Unit Overview – Socially Responsible Engineering & Technology (POS)

Course: Y1U6

Unit Title: Got Efficiency? (Alternate Energy)

Approximate Length of Unit: 8 Weeks (based on five day weeks; 45 minute periods each day)

Unit Summary

This unit will begin by raising student interest and awareness about how energy is used and the impacts on the world around us. The world population is continuing to increase at the same time a larger percentage of the population is becoming more technologically advanced. These advancements take an increasing amount of energy to create, operate and maintain.

At the beginning of the unit students will complete an energy audit for their home and then compare this to the energy used by families living in other parts of the world. The knowledge gained from this activity will be reflected on and be the basis for selecting the specific problem to solve.

Throughout the unit the use of the engineering design process will be used as a method to develop a solution to a problem. They will also acquire insight into the growing field of alternate energy.

Primary interdisciplinary connections: Math, Science

21st century themes: Systems, Alternate Energy

Unit Rationale

According to the United States Energy Information Administration, world energy consumption is projected to increase by 49% from 2007 to 2035. This is an alarming number given the worlds current reliance on non-renewable sources of energy. In addition, the United States constitutes only five percentage of the world's population but consumes almost 25% of the world's energy. There is a defined need for alternative energy sources as well as an increase in the efficiency of how energy is used.

Suggested Materials:

Wood, plastic, metal or existing case to house the device. Adhesives to hold parts together. Batteries, if needed to power a device. Such as:

Electronics

Insulated 24ga stranded wire in different colors

Insulated 24ga solid wire in different colors

Breadboards

Electronic components

Construction/Prototyping

Wire strippers

Electrical tape

Wood

Acrylic sheets in various sizes

<u>**Suggested Tools/Machines:**</u> *Basic material processing and electronics tools. Such as:* Woodworking hand tools Power tools Soldering irons Woodworking power tools
Unit Assumptions – Content covered in Units 1 to 4. Students have been exposed to the problem solving process more than once and that the steps are understood. Students have experience using hand and power tools to safely and accurately process materials. Students have experience working as part of a team to accomplish a goal. Students have been introduced to technical drawing.

Learning Targets	
Math (NJCCCS 4) **4.2 Units of Measurement**: Measurement helps describe our world using numbers. An understanding of how we attach numbers to real-world phenomena, familiarity with common measurement units (e.g., inches, liters, and miles per hours), and a practical knowledge of measurement tools and techniques are critical for students' understanding of the world around them.	
CPI #	**Cumulative Progress Indicator (CPI)**
4.2.12.D.2	Choose appropriate tools and techniques to achieve the specified degree of precision and error needed in a situation.
Science (NJCCCS 5) **5.1 Science Practices:** All students will understand that science is both a body of knowledge and an evidence-based, model-building enterprise that continually extends, refines, and revises knowledge and reasoning skills that students must acquire to be proficient in science.	
CPI #	**Cumulative Progress Indicator (CPI)**
5.1.12.C.2	Use data representations and new models to revise predictions and explanations.
5.2 Physical Science: All students will understand that physical science principles, including fundamental ideas about matter, energy, and motion, are powerful conceptual tools for making sense of phenomena in physical, living, and Earth systems science.	
CPI #	**Cumulative Progress Indicator (CPI)**
5.2.12.D.2	Describe the potential commercial applications of exothermic and endothermic reactions.
5.4 Earth Systems Science: All students will understand that Earth operates as a set of complex, dynamic, and interconnected systems, and is a part of the all-encompassing system of the universe.	
CPI #	**Cumulative Progress Indicator (CPI)**
5.4.12.E.1	Model and explain the physical science principles that account for the global energy budget.
Engineering and Technological Literacy (NJCCCS 8.2)	

8.2 Technology Education, Engineering, and Design: All students will develop an understanding of the nature and impact of technology, engineering, technological design, and the designed world, as they relate to the individual, global society, and the environment.

CPI #	Cumulative Progress Indicator (CPI)
8.2.12.F.1	Determine and use the appropriate application of resources in the design, development, and creation of a technological product or system.

21st Century Skills (NJCCCS 9.1)

9.1 21st-Century Life & Career Skills: All students will demonstrate the creative, critical thinking, collaboration, and problem-solving skills needed to function successfully as both global citizens and workers in diverse ethnic and organizational cultures.

CPI #	Cumulative Progress Indicator (CPI)
9.1.12.A.1	Apply critical thinking and problem-solving strategies during structured learning experiences.
9.1.12.B.1	Present resources and data in a format that effectively communicates the meaning of the data and its implications for solving problems, using multiple perspectives.

9.4 Career and Technical Education: All students who complete a career and technical education program will acquire academic and technical skills for careers in emerging and established professions that lead to technical skill proficiency, credentials, certificates, licenses, and/or degrees.

