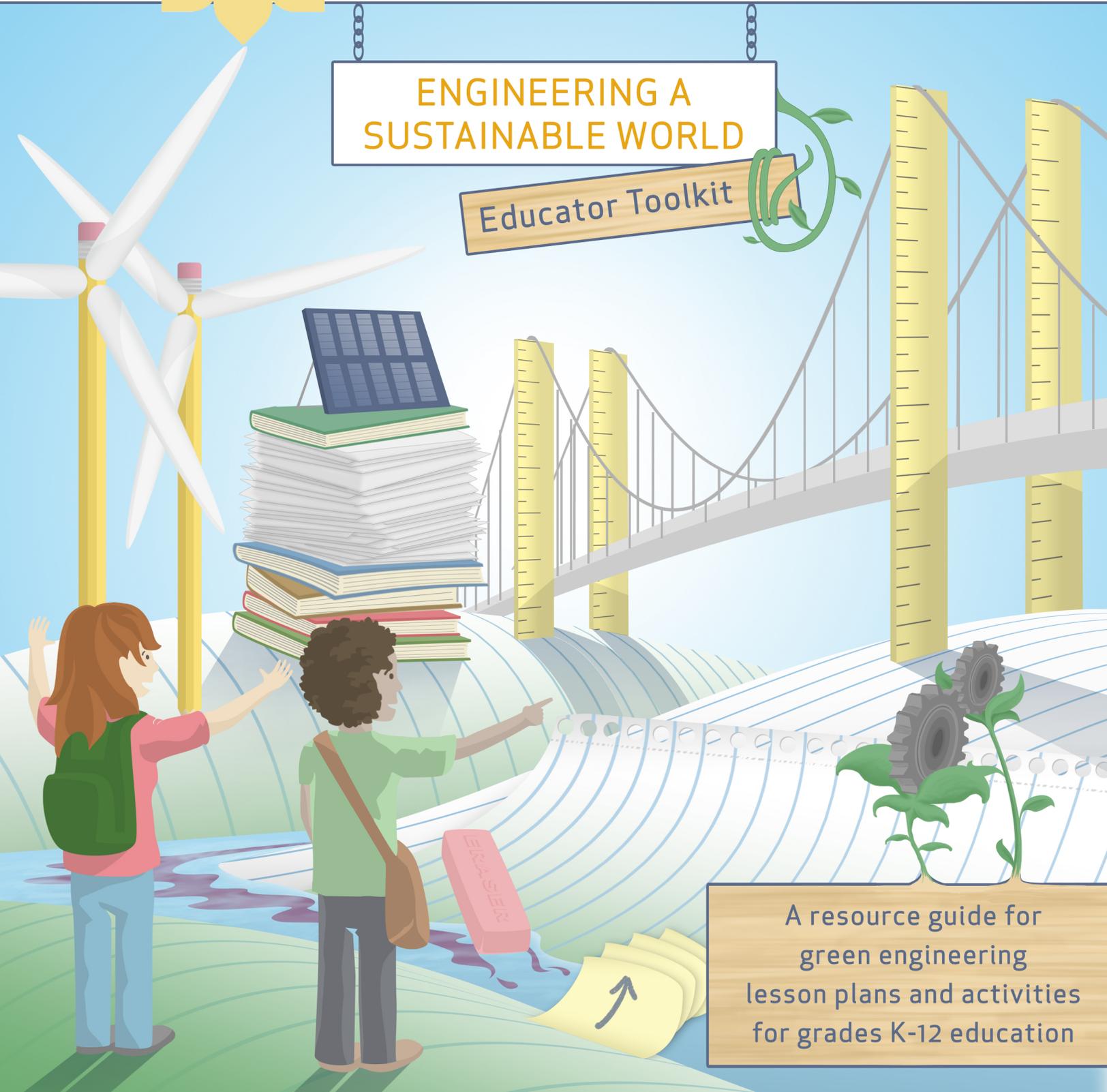


National Environmental Education Week

ENGINEERING A
SUSTAINABLE WORLD

Educator Toolkit



A resource guide for
green engineering
lesson plans and activities
for grades K-12 education

National Environmental Education Week is a program
of the National Environmental Education Foundation



National Environmental
Education Foundation
Knowledge to live by

Introduction and Contents

As part of **Greening STEM: Engineering a Sustainable World**, National Environmental Education Week's 2014 theme explores the application of engineering to sustainable solutions for a healthier planet and healthier people. Environmental education can provide students with opportunities to engage in meaningful and interesting engineering projects that can excite them about STEM (science, technology, engineering and math) and empower them to take part in creating solutions to environmental challenges.

