Wind Energy
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Background

- IMSA has a one semester engineering course that has utilized a two-week, kit-based windmill challenge in the past.

- In recent years, it was also embedded in a unit on alternative energy, along with solar energy and microbial fuel cells.

- IMSA has now developed a condensed wind challenge to be completed in 2 hours.

- The concepts and procedures could be elaborated upon to create a longer project in the traditional classroom setting.
Wind Challenge

- Discussion of Energy, Alternative Energy, and Wind
  - Round one – given a standard set of equipment:
    - Select the number blades (up to 12), cut out blade shape, & set blade angle
    - Record the voltage over a 30s period
    - Advance the best 2 designs from each cluster of 3 groups
  - Discussion of Successes and Failures, Principles, etc.
  - Round Two – differential shaft speed and orienting device:
    - Build up pulley diameter (spool shaft) with rubber bands
    - Allow device to orient in wind (add a tail?)
    - Record official 1 minute voltage recording at cross-wind table
    - Recognize top performers
  - Discussion of Performance and Engineering Process
<table>
<thead>
<tr>
<th>HS-ETS1-1</th>
<th>Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.</th>
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</thead>
<tbody>
<tr>
<td>HS-ETS1-2</td>
<td>Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.</td>
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<tr>
<td>HS-ETS1-3</td>
<td>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.</td>
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<tr>
<td>HS-ETS1-4</td>
<td>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.</td>
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</table>
Next Generation Science Standards

HS-PS3-3

Students who demonstrate understanding can:

Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.∗ [Clarification Statement: Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency.] [Assessment Boundary: Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.]

https://www.nextgenscience.org
UN Sustainable Development Goals

- By 2030, ensure universal access to affordable, reliable and modern energy services
- By 2030, increase substantially the share of renewable energy in the global energy mix
- By 2030, double the global rate of improvement in energy efficiency
- By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology
- By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States, and land-locked developing countries, in accordance with their respective programmes of support

http://www.un.org
Next Generation Science Standards

https://www.nextgenscience.org
Pedagogically Speaking…

- **IMSA’s Core Competencies:**
  - Competency Driven (Mastery of Content)
    - Disciplinary Core Ideas
  - Inquiry Based (Students question, discover)
    - Scientific and Engineering Practices
  - Problem Centered (Develop Interest, Real World)
    - Phenomenon
  - Integrated (Physics, Math, Engineering, Environment, Economics, Communication)
    - Cross Cutting Concepts
Round One

- Select the number blades (up to 12), cut out blade shape, & set blade angle

- Record the voltage over a 30s period

- Advance the best 2 designs from each cluster of 3 groups
Successes?
Round Two

- Build up pulley diameter (spool shaft) with rubber bands
- Allow device to orient in wind (add a tail?)
- Official 1 minute voltage recording at cross-wind table
Suggestions?
Concepts & Skills

- Global Warming & Alternative Energy
- Wind Power, KE, (Bernoulli, Power Equation, & Betz?)
- Prototyping & Collaboration
- Test equipment (voltmeters, ammeters?, LabQuests?)
- Transduction, Energy (non)Conservation, Efficiency
- Mechanical Advantage and Torque
- Two-stage development
- Optional Extensions
  - Oral and written reports
  - Carbon footprint
  - Circuits
  - Induction
  - CAD and 3D printing
  - Modeling Fluid Flow
  - Rotational motion, RKE
Thank You!