CPI #	Cumulative Progress Indicator (CPI)
9.4.12.O.17	Employ critical thinking skills (e.g., analyze, synthesize, and evaluate) independently and in teams to solve problems and make decisions.
9.4.12.O.68	Employ planning and time management skills and tools to enhance results and complete work tasks.
9.4.12.O.(1).11	Demonstrate understanding of processes and concepts that are key to understanding the design process.

Mathematics (Common Core)

Modeling with geometry.

G-MG.3. Apply geometric methods to solve design problems.

Science (Common Core)

Key Ideas and Details

RST.9-10.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

Industry Standards

NOCDI

- Employability skills – Workplace Readiness
- STEM – Pre-Engineering, Engineering Technology

Unit Essential Questions	Unit Enduring Understandings
• In what ways is energy used in modern society? • How does the energy that we use affect the environment?	• It is possible for energy usage to surpass energy production. • Energy usage has an impact on the world

• What social and ethical responsibilities to individuals and organizations have to limit their utilization of energy? • What are the scientific principles that govern the use and transformation of energy?	that we live in. • Energy is used in the production, transport, use, maintenance, and disposal of products. • There are natural limitations to how energy can be created and transformed.

Unit Learning Targets

Students will ...

1. Differentiate between renewable and non-renewable energy sources.(5.4.12.E.1)
2. Research and document the rate at which they are using energy in their current lifestyle. (5.1.12.C.2) (5.4.12.E.1)
3. Research and document the carbon footprint that is created based on their energy consumption. (5.1.12.C.2)
4. Compare and contrast their energy consumption/carbon footprint to those of individuals in other parts of the world in order to create more energy efficient systems. (9.4.12.O.17)
5. Create a Public Service Announcement related to alternative energy. (5.2.12.D.2)
6. Identify the interfacing of systems in the production and use of energy, and ways in which these systems could be improved. (5.1.12.C.2)
7. Demonstrate an understanding of the Engineering Design Process by using it to create a solution to a proposed problem, and document the process.(9.1.12.A.1) (9.4.12.O.(1).11)
8. Safely and accurately use tools to process materials in generating a solution to a problem. (4.2.12.D.2) (9.4.12.O.(1).11).
9. Develop and produce a product that will monitor and/or limit the amount of energy used for a defined task. (8.2.12.F.1) (9.4.12.O.17) (9.4.12.O.68) (G-MG.3)
10. Document the use of the engineering design process to develop a solution to a problem. (8.2.12.F.1) (9.4.12.O.17) (9.4.12.O.68) (9.4.12.O.(1).11) (RST.9-10.3)
11. Present evidence of a solution to a problem using the data gathered in the testing process. (9.1.12.B.1)

Background/Scenario:
There are many energy efficient devices and energy monitors that have been developed. However, the energy usage of the world population continues to increase at an alarming rate.

Design Brief:
In a team of 2-3 students identify a need for a device that will either monitor and/or limit energy usage. The energy audit and public service announcement activities are a great place to start when looking to identify a need.

Specifications/Criteria:

- The device should be efficient in energy consumption, saving more than it uses.
- It should require minimal maintenance.
- The device should be no larger than 10”x12”x20”.

- The device may focus on mechanical, battery, solar, cord powered, wind or any other energy form approved by the instructor. It can be a passive device. Efficiency is critical!

Constraints:

Time:

- The feedback given should be at least every 24 hours.

Money:

- The prototype should cost $25 or less in materials.

Energy:

- Energy efficiency should be the primary focus of the device.

Tools/Machines:

- Hand tools.
- Power tools.

People

- Two students per group. If there is an odd number of student's in the class it is possible for there to be either a group of three or a student that works alone.

Information

- From this unit, research and prior experiences.

Materials

- Electronics.
- Construction/Prototyping.
- Other materials are listed at the beginning of the unit.

Other

Stakeholders:

Consumer/User.

Community at large.

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<tr><th colspan="2"></th></tr>
<tr><th>Teacher Instruction</th><th>Student Evaluation</th></tr>
<tr><td colspan="2">Step One: Identify the Problem</td></tr>
<tr><td>Lessons/ Topic(s)

