Carbon Nation:  
Invention and Innovation  
(Date) Fall 2014  
School Name and Location  

Instructor:  
Class room:  
E-mail:  

Source Website: http://www.carbonnationmovie.com/  

Project Origins:  

Carbon Nation is a 2010 documentary movie by Peter Byck about technological and community-based energy SOLUTIONS to the growing worldwide carbon footprint. Rather than highlighting the problems with use of fossil fuels, Carbon Nation presents a series of ways in which the 16 terawatts of energy the world consumes can be met while reducing or eliminating carbon-based sources. It contains optimistic interviews with experts in various fields, business CEOs, and sustainable energy supporters to present a compelling case for change while having a neutral, matter-of-fact explanation. Even if you doubt the severity of the impact of climate change or just don't buy it at all, this is still a compelling and relevant film that illustrates how SOLUTIONS to climate change also address other social, economic and national security issues. The film is narrated by Bill Kurtis.

Project Description:  
This project is designed for the high school (9-12) student. It is offered as an interdisciplinary project-based assignment and is thematic in nature. Students work collaboratively in teams to design innovative and unique products that meet the demands of real world problems taking place in their own communities, while focusing on the skills necessary to take “inventions” to “innovation” in the market place. Examples of project topics can be taken from the Carbon Nation movie or can be initiated by the student/teacher based on observed community needs. These can include: green technologies, advances in carbon sequestration, and sustainable water supplies in arid regions. Development and practice of analytical thinking, problem-solving, systems design, creativity, communication and peer review, all 21st Century skills, provide students with an avenue to demonstrate what they have learned through applied projects.

Project Overview:  
This research-based project can be taught as an integration into the traditional classroom content, or can be added as a separate, larger cummulating unit within the standard curriculum. Information for the project components will be available on the Carbon Nation Project website.
The project is broken down into five key components:

1) Students begin by watching the documentary “Carbon Nation” (CN) and take notes on social, economical and environmental elements to the stories told in the film. This should be done in a 4 column chart with a descriptor/number of the stories in the left column:

<table>
<thead>
<tr>
<th>Social Elements</th>
<th>Economic Elements</th>
<th>Environmental Elem.</th>
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<tbody>
<tr>
<td>Story 1: Wind Farmer</td>
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<tr>
<td>Story 2: Etc….</td>
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</table>

In groups, students will then map out in a “systems format’ the complexity of a story told in CN (see resources for this detailed lesson plan). When a common initial story has been mapped out, groups will then map out other stories and create a common systems map connecting the overlapping relationships between all stories covered in CN.

2) When students have successfully demonstrated their ability to systems map the stories in Carbon Nation, they will now (in groups) identify an energy & technological need in their community based on their own observations- coupled by reaching out to community members (stakeholders/mentors). The groups will then identify the current problem and need for change by building a systems map that reflects the relationships and complexities that make up the local issue at hand. From that map, students then start to design a prototype, experiment, or invention that addresses the identified community need.

3) Students will then formally propose their design to the teacher, other groups and the intended community members for approval. This will need to consist of a creative and catching proposal pitch that is presented in a way that is engaging and appropriate to the intended audience. This can be a formal presentation, flyer, PSA, video, website, etc. Ultimately the proposal must have the approval of the community it is intended to affect.

4) Students will then start to innovate upon a current existing technology/solution and develop a new product (invention) to research, develop, market and present. They may also design an entirely original project not based on a currently existing technology. Students may initiate projects or choose projects suggested by the instructor. Materials and resources for the project will need to be secured by the students and/or school. During the proposal, it would be wise to solicit community members & organizations for resource support in developing the project. This will be the most time-intensive portion of the project and the teacher should map out a timeline appropriate to their curriculum pacing to provide adequate time for the project. This must include resource acquisition, building, testing & modifications and then data analysis for effectiveness. Each project must apply both inventive and innovative principles (i.e. solar, bio-engineering, green architecture, etc.) A project may be a part of a larger project, but its goals and
relationship to the larger project should be well defined.

5) A plan to market the invention/product will need to be included in the project design report. This will consist of a formal project report, promotional video and symposium style poster. Regardless if the project prototypes has been deemed to be functional or not, groups must fully present the successes and challenges of the intent of their design. It should be recognized that there are no success or failures if scientific and research methods were carried out correctly. Final reports and videos should account for the effort, trials and possible improvements to the final prototype. The final step to the project will be uploading the design to the “Submit Solutions” page on the Carbon Nation website.