By incorporating engineering lessons into other STEM subjects across all grade levels, educators allow students to combine what they've learned in an effort to solve real problems. These lessons and activities encourage students to investigate all of the "making, moving and improving" activities involved in the work of an environmental engineer. The processes carried out in these lessons teach useful correlations, deeper understandings and real world applications of skills that students may not usually attribute to the world of engineering.

This toolkit highlights a variety of educator resources for all grade levels for applying engineering principles to environmental challenges in the classroom.

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Biomimicry

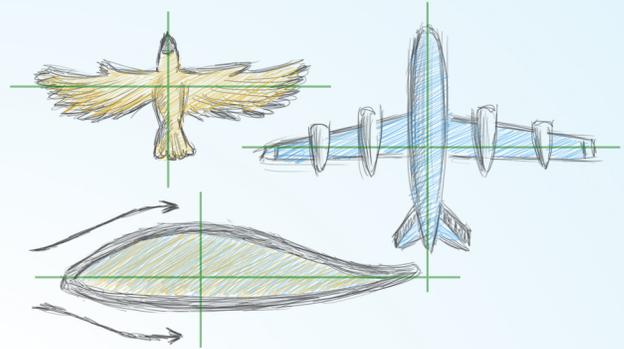
Many of the environmental problems that engineers are working to solve already have hints to solutions in the natural world. Over the course of evolution, organisms have adapted to move, eat, sense and survive in very efficient ways. By studying examples of these evolutionary achievements, engineers are able to imitate structure and design elements to inspire their own innovations.

Grades K-4

Animals and Engineering

Source: [TeachEngineering](#)

Students are introduced to the classification of animals and animal interactions. Students also learn why engineers need to know about animals and how they use that knowledge to design technologies that help other animals and/or humans.



Build a Meerkat

Source: [National Geographic Education](#)

Students make a meerkat model while identifying unique body characteristics that are iconic of the animal. Students learn how adaptations and certain physical traits are crucial to a meerkat's survival.

Grades 5-8

Engineering in Nature

Source: [ARKive](#)

The Engineering in Nature Challenge inspires students to explore engineering principles while developing a greater connection to nature. Ranging from simple machines to aerodynamics, students can complete design challenges transforming them from a builder, to an engineer, and finally, an inventor all with the one-on-one support of exceptional real world scientists.

Biomimicry Design Approaches

Source: [Biomimicry Education Network](#)

Students look at two ways to design using biomimicry: Biology to Design and Challenge to Biology. Using different starting points, students will make connections between animal adaptations and new technologies they could inspire.

Grades 9-12

Biomimicry and Sustainable Design – Nature is an Engineering Marvel

Source: [TeachEngineering](#)

This lesson introduces students to the concepts of biomimicry and sustainable design. Chemical, aeronautical, automotive, manufacturing, industrial, civil, and bio-engineering are only a few of the areas where the study of biomimetics and the application of sustainable design have led to beneficial advancements.

Learning from Nature

Source: [Sustainability Leaders Network](#)

An open-source curriculum designed to strengthen and inform the biomimicry movement among educators and learners locally and around the world.

Sustainable Energy & Design

One of the significant challenges environmental engineers are constantly working to improve is the sustainable use of resources. Since the recognition of the potential for renewable energy sources such as solar, wind, and water, engineers have faced the task of understanding, designing, constructing and improving these systems.

