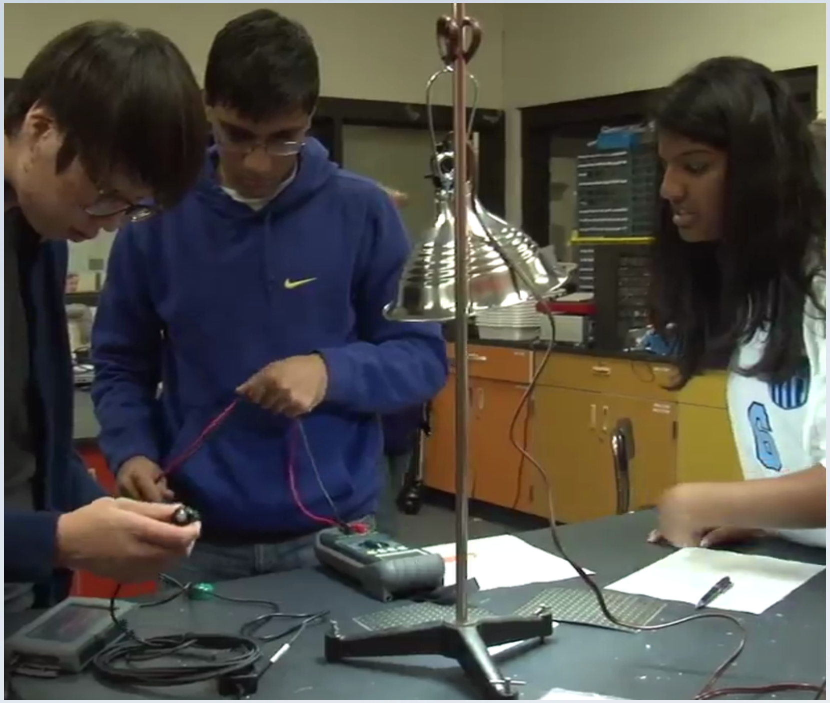
Activities: Preliminary

Magnet/coil generator

Hydrogen tube/spectroscope

(Not pictured: modelling exercise)



Solar panels

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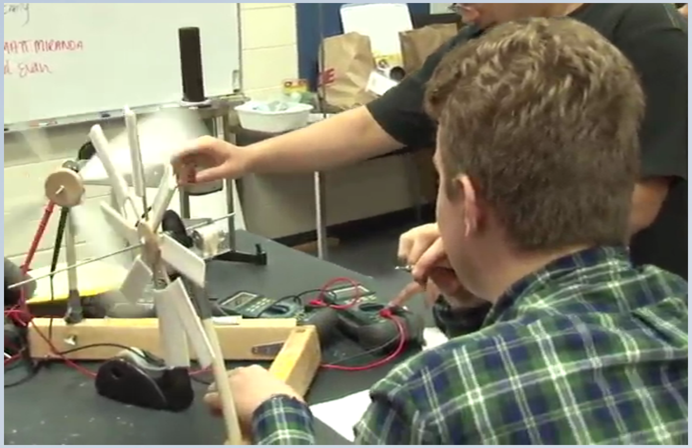
Activities: Preliminary



Wind turbine

Microbial fuel cells

Galvanic cell

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Features

- Contextual discussions
- Rubric design for project evaluation
- A project with a world-wide impact

Logistics

- Students divided into 6 groups of 3-4 students
- 3 technologies available: wind; solar-electrical; microbial fuel cells (MFC)—2 groups per technology
- Time of project expanded from 2 weeks (for old wind unit) to 4-1/2 weeks.

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Stations

- Modelling
- Solar panel
- Spectroscope with hydrogen tube
- Wind turbine
- Magnet/solenoid generator
- MFC
- Galvanic cell

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Performance Evaluation

- How should success be measured?
  - Technologies have different capabilities.
  - What would constitute a fair comparison?
- How should efficiency be defined?
  - What is most valued?
  - What are the real costs?

Student Evaluation Criteria

- Example:
  - Performance 25%
  - Health and Safety 11%
  - Nuisance and Aesthetics 11%
  - Marketability & Global Impact 11%
  - Reports (including innovation) 42%

First 3 Semesters—Self Assessment

- What worked well
  - Exploration stations
  - Beta design and build
  - Final report
- What didn't work
  - Alpha presentations and rubric development
  - Alpha testing was an extended exploration—could use focusing questions developed by groups
  - Microbial fuel cells are highly variable and produce very low energy

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