Suggested Grading Scale
The grade for the course is based primarily on the following:
- marketing plan (10%)
- conference-style poster (10%)
- formal presentation of research (10%)
- a journal-style paper (20%)
- final production of a product (20%)
- instructor’s evaluation of the students planning, progress, record keeping and ability (teamwork, work ethic, writing clarity, etc.) (30%)

Project Outline:  *The following timeline is based on the Carbon Nation Project being integrated into the traditional classroom content. It can also be modified to fit at the end of a unit/semester.*

<table>
<thead>
<tr>
<th>Proposed Length</th>
<th>Topic(s) of Study</th>
<th>Skill Development</th>
<th>Tasks &amp; Assignments</th>
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</thead>
<tbody>
<tr>
<td>1-2 days</td>
<td>View the film <strong>Carbon Nation</strong> (86 minutes) Can also be shown in separate “chapters”</td>
<td>Note taking  Critical thinking Listening</td>
<td>Students take notes (see above chart) during movie on the different solutions to energy creation and storage.</td>
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<tr>
<td>3 days</td>
<td><strong>Carbon Nation Systems Maps</strong> (see prior lesson plans)</td>
<td>Systems thinking/ mapping (see resources) Time management Data collection Team skills Study skills</td>
<td>Wind story map 1 to 2 systems maps of other CN stories</td>
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<tr>
<td>2 days</td>
<td>Identify the Problem</td>
<td>Identify an energy &amp; technological need in their community based on their own observations</td>
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<td></td>
<td>Brainstorming</td>
<td>Outreach to community members (stakeholders/mentors).</td>
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<td>Problem identification</td>
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<td>Community outreach and contact</td>
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<td>Writing a concise testable problem statement</td>
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<tr>
<td>5 days</td>
<td>Background Research</td>
<td>Selected research topics</td>
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<td></td>
<td>Methods of Note-taking</td>
<td>Writing background research questions</td>
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<td>Technology Research Tools</td>
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<td></td>
<td>Marketing and Feasibility Studies</td>
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<td></td>
<td>Identifying reliable scientific resources</td>
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<td>Quotations within a formal paper</td>
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<td></td>
<td>Notebook organizer</td>
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<tr>
<td>5 days</td>
<td>Writing Hypotheses</td>
<td>Research Questions Developed and Refined</td>
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<td>Literature Review</td>
<td>Literature Review paper draft and outline draft</td>
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<td>Proposal Writing</td>
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<td>Organizing a Laboratory Notebook</td>
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<tr>
<td></td>
<td>Practicing Writing Hypotheses</td>
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<td>Scientific Writing and Proposal Components</td>
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<td>Data Collection issues</td>
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<tr>
<td>4 days</td>
<td>Writing Research Proposals</td>
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<td>Research Procedures</td>
<td>Research proposal approved or revised</td>
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<td>Peer Review techniques for Research Proposals</td>
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<td>Parenthetical documentation</td>
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<td>APA documentation Correct Cites Amount of documentation and use of quotes</td>
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<td>Research materials and supplies</td>
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<td></td>
<td>Budgets/cost analysis</td>
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<tr>
<td>Duration</td>
<td>Task</td>
<td>Description</td>
<td>Outcome</td>
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<tr>
<td>3 days</td>
<td>Proposing the Project</td>
<td>Audience Targeting, Media Development, Editing and Finishing</td>
<td>Developed Multi-Media piece showcasing work, Present to community for approval/feedback</td>
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<tr>
<td>3-4 days</td>
<td>Writing the Carbon Nation Research Paper</td>
<td>Students begin the invention/ experimental design process according to proposal</td>
<td>Edit and revise research proposal (2-3rd draft), Conduct experiment, Adjust methodology, Preliminary analysis of data and revision</td>
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<tr>
<td>5-10 days</td>
<td>Cont. Conducting the Carbon Nation Project</td>
<td>Experimental Design Process</td>
<td>Conduct experiment, Adjust methodology, Preliminary analysis of data and revision of plan</td>
</tr>
<tr>
<td>2 days</td>
<td>Begin Descriptive Statistics</td>
<td>Using descriptive statistics to explain experimental results</td>
<td>Create graphical representation of qualitative and quantitative data</td>
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<td>Graphical Representations</td>
<td>Recording Calculations</td>
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<tr>
<td>2 days</td>
<td>Inferential Statistics and Data Interpretation</td>
<td>Data Interpretation skills</td>
<td>Assess Data, Adjust Experimental Design</td>
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<td><em>Interpreting Graphical and Statistical Data (see handout)</em></td>
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<tr>
<td>5-10 days</td>
<td>Cont. Conducting the Carbon Nation Project (final revisions dues)</td>
<td>Experimental Design Process</td>
<td>Finalize experiment, Adjust methodology, Final analysis of data and revision of plan</td>
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Suggested Carbon Nation topics include:

