



BEYOND GLBRC: SELECT BIOENERGY BIBLIOGRAPHY FOR EDUCATORS

Energy Overview & Statistics

Alternative Fuel Statistics - Comprehensive information from the Energy Efficiency and Renewable Energy arm of the DOE. Find information on fuels, vehicles, laws and incentives, data, etc. For a quick update on today's prices and current production stats try biofuels data from the US Department of Energy, Energy Information Administration.
<http://www.afdc.energy.gov/afdc/>

EIA Biofuels Data. Ethanol Statistics. - Updated biofuels data from the US Department of Energy. Reports biofuel prices, production levels and availability.
http://www1.eere.energy.gov/biomass/biofuels_data.html

Energy Information Administration Official Energy Statistics. U.S. Government. - An updated source of statistics on energy consumption and production in the US and around the world. The link "Energy Explained" is especially user-friendly, with graphs describing US, State and International energy consumption and descriptions of different energy sources.
<http://www.eia.doe.gov/>

Fundamental Principles of Energy. Encyclopedia of Earth. T. Lawrence. Cleveland, C. J. 2008. This is a broad and wide-ranging article that covers topics including the physics of energy, climate and the earth's energy balance, and control of energy resources as a cause of violent conflict. There is an extensive list of "further reading".
http://www.eoearth.org/article/Ten_fundamental_principles_of_net_energy

The National Academies - What You Need To Know About Energy - This page on biofuels is part of a larger website from the National Academies with resources and information regarding energy use in the United States. The website explores how we get our energy, the task of increasing efficiency, the extended costs of our energy use, as well as the variety of sources which can meet our energy demands. Both conventional sources, such as fossil fuels, as well as emerging technologies, such as biofuels, are examined. National Academies discusses how we are using biofuels today, how they fit into the broader picture of our energy use, as well as their role in the future.
<http://needtoknow.nas.edu/energy/energy-sources/emerging-technologies/biofuels.php>

Renewable Fuels Association Ethanol Industry Statistics
<http://www.ethanolrfa.org/pages/statistics>

Image Galleries

DOE Bioenergy Research Centers Image Gallery - This page has many high quality images and figures created by DOE for use in their materials and at GLBRC.
<http://genomics.energy.gov/gallery/brc/>

Kellogg Biological Station Long-Term Ecological Research Photo Gallery - The KBS LTER photo gallery has lots of photos of GLBRC sites, farmscapes, crops, equipment and a lot more.
<http://lter.kbs.msu.edu/photos/>

NREL Photogallery - Features many photos that can be sorted by category.
http://www.nrel.gov/data/pix/searchpix_visual.html

Videos

Biofuels: Beyond Ethanol - A 10-minute piece by KQED which provides background on the lab science behind the biofuel challenge and focusses on how the areas of synthetic biology and directed evolution can create microbes that produce fuels similar to those we currently use in our vehicles. Features JBEI, another Bioenergy Research Center.

<http://www.kqed.org/quest/television/view/819>

Decoding Synthetic Biology - A 10-minute piece, by KQED, examining how scientists can build new microbes using gene sequences of choice. An educator guide is also available.

<http://www.kqed.org/quest/television/decoding-synthetic-biology>

Fields of Energy: The Minnesota Department of Agriculture. - A free DVD with student hosts. Two short segments show how corn ethanol is made and the research into cellulosic ethanol. These two segments are currently available online as well.

<http://www.mda.state.mn.us/kids>

Green Revolution - The "Green Revolution" series by the National Science Foundation features researchers hoping to find clean energy solutions for the future. Watch the Biomass video to learn more about how biomass can be used to produce fuel, and to see one of the GLBRC labs.

http://www.nsf.gov/news/special_reports/greenrevolution/

Converting Biomass to Liquid Fuels. National Renewable Energy Laboratory. 2008. - A 5 minute online piece that gives a nice overview of what is cellulosic ethanol, the production process, and the areas of scientific research needed to create the fuel. GLBRC is working in these same areas.

http://www.nrel.gov/learning/re_biofuels.html

Plant Breeding Educational Videos - 'Fields of Study' interviews researchers working in the UW-Madison Plant Breeding and Plant Genetics Program. Currently, there are videos available on corn, peppers, and switchgrass breeding. 'Switchgrass Breeding' provides an overview of the crop's advantages as a perennial grass that can be used to combat soil erosion and to produce biofuels. These videos are appropriate for upper elementary school students and higher.

<http://www.wisconsinplantbreeding.com/educators/videos/>

Classroom Activities

Biofuels from Forest Resources: Handouts and Procedures: Cellulosic Ethanol from Forest Resources. - This 5 day, college level lab, takes students through the process of pretreatment, hydrolysis, fermentation, and yield analysis of ethanol created from woody biomass. Posted with permission from Michigan Technological University.