Grades K-4

Harnessing Wind

Source: [TeachEngineering](#)

Students are introduced to the ways that engineers study and harness the wind. They learn about different kinds of wind and how to measure wind direction. In addition, they learn how air pressure creates wind and how engineers design and test wind turbines to harness renewable wind energy.

Here Comes the Sun: Engineering Insulated Homes

Source: [Engineering is Elementary](#)

Keeping homes at a comfortable temperature takes a lot of energy. Students use their green engineering skills to insulate a model home and learn about what materials and structures are the most and least energy efficient.

Grades 5-8

Build a Solar Still

Source: [eGFI](#)

In this lesson from the Peace Corps, students in grades 3-8 learn how to generate fresh water from seawater, using the power of the sun and the natural processes of evaporation and condensation. They study the water challenges in Cape Verde and the advantages of distilling water through a simple solar still. They then build and evaluate their own working model.

KidWind WindWise Lessons

Source: [KidWind](#)

This collection of lesson plans covers many aspects of wind turbine engineering, including what causes wind, what types of blades are most efficient and what impacts turbines pose to wildlife and humans.

Grades 9-12

Green Roof Design

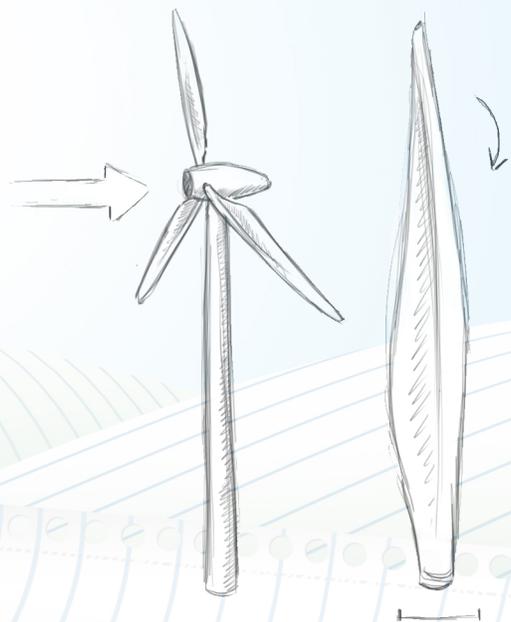
Source: [American Association for the Advancement of Science](#), [Science NetLinks](#)

In this student-centered learning model, students work collaboratively in small teams to design a heat- and water-conserving "green roof" of plant material for an urban apartment building. This is a multimedia project involving Web and library research, hand drawings, creation of exhibit boards with text, photos and data graphics, and a final presentation of findings.

Build Your Own Rain Barrel

Source: [Chesapeake Bay Foundation](#)

This how-to guide provides background information on why controlling stormwater runoff matters to the environment and how engineering skills can be used to design a functional and environmentally efficient rain barrel system.



Recycling & Reusable Materials

Recycling, composting, and environmentally friendly disposal methods are important challenges in the field of environmental engineering. Identifying ways to dispose of non-recyclable materials with minimal environmental impact is just as important as understanding what materials are reusable and the different ways they can be re-engineered and repurposed.

Grades K-4

"Go Green" Recycled Racers Unit

Source: [Engineering is Elementary](#)

This green engineering unit from Engineering is Elementary challenges students to build a functioning car completely out of recycled materials. Students learn about how wheels, axels and forces of propulsion work in addition to the benefits of recycling, all while racing their friends!

Trash to Treasure

Source: [TeachEngineering](#)

Student teams use the engineering design process to create a useful product of their choice out of recyclable items and "trash." The class is given a "landfill" of reusable items, such as aluminum cans, cardboard, paper, juice boxes, chip bags, egg cartons, milk cartons, etc., and each group is allocated a limited amount of bonding materials, such as duct tape, hot glue and string.

Grades 5-8

What a Piece of Junk

Source: [National Building Museum](#)

The Green by Design school program helps students in grades 4-9 understand the complexity of issues associated with making environmentally friendly living decisions and the effect different decisions have on their surroundings.