1. Make Solar Energy Economical
   a. solar power-energy output vs. initial cost
   b. designed a process to store solar power within a fuel cell for long periods of time

2. Advances in Bio-fuels (algae, corn, etc.)

3. Manage the Nitrogen Cycle
   a. Urban agriculture (hydroponics, etc.)
   b. Food Processing
   c. Land use

4. Provide Access to Clean Water
   a. creation of “ultra pure water” for semi-conductor industries
   b. provide access to clean water for remote geographical locations around the globe

5. Restore and Improve Urban Infrastructure
   a. Housing Enhancements for a Sustainable Building

6. Engineering Hybrid vehicles
   a. Benefits vs. cost in building and owning hybrid vehicles
   b. Building vehicles for a variety of uses and distances

7. Develop Carbon Sequestration Methods

8. Development of Geothermal resources

9. Advanced techniques for recycling and repurposing waste materials

10. Harnessing the power of wind energy

11. Engineer the tools of Scientific Discovery
    a. Refine methods for peer review in research articles
    b. Examining cost structures for research and development
    c. Compare, contrast and evaluate claims in bias in scientific literature (print and
Outreach Coordination: If available, establishing project mentors within the local community will assist students with understanding relevant topics and viable solutions. Community mentors provide feedback and advice to student teams, as well as provide an avenue for community involvement and support within the classroom.

Resources:
https://sites.google.com/a/pvlearners.net/sustainability/collaborative-resources

Systems & Mind Mapping Sites:
- bubbl.us
- spiderscribe.com
- lucidchart.com
- mindmeister.com
- mindmup.com
- mindomo.com
- text2mindmap.com

Sources:
- Research ppt resources
- Google Scholar
- Directory of Open Journals
- National Library of Medicine
- Stanford University
- PLOS Open access
- Science Search Engine
- Guide to sources

Research Guidelines:
- Journal vs. Magazine
- What is a journal article video
- How to read a journal article
- More how to read
- How to read a scientific journal article ppt
- Quick guide the parts of an article
- How to write an annotated bibliography
- How to write a literature review
- How to write a scientific research paper
- Abstract examples

Research Writing and Poster Format
- APA Guidelines
- APA citation machine
Assessment:
- Formative: The objective is to gather feedback that can be used by the instructor and the students to guide improvements in the subject matter.
  
  Examples:
  - Criteria and goal setting—established by teacher to guide student projects and timelines. To be used as an organizational and informational tool to project completion.
  - Observations
  - Questioning strategies
  - Self and peer assessments
  - Student record-keeping/laboratory notebook checks
  - Teacher one to one meeting with students to monitor group/individual progress and keep students on track.

- Summative: The objective is to measure the level of success or proficiency that has been attained at the end of an instructional unit by comparing it to a standard or benchmark.
  
  Examples: Presentation of Research projects
  - Demonstrations
  - Written analysis of Research projects and Literature reviews

- End-of-Program Assessment: Select technical skill standards (noted with *) are included in an end-of-program standards assessment in order to measure proficiency.

Standards Alignment: Common Core & Next Generation Science Standards
(Common Core ELA/ Science and Technology, Writing and Mathematics:

Reading:
RI.9-10.1 Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.
RI.9-10.8 Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is valid and the evidence is relevant and sufficient, identify false statements and fallacious reasoning.
RST.9-10.7 Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse
formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

SL.9-10.2 Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source.

Writing:

W.9-10.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

W.9-10.1 Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

W.9-10.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.9-10.1 Write arguments focused on discipline-specific content.

W.11-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

SL.11-12.2 Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

W.11-12.1 Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

W.11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.11-12.1 Write arguments focused on discipline-specific content.

Mathematics:

MP.2 Reason abstractly and quantitatively
MP.3 Construct viable arguments and critique the reasoning of others
MP.4 Model with mathematics
F.IF Interpret functions that arise in applications in terms of the context
F.BF Build a function that models a relationship between two quantities
F.LE Construct and compare linear, quadratic, and exponential models and solve problems
G.MG Apply geometric concepts in modeling situations
A-CED.1 Create equations that describe numbers or relationships
S.ID Summarize, represent, and interpret data on a single count or measurement
variable; Summarize, represent, and interpret data on two categorical and quantitative variables
S.IC Make inferences and justify conclusions from sample surveys, experiments, and observational studies

Standard Alignment: Connections to the Next Generation Science Standards:

HS-ESS3-1 Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

HS-ESS3-2 Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.

HS-ESS3-3 Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.

HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

HS-ESS3-5 Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

HS-ESS3-6 Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

HS-ESS2-4 Use a model to describe how variations in the flow of energy into and out of Earth’s systems result in changes in climate.