Lesson 1: Overview of design challenge and introductory activities.
Introduction “How efficient is America?”
“What are ways that we produce and use energy?”
Lesson 2: Energy Audit and carbon footprint
“I’m being audited?!
“How big is my carbon footprint?”
Lesson 3: Public Service Announcement (PSA)
“Creating a Public Service Announcement (PSA)”</td><td><u>Formative Assessments:</u>
Teacher questioning during instruction
Opportunity for students to pause, reflect, summarize or discuss at various intervals during lessons
<u>Summative Assessments:</u>
Completed energy audit with rubrics/rating scales (ULT #1, 2, 3 &4)
Completed PSA with rubrics/rating scales (ULT #4 & 5)
Quiz on terminology related to energy. (ULT #1)</td></tr>
<tr><td>Notes:
Some useful websites:
http://www.carbonfootprint.com/calculator.aspx
http://www.worldenergy.org/
http://www.nationmaster.com/country/us-united-states/ene-energy
http://epa.gov</td><td>Notes:</td></tr>
<tr><td colspan="2">Step Two: Frame the Design Brief</td></tr>
<tr><td>Lessons/ Topic(s)

Lesson 4: Framing the design brief for the energy monitoring/limiting device.</td><td><u>Formative Assessments:</u>
Group discussion and peer assessment of work at each stage as the design brief and then specification and constraints are developed. The teacher should be circulating the room to monitor discussions and offer guidance and answer questions that may arise.
<u>Summative Assessments:</u>
Design brief page created by team included in the design portfolio. (ULT #7& 10)</td></tr>
<tr><td>Notes:</td><td>Notes:
Formative:
The students should start this process by</td></tr>
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<tr><td></td><td>sharing their energy audit, carbon footprint, and public service announcement with one another. This should serve as a starting point for students to identify a problem to solve in a school, classroom, house, or home. They may also decide to focus on some other area of interest such as aerodynamics of bicycles, material substitution to make a car lighter, etc.</td></tr>
<tr><td colspan="2">Step Three: Research & Brainstorming</td></tr>
<tr><td>Lessons/ Topic(s)

Lesson 5: “What happens when we run out of ideas? Using additional brainstorming methods.”</td><td><u>Formative Assessments:</u>
o Group whiteboards so that peers and the teacher can visually track the brainstorming method used as well as the progress and direction.

<u>Summative Assessments:</u>
• Formal documentation of the brainstorming process, graded per rubric (ULT #6&7)</td></tr>
<tr><td>Notes:

Students will need guidance at this point to select a reasonable problem to solve. It is important that they choose a problem that is not so easy to solve that they miss out on learning something new, and not so complex that they run out of time to solve it.

Here is a website that shares some some creative solutions to energy related issues:
www.instructables.com</td><td>Notes:
Team responsibilities can be assigned as follows:

Project Manager (1) – Focuses on completing documentation and maintaining work schedule to ensure project is completed on time.

Designer (1) – needs to make sure that a similar device does not already exist. They are also responsible for making sure that the solution meets the specifications and constraints.

Manufacturer (1) – needs to be able to develop a prototype using the materials available and/or recycled materials.</td></tr>
<tr><td colspan="2">Step Four: Generation Alternate Solutions</td></tr>
<tr><td>Lessons/ Topic(s)
Lesson 6: “Technical Drawings and Schematics”
• Review of technical drawing practices.
• Generate technical drawings of alternate solutions.</td><td><u>Formative Assessments:</u>
o Peer evaluation of completed drawings and time for revisions.

<u>Summative Assessments:</u>
o Completed alternate solutions that meet the criteria outlined in the</td></tr>
</table>

	rubric. (ULT #9&10)
Notes: Students may spend at least one additional day working on the generation of alternate solutions.	**Notes:** The rubric for the project should have criteria for each step in the design process. The summative assessment on steps as they are completed is an important aspect of ensuring that students are meeting the requirements of the class as they progress through the project.
Step Five: Chosen Solution with Rationale	
Lessons/ Topic(s) Lesson 7: Refine ideas to generate alternate solutions.	**<u>Formative Assessments:</u>** ○ Teacher conferences with students to provide verbal feedback and an opportunity to make appropriate changes prior to submitting the portfolio for a grade. **<u>Summative Assessments:</u>** ○ Assessment of the chosen solution and rationale, per rubric. This will be added to portfolio. (ULT#7&10)
Notes:	**Notes:** **Formative:** Teacher will share example documentation work of both exemplary and unsatisfactory levels to serve as a guide for students. Teacher will provide feedback to each group, which they can then use to refine their ideas and update documentation. **Summative:** The rubric for the project should have criteria for each step in the design process. The summative assessment on steps as they are completed is an important aspect of ensuring that students are meeting the requirements of the class as they progress through the project.
Step Six: Developmental Work	
Lessons/ Topic(s) Lesson 8: Developmental work – Generating optimum design ideas	**<u>Formative Assessments:</u>** ○ Teacher questioning/conferences with students to discuss design ideas and timeframes to complete the project. ○ Team discussions to compromise

