**Lesson Plan Template**

**Modified 5/08/13 from** [**LEARN NC**](http://www.learnnc.org/) **(**[www.learnnc.org](http://www.learnnc.org))

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For LEARN NC partners

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| **Title (Required)** | **Activity 5 – Fossil Fuel and Biofuel Comparison** |
| **Introduction (Required)** | In this activity, students will compare the energy output of various fuels as well as the carbon dioxide emissions for each. Both petroleum-based fuel and renewable fuels will be compared. A renewable fuel is one that is derived from a non-petroleum source. Research currently focuses on producing fuel from various crops (soybean, sunflower, canola), animal waste (pig manure) or municipal solid waste from a landfill. Scientists estimate that fossil fuel supplies will be depleted in the next 50 – 120 years.  Students will write and balance combustion equations for octane, methane, ethanol and biodiesel. Once the calculations are complete, students will analyze data to conclude which fuel would be the best choice for future mass production. |
| **Learning Outcomes (Required)** | **Students will**   * Write and balance the chemical reactions for fuel combustion. * Compare and evaluate the usefulness of alternative fuel sources. |
| **Curriculum Alignment (Required)** | From the Next Generation Science Standards (<http://www.nextgenscience.org/>):   |  |  | | --- | --- | | HS-ETS1-3. | 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. |   From the NC Essential Standards “unpacked” content for chemistry:   * **2.1.4** Infer simple calorimetric calculations based on the concepts of heat lost equals heat gained and specific heat. * **2.2.1** Explain the energy content of a chemical reaction (interpret potential energy diagrams for endothermic and exothermic reactions including reactants, products, and activated complex-with and without the presence of a catalyst) |
| **Classroom Time Required (Required)** | **Activity 5** – one 90 minute block |
| **Materials Needed (Required)** | **Activity 5 Materials:**  Teachers: Comparing Fuel Sources handout answer key  Students: Comparing Fuel Sources handout, calculator, molecular modeling kit |
| **Pre-activities (Required)** | **Activity 5 – Fossil Fuel and Biofuel Comparison**  The teacher should prepare the molecular modeling sets before class begins. If time is an issue, students can work in small groups and analyze one of the fuels and then share results with the rest of the class. |
| **Activities (Required)** | **Activity 5 – Fossil Fuel and Biofuel Comparison**  In this activity, students will compare the energy content of four fuels – methane, ethanol, octane and biodiesel. This activity uses molecular models to demonstrate the combustion of the fuels to produce carbon dioxide and water. Students then compare the energy content of the reactants to products. The teacher may point out that a good fuel releases a great deal of energy and that the net energy output is high. However, students also get a chance to consider how much carbon dioxide each fuel produces. The teacher can ask them to consider the trade off, energy versus global warming CO2. At the conclusion of the activity, students are asked to make a recommendation of the best fuel source, based on both the energy and emissions data.  Each student can build models with a molecular modeling kit. If there are not enough kits, students may work in small groups. A low-cost option is to purchase soft candy (jelly beans or marshmallows work well) and toothpicks for building the models.  The information students study in this activity can be used to continue their research for their summative assessment product. If Activity 3 has not been used, students will need some of the resources listed in this module for information on global warming and the economic impact of biodiesel comparisons with other fuels. |
| **Assessment (Required)** | Teachers can use a variety of formative assessments that are not graded, but will inform instruction after each activity. The following are some suggestions for these informal assessments.   * Entrance/exit tickets – each student fills out a small ticket. The teacher can ask a content question, such as “Name two things you have learned about energy” or an open-ended question, such as “Write one question that you still have about calorimetry.” The teacher can then use the responses to guide future instruction. * Starter question – The teacher can make a quick power point slide with a heat problem for students to work out. * Thumbs up/thumbs down – A quick poll of understanding by a show of “thumbs up” or “thumbs down” can let the teacher know if students are confused. If students are not likely to give responses in this way, polleverywhere.com or gosoapbox.com are websites that have similar functions. * Whiteboarding – students may work in small groups. The teacher assigns one problem from the homework sheet and the group puts the solution on the board and explains it to the rest of the class. This provides an easy way to uncover misconceptions. * Electronic feedback – padlet.com allows teachers to build a wall and students to post comments. In this unit, a padlet could be created to post student questions or student feedback from each activity. Gosoapbox.com is a student management site where students can post questions, teachers can give quizzes or polls, and students can post discussion comments during class.   Summative assessments are more formal and are graded. A number of suggested assessments are listed below. Teachers may select work that is appropriate for their classes.   * Heat Practice Problems – a power point with four heat problems with answers worked out on the last slide. Can be used as a quiz after Activity 2. * Quiz – a short quiz can be given after Activity 3. * Class summary – the entire class can create a KWL-type chart once the activity is complete. Padlet.com is one option to do this electronically. A low-tech option is to create whiteboards. Students can use this as a study guide before the test. * Written test – a test with multiple choice, heat problems, graphs and short answer questions has been included. This test is best given once the entire unit has been completed. * Lab report – students can write up formal lab reports for Activity 3 and 4. . A suggested format can be found on a prezi. The link is <http://prezi.com/lxl9c0rw81mv/?utm_campaign=share&utm_medium=copy> * Student presentations – students can create a presentation to support or oppose biodiesel production in the United States. Options for formats include: power point; prezi.com; piktochart.com. Students can also make videos, posters, or skits. This will be most effective after Activity 5. * Class debate – students can be assigned roles (environmentalist, farmer, scientist, congressman, etc.) to help them focus research for the debate. The debate will be most productive if it is held after the completion of the unit. |
| **Community Engagement (Required)** | In North Carolina, there are several sites involved in biofuel production or research. These operations offer education outreach by offering tours or guest speakers to school groups. Teachers should brainstorm   * Piedmont Biofuels – Pittsboro, NC – free public tours on Sunday afternoons and the first Friday of each month * Patriot Biofuels – Greensboro, NC * Biofuels Center of North Carolina – Oxford, NC – tours are available or guest speakers can visit schools * Catawba County landfill site – Newton, NC – free tours can be scheduled * Guest speakers – North Carolina A&T bioenergy center, Greensboro; North Carolina Biotechnology Center, Research Triangle Park. |
| **Websites (Optional)** | **Introductory Articles** – these have basic information that you will want to read before you start looking at other aspects  A list of common FAQs   * http://biodiesel.org/what-is-biodiesel/biodiesel-faq's * http://www.patriotbiodiesel.com/category\_s/1820.htm   A great introduction to biodiesel   * <http://biodiesel.org/what-is-biodiesel/biodiesel-basics>   History of Biofuels   * <http://blog.hemmings.com/index.php/2013/07/10/a-brief-history-of-biofuels-from-the-civil-war-to-today/>   A basic dictionary of terms   * http://www1.eere.energy.gov/bioenergy/glossary\_full\_text.html   NC State Energy report 2010 – overview of policies, regulations and energy statistics for NC   * http://www.energync.net/Portals/14/Documents/Publications/ANNUAL%20NC%20ENERGY%20REPORT%20final%20feb%202010%20v2-1.pdf   **Biodiesel Production**  A one-page schematic of how biodiesel is produced   * http://biodiesel.org/docs/ffs-production/production-fact-sheet.pdf?sfvrsn=4   US Dept of Energy data – current prices of fuel in different areas of the country   * http://www.eia.gov/petroleum/gasdiesel/   **Advantages and Disadvantages**  Biodiesel Myths v. Facts brochure (pro-biodiesel)   * http://biodiesel.org/docs/default-source/ffs-basics/biodiesel-myths-vs-facts.pdf?sfvrsn=10   Alternative Fuels Data Center – you can compare various types of fuel   * http://www.afdc.energy.gov/   Create your own comparison chart for various fuels   * http://www.afdc.energy.gov/fuels/fuel\_properties.php   A short article on renewable v. nonrenewable sources of energy   * http://www.ecology.com/2011/09/06/fossil-fuels-vs-renewable-energy-resources/   Crunching the Numbers on Alternative Fuels – Popular Mechanics articles   * http://www.popularmechanics.com/cars/alternative-fuel/news/2690341 * http://www.popularmechanics.com/cars/how-to/4314657?click=main\_sr   Ending the Food vs. Fuel Debate   * http://www.renewableenergyworld.com/rea/news/article/2012/10/ending-the-food-v-fueldebate-researchers-define-surplus-land   Food vs. Fuel Debate – CNBC article   * http://www.cnbc.com/id/48477352   **Video Resources –** Each video clip has the time listed at the end of the title  Invention Nation: Biodiesel video (3:38)   * http://videos.howstuffworks.com/science-channel/5044-invention-nation-biodiesel-video.htm   Public service announcement – introduces the use of fuel from organic materials (0:30)   * http://bcove.me/r6k4gt36   “Here, Now” commercial – use of biodiesel in Dallas (0:37)   * http://bcove.me/rwararju   “Fast Track” commercial – a biodiesel truck breaks a land speed record (0:37)   * http://bcove.me/9cdwh71s   Jay Leno’s Garage – Jay talks to a scientist about using biodiesel in some of his cars (1:31)   * http://bcove.me/316xk1ki   Motorweek segment – interviews farmers and various industries using biodiesel (7:55)   * http://bcove.me/3yzusjn6   Biofuel lesson from National Defense Education Program – brief description of how organic materials are being developed into gasoline, biodiesel, and jet fuel   * http://www.ndep.us/Biofuel   CNN Story on the Catawba County landfill site   * http://www.cnn.com/video/?/video/tech/2009/08/20/wolf.green.town.cnn   **Careers in Biofuels**  A US Bureau of Labor Statistics report on biofuel associated careers with salaries and credentials   * <http://www.bls.gov/green/biofuels/biofuels.pdf>   Biofuel and Biodiesel product development careers – lists job outlook, salaries, personality traits and has links to other related careers   * <http://myfootpath.com/careers/science-careers/biofuel-and-biodiesel-product-developer-careers/>   Green Career Guide – basic information about school and expectations for various biofuel jobs   * <http://www.greencareersguide.com/Cellulosic-Biofuels.html> |
| **Author Info (Required)** | Marci Harvey is a chemistry and physics teacher at West Forsyth High School in Clemmons, NC. She has been teaching in NC for 17 years. She has a BS in chemistry from the College of Charleston and a MS in chemistry from the University of South Carolina. Marci earned National Board certification in 2008. This lesson is part of a Kenan Fellowship “Pump New Life into the Classroom with Biofuels.” completed at North Carolina A&T University. |