<http://glbrc.org/sites/default/files/Fermentation%20Fuels%20From%20Forest%20Handout%20&%20Procedures.pdf>

Dig it! The Secrets of Soil, Greenhouse Gas Calculator (Smithsonian Museum of Natural History) - This interactive, animated online activity puts students in the role of a farmer, deciding what crops to grow and what farming practices to use to balance high yield with lower greenhouse gas emissions.

<http://forces.si.edu/soils/index.html>

Fuel-Grade Ethanol from Corn Mash. - This high school level lab takes students through the process of pretreatment, fermentation, and yield analysis of ethanol created from corn mash. Posted with permission from Luverne High School.

<http://www.isd2184.net/%7Ejensenje/biology/activities/ETOH/etoh.htm>

Westfield, WI High School Biodiesel Program. - The school converts waste vegetable oil into biodiesel to run their school buses.

<http://westfield-bus.org/content/view/165/1/>

Government Policies & Reports

Energy Information Administration. 2010. Annual Energy Review 2009.
<http://www.eia.doe.gov/emeu/aer/pdf/aer.pdf>

EPA Lifecycle Analysis of Greenhouse Gas Emissions from Renewable Fuels. Fuel & Additives. 2010. United States Environmental Protection Agency - Office of Transportation and Air Quality.
<http://www.epa.gov/oms/renewablefuels/420f10006.htm>

Renewable Fuel Standard. Fuel & Additives. 2010. United States Environmental Protection Agency. - This page from the Environmental Protection Agency's website contains regulations and standards for the Renewable Fuel Standard program.
<http://www.epa.gov/otaq/fuels/renewablefuels/index.htm>

United States Department of Agriculture. 2010. A USDA Regional Roadmap to Meeting the Biofuels Goals of the Renewable Fuels Standard by 2022. - This report outlines the current state of biofuel production in the United States, as well as the potential for production by region. It identifies challenges and opportunities in meeting the Renewable Fuel Standard mandate for 36 billion gallons of renewable fuel by 2022.
http://www.usda.gov/documents/USDA_Biofuels_Report_6232010.pdf

Environmental Law Institute. 2009. Estimating U.S. Government Subsidies to Energy Sources: 2002-2008 - This report compares subsidies to fossil fuel with renewable energy sources, including taxes vs direct investment. Good graphics available as well.
http://www.elistore.org/reports_detail.asp?ID=11358
http://www.eli.org/pdf/Energy_Subsidies_Black_Not_Green.pdf

Popular Press Articles

Bourne, Joel K. "Green Dreams: Making fuel from crops could be good for the planet--after a breakthrough or two." 2007. National Geographic. - A readable National Geographic article with supporting activities comparing different forms of ethanol with gasoline and algae-based diesel for transportation fuels. Try the "Compare Biofuels" option to investigate net energy and green house gas emissions for each fuel.
<http://ngm.nationalgeographic.com/2007/10/biofuels/biofuels-text>

Kaufman, Frederick. "What's New for Dinner." 2010. On Earth Magazine. - An engaging article about using life cycle assessment to improve the bottom-line, and thus the sustainability, of the tomato producer industry.
<http://www.onearth.org/article/whats-new-for-dinner>

Monahan, P. "Biofuels: An Important Part of Low-Carbon Diet." 2008. Catalyst 7(2). - This article assesses sustainability of biofuels and also address the creation of biofuels. It is written in a way that it could be understood by high school students.
<http://www.ucsusa.org/publications/catalyst/biofuels-an-important-part-of.html>

Martin, A. Fuel Choices, Food Crises and Finger-pointing. 2008. New York Times. New York, New York. - This article from the New York Times does a good job of laying out the complexities of the food versus biofuel crop production debate without oversimplifying. It should be readable by high school students.
<http://www.nytimes.com/2008/04/15/business/worldbusiness/15food.html>

Rosenthal, E. New Trend in Biofuels Has New Risks. 2008. New York Times. New York, NY. - This is a short and easy read on the problems of using invasive plant species as biofuels crops. It should be readable by high school students.

<http://www.nytimes.com/2008/05/21/science/earth/21biofuels.html>

Scientific Articles

Sustainability:

Dale, V., K. Kline, et al. Ecological Society of America. 2010. "Biofuels: Implications for Land Use and Biodiversity." - This report provides a thorough scientific summary of the issues associated with biofuel crop production, and the corresponding potential changes in land-use and biodiversity. It is appropriate for high school and college students.

<http://glbrc.org/sites/default/files/Biofuels-implications-for-land-use-and-biodiversity-ESA.pdf>

Ecological Society of America. 2000. "Carbon Sequestration in Soils."

This is a readable explanation of how carbon is stored in soil, the benefits of soil carbon and practices that help maintain higher levels of carbon in the soil.