Classroom Paper Recycling

Source: [TryEngineering](#)

Students work in teams to recycle and manufacture their own recycled paper while learning how recycled paper is manufactured on a larger scale in paper facilities. Student teams evaluate current processes for creating paper and develop improvements to the procedure.

Grades 9-12

Decomposing Energy

Source: [Science Buddies](#)

Students might be surprised to find that such things as banana peels, coffee grounds, and newspaper can actually provide energy. Through this composting experiment, students transform kitchen and other solid wastes into homemade fertilizer to investigate whether the heat in an active compost bin or pile can be used to heat water.

Lesson: Landfills and Contamination

Source: [eGFI](#)

What happens to garbage? In this lesson, students grades 9-12 derive the answer by building their own landfill. While observing how household waste can leach into soil and groundwater, they also learn the importance of well supervised, sanitary disposal sites.

Environmental Conservation

The ultimate goal of an environmental engineer is to design with nature in mind. At the forefront of this task is the effort to protect and conserve the beauty of the natural world that, in some places, can be extremely fragile. These activities help investigate some of the ways that a solid background in engineering can be the key to successful conservation efforts.

Grades K-4

Hop To It – Controlling Invasive Species

Source: [Engineering is Elementary](#)

This mechanical engineering activity asks students to help engineer a humane trap to control and invasive toad species. In addition to learning about what makes an effective humane trap, students will also learn about why invasive species can cause so much trouble when introduced to a new ecosystem.

Oil Spill Solutions

Source: [eGFI](#)

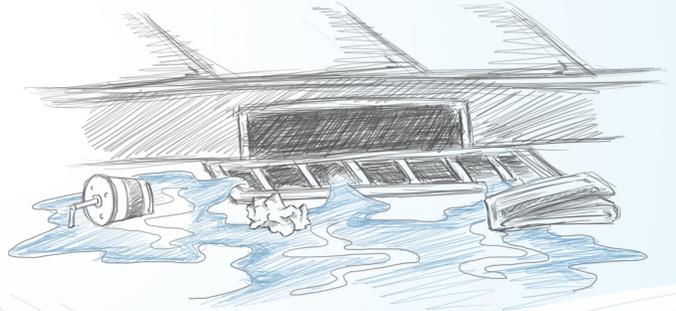
Students work in teams to analyze an “oil spill” in the classroom. Then, the students design, build, and test a system to first contain, and then remove the oil from the water. Students select from everyday items to build their oil containment and clean-up systems, evaluate the effectiveness of their solution and those of other teams, and present their findings.

Grades 5-8

Pollution Patrol

Source: [TryEngineering](#)

This lesson focuses on devices that are used to detect air pollution. Teams of students construct outdoor air pollution detectors from everyday materials. They then test their devices to see how much particulate pollutants they can capture.



How Natural Areas Filter Water

Source: [Nature Works Everywhere](#)

In this lesson, students learn about the importance of water quality for human health and agriculture. They relate their own consumption activities to the water supply and also brainstorm various threats to the water supply. By contrasting natural filters with impervious (paved) areas, students compare the impact of development on the ability of nature to provide clean freshwater.

Grades 9-12

Do Your Stormdrains Keep the Ocean Trash Free?

Source: [Science Buddies](#)

Students test models of local grated storm drain inlets to determine if they are designed in a manner that keeps plastic litter from entering your community's stormwater drainage system. If the storm drain inlets are not working efficiently, students work to improve the design and prevent plastic litter from passing through the grated inlets.

Where's the Beach? – Investigating Ways to Protect Coastlines from Erosion

Source: [Nature Works Everywhere](#)

In this lesson, students compare strong (but expensive) construction materials with the less robust (but cheaper) oyster reefs. Students first use an online tool to find historic tide data in a selected coastal location. Then, they use a hands-on model to explore the use of different materials in protecting coastlines.

Apps & Games for Environmental Engineering

National Environmental Education Week's 2014 theme is **Greening STEM: Engineering a Sustainable World**, part of EE Week's Greening STEM focus. Discover new, digital resources that explore the application of engineering to sustainable solutions for a healthier planet and healthier people.