	on the development of the optimum solution. **Summative Assessments:** ○ [This section of the portfolio will be graded after Step Eight of the design process is completed.]
Notes: Teacher will ensure that students complete tasks, while emphasizing design and experimentation. Students will complete working drawings, notes, and gather materials, and test modeling techniques in order to develop an optimum solution.	**Notes:** If is important the students choose an optimum design that meets the requirements of the project and is attainable in the amount of time given.
Step Seven: Prototype	
Lessons/ Topic(s) Lesson 9: Modeling optimum solutions using appropriate supplies	**Formative Assessments:** ○ Teacher critique of final solutions as they are being constructed. **Summative Assessments:** ○ [This section of the portfolio will be graded after Step Eight of the design process is completed.]
Notes: Teacher will ensure that all students complete tasks with an emphasis on safety, accuracy, and teamwork.	**Notes:**
Step Eight: Testing and Evaluation	
Lessons/ Topic(s) Lesson 10: Testing methods	**Formative Assessments:** ○ Teacher critique of testing methods to teacher, prior to official test. **Summative Assessments:** ○ Portfolio assessment of the steps six, seven and eight, per rubric. The portfolio should contain documentation of the testing process and results supporting how the device meets or exceeds the specifications and criteria the group established. (ULT #6,7,8,9,&10)
Notes: Students will model the device as accurately as possible. The quality of the model is important, but function is	**Notes:** Teacher will guide students in developing methods to test and evaluated the device as

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<tr><td>critical.</td><td>accurately as possible.</td></tr>
<tr><td colspan="2">Step Nine: Redesign and Reflect</td></tr>
<tr><td>Lessons/ Topic(s)
Lesson 11: Redesign and reflect</td><td><u>Formative Assessments:</u>
○ Written teacher observations made during the testing process will be given to students to assist in the reflection process.

<u>Summative Assessments:</u>
○ Students will complete evaluation prompts provided by teacher and include in portfolio. (ULT #7 & 11)</td></tr>
<tr><td>Notes:
Students will document redesign possibilities in their portfolio. It is important that they make connections between the prototype and the testing when recording possible modifications.</td><td>Notes:</td></tr>
<tr><td colspan="2">Step Ten: Communicate</td></tr>
<tr><td>Lessons/ Topic(s)
Lesson 12: Presentation preparation and delivery</td><td><u>Formative Assessments:</u>
○ Practice presentation with teacher/peer feedback based on rubric.

<u>Summative Assessments:</u>
○ Presentations of design process showing final solution and data gathered during the testing and evaluation process. (ULT #11)</td></tr>
<tr><td>Notes:
Teacher will establish procedures and timeframe for student presentations to the class. Students are expected to use technical terminology to demonstrate an understanding of concepts during their presentation. Classmates should be encouraged to provide constructive feedback.</td><td>Notes:</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Corresponding Technology Student Association (TSA) Activities</td></tr>
<tr><td colspan="2">Technology Problem Solving
Engineering Design
Manufacturing Prototype</td></tr>
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Lesson Plans	
Lesson	**Timeframe**
Lesson 1 Overview of world energy consumption	45 minutes / 2days 2 days to lecture
Lesson 2 Energy audit and carbon footprint	45 minutes / 3 days 2 days for personal energy audit, 1 day to calculate carbon footprint
Lesson 3 Public Service Announcement (PSA).	45 minutes / 2days 2 days to create a public service announcement
Lesson 4 Framing the design brief for the energy monitoring/limiting device	45 minutes / 3 days 1 day to lecture, 2 days to determine individual design briefs, specs, and constraints
Lesson 5 What happens when we run out of ideas? Using additional brainstorming methods.	45 minutes / 2 days
Lesson6 Technical drawings and schematics.	45 minutes / 1 day
Lesson 7 Refine ideas to generate alternate solutions.	45 minutes / 4 days 1 day for teacher to provide feedback to each group, 3 days for groups to revise ideas, notes and working drawings
Lesson 8 Developmental work – Generating optimum design ideas	45 minutes / 4 days 1 day to review techniques and criteria, 3 days to develop optimum design
Lesson 9 Modeling optimum solutions using appropriate supplies	45 minutes / 7 days 1 day to review expectations, 6 days to create models.
Lesson 10 Testing Methods	45 minutes / 5 days
Lesson 11 Redesign and reflect	45 minutes / 3 days
Lesson 12 Presentation preparation and delivery	45 minutes / 4 days 1 day to review expectations, 1 day to prepare, 2 days to present
Teacher Notes:	

Curriculum Development Resources

Instructables is a How To and DIY community where people make and share inspiring, entertaining, and useful projects. www.instructables.com

International Technology and Engineering Educators Association http://iteea.org/

New Jersey Technology and Engineering Educators Association http://njteea.org/

Make Magazine http://makezine.com/