<http://glbrc.org/sites/default/files/carbonsequestrationinsoils.pdf>

Field, C. B., J. E. Campbell, et al. 2008. "Biomass energy: the scale of the potential resource." Trends in Ecology & Evolution 23(2): 65-72. - For those interested in the food versus fuels debate, this scientific article looks at the global base of abandoned cropland and the corresponding productivity of these areas. This article is scientifically dense and is likely best for advanced high school students.

<http://www.cell.com/trends/ecology-evolution/abstract/S0169-5347%2808%2900009-8>

Hill, J., E. Nelson, et al. 2006. "Environmental, economic, and energetic costs and benefits of biodiesel and ethanol biofuels." PNAS 103(30): 4. - What are the net energy balances, and the energy inputs and outputs for biofuels? This article details a life-cycle analysis of both corn grain ethanol and soybean biodiesel biofuels. While this article is technical, with some guidance, it should be understandable by high school students.

<http://www.pnas.org/content/103/30/11206.abstract>

Hill, et al. 2009. "Land clearing and the biofuel carbon debt." Science 319(5867): 1235-1238. - Research on the greenhouse gas and particulate matter emissions coming from different biofuel production techniques.

<http://www.sciencemag.org/cgi/content/abstract/319/5867/1235>

Hillel, D., C. Rozenzweig. 2009. "Soil Carbon and Climate Change." CSA News. 54(06): 4-11.

This article from the Crops, Soils and Agronomy CSA News discusses the role of soil carbon and how agricultural management can alter the amount of carbon sequestered in the soil. It addresses specific practices and how those affect climate change by releasing more or less carbon dioxide into the atmosphere.

<http://glbrc.org/sites/default/files/Soil%20Carbon%20and%20Climate%20Change.pdf>

James, L., et al. 2009. "Profitability of Converting to Biofuel Crops". Swinton and D. Pennington of Michigan State University discusses the economics of farming various biofuel crops and break-even points to convert from corn to other feedstocks.

<http://web2.msue.msu.edu/bulletins/Bulletin/PDF/E3084.pdf>

McKone, T.E., et al. 2011. "Grand Challenges for Life-Cycle Assessment of Biofuels." Short paper on the major challenges facing Life Cycle Assessments.

Robertson, G. P., V. H. Dale, et al. 2008. "Agriculture - Sustainable biofuels Redux." *Science* 322(5898): 49-50. - The 2008 Farm Bill provides a subsidy for the production of cellulosic ethanol. The large group of authors associated with this article looks at the sustainability implications of this subsidy, and detail environmental and ecological research that they feel is needed. This article is likely readable by high school students.

<http://www.sciencemag.org/cgi/content/summary/sci;322/5898/49>

Tilman, et al. 2009. "Beneficial Biofuels—The Food, Energy, and Environment Trilemma." - A two page summary of what a prominent group of scientists propose as the best way to develop the cellulosic biofuels industry in a sustainable way.

<http://www.sciencemag.org/cgi/content/short/325/5938/270>

Pretreatment:

Mosier, N., Wyman, C., Dale, B., et al. 2005. "Features of promising technologies for pretreatment of lignocellulosic biomass." *Bioresource Technology* 96 (2005) 673-686.

Overview of plant structure and challenges of accessing cellulose provided on pages 673-676.

Also provides detailed descriptions of pretreatment options. Useful for high school students and teachers, especially chemistry teachers who may be interested in mimicking procedures outlined for pretreatment.

Yang, B. and E. Wyman, 2007. "Pretreatment: the key to unlocking low-cost cellulosic ethanol." *Wiley Interscience: Biofuels, Bioproducts, and Biorefining* 2:26-40. - Gives a nice background of the use of petroleum and biofuels in the introduction. Also provides a comparison each pretreatment method, including pros and cons, on page 31. Figure 1 (page 29) provides an outline of the biological conversion of cellulosic biomass into ethanol, including effects of pretreatment processes on other operations. Best suited for high school students or teachers who want to know more about pretreatment methods.

<http://www3.interscience.wiley.com/journal/117865555/abstract>

Microbes:

Rubin, E. M. 2008. Genomics of cellulosic biofuels. *Nature* 454. - An overview of the most common microorganisms in biofuels research and status of genome sequencing.

<http://www.nature.com/nature/journal/v454/n7206/abs/nature07190.html>

Plants:

Pauly M., Keegstra K. Cell-wall carbohydrates and their modification as a resource for biofuels. *The Plant Journal*. 2008. 54(4):559-568. - A technical overview of plant cell wall structure and a good introduction to sugar content in plants being researched in biofuels. Appropriate for those who already have background in biology, but need an introduction to the cell wall issues related to biofuels."

<http://pt.wkhealth.com/pt/re/plnt/abstract.00008572-200805040-00004.htm>