Biobots Under Sea Rescue

Grades K+ / iPad

Biobots Under Sea Rescue lets young students design an underwater rescue robot inspired by nature's super animals. In this game, students learn about different marine creatures through videos and animations. Students apply the learning by choosing the right combination of robotic systems for a rescue mission.

Ansel and Clair: Little Green Island

Grades 2-4 / iPhone, iPod Touch, iPad

Ansel and Clair: Little Green Island is an adventure game that helps kids grow in environmental awareness. This app provides an overview of environmental issues, particularly pollution, for younger students. Students not only learn about these issues, but must find solutions. The interactive gameplay and real-world examples provide in-depth learning.



SimCityEDU: Pollution Challenge!

Grades 5-8 / Windows, Mac

With *SimCityEDU*, the environmental impact of cities, and ways to mitigate this impact through sustainable planning, are the major focus. This classroom-ready tool has built-in lessons and teacher resources that remove a lot of the challenge of integrating games into instruction.

Enercities

Grades 6-12 / Windows, Mac

Enercities lets students take charge of planning a sustainable, 200 person community of the future. Students build a city, placing power grids, housing developments, industrial zones and parks. By responsibly managing a growing community, students learn about resource scarcity, the environmental impact of development, and sustainable building practices.



Stop Disasters!

Grades 7-12 / Windows, Mac

Stop Disasters! is a serious simulation game published by the United Nations and International Strategy for Disaster Reduction. The game shows students the kinds of natural disasters linked to environmental issues. Each round presents a new challenge, which typically involves building shelter, defending resources, and developing land into infrastructure that yields added safety or contributes to the area's economy.

Learn more at eeweek.org



National Environmental
Education Week

Engineering & Our Planet Infographic

Exploring the past, present and future of environmental problem-solving through science, technology, **engineering** and math (STEM).

The Past



Hydrating Ancient Rome

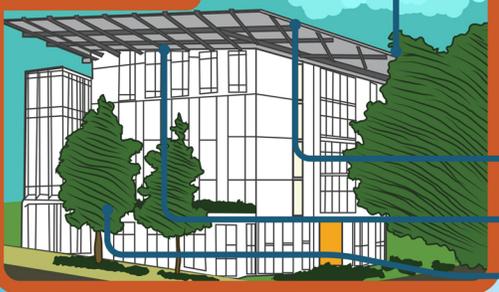
Ancient Roman engineers built a system of tunnels and channels – called aqueducts – that used the power of gravity to carry fresh water to Rome from surrounding areas

Carried water up to 60 miles

Constructed between 312 BCE and 455 CE

About 260 miles of tunnels

The Present



Designing Green Buildings

Seattle's Bullitt Center is one of the "greenest" commercial buildings on Earth. Not only does it provide occupants with fresh air, daylight and green space, it is also an innovative space to learn about green building technology

575 solar panels power the entire building

Rainwater is collected on the roof and used throughout the building

Net zero carbon footprint

The Future



Capturing Carbon Cleanly

Researchers are developing a device called an air extractor that removes carbon dioxide (CO₂) from the air in a process called engineered chemical sinkage. The device is playfully referred to as an "artificial tree"

Artificial "leaves" remove about 1 ton of CO₂ per day

Sodium carbonate on the plastic "leaves" pulls CO₂ from the air and converts it to baking soda

Air extractor, or "artificial tree," technology could be in large-scale use in 10-20 years

Your Future in Environmental Engineering

The rapidly growing field of environmental engineering offers many opportunities for those with skills and interest in STEM to positively impact the planet

What they do: Use science and engineering principles to solve environmental problems

Median salary: \$78,740 per year

59 universities in the U.S. offer accredited environmental engineering programs



Environmental Engineering jobs are expected to grow at more than double the average job growth rate between 2010-2020

Sources:

- PBS NOVA
- Encyclopedia Britannica
- The Bullitt Foundation

- PBS NewsHour
- The Yale Forum on Climate Change & The Media
- U.S. Bureau of Labor Statistics

Find out more at eeweek.org