THE NEXT FRONTIER: Engineering the Golden Age of Green



EDUCATION OUTREACH PROGRAM

Education Outreach Program

The Next Frontier: Engineering the Golden Age of Green can serve as a valuable tool when teaching the importance of renewable, clean energy technologies and good government policy in shaping our nation's future.

The one-hour documentary focuses on those technologies that can improve our future and create significant economic opportunities. *The Next Frontier* features Becky Worley of *ABC's Good Morning America* traveling the world looking for the solutions that address the serious problems of excessive carbon dioxide emissions and our dependence on fossil fuel. Among those featured in the film: California Air Resources Chair Mary Nichols, UC Berkeley professor Dan Kammen and Ken Caldeira of Stanford University.

This informative and entertaining documentary provides students with a unique look at the problem of climate change and the available solutions. The film offers a platform for science, engineering and government classes to discuss the role of government, private business and inventors in the creation of a new industry. The documentary provides students an opportunity to learn more about government and participate in creative problem solving discussions to address climate change now and in the future.

The Next Frontier is sponsored by the Professional Engineers in California Government (PECG) which represents 13,000 state-employed engineers and related professionals including those creating and implementing policies to reduce carbon emissions and promote the use of electric vehicles and renewable energy.

"We're looking for solutions that scientists and engineers are working on right now. Ideas and technologies that could solve the problem... boost the economy and improve our quality of life."



Becky Worley, Host The Next Frontier

Enduring Understandings & Essential Questions

Enduring Understandings describe the significant concepts and vital generalizations that viewers should be able to comprehend about climate change, renewable energy, energy efficiency, and carbon capture. **Essential Questions** direct deeper meaning and promote ongoing inquiry about these enduring concepts, big ideas, and content items.



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Climate Change: A Serious Threat

Enduring Understandings:

Climate change is a serious threat and if we don't do something about it today, it's going to get worse.

Essential Questions:

- Is there a beneficial byproduct of burning of fossil fuels (oil, coal, natural gas)?
- How much of the energy in the U.S. is dependent upon fossil fuels?
- How does burning fossil fuels lead to trapping more heat on the surface of the earth?
- If carbon has always been a natural part of our atmosphere, then why this a life-threatening problem?
- Which American trait can lead us to solutions?

"Climate change is very real. We got into this situation because of the way we use energy, and the way we use energy is how we're going to get ourselves out of it."

"





Mary Nichols, Chair California Air Resources Board

What We Can Do Today

Enduring Understandings:

Innovative technologies and policies will address the serious problem of excessive carbon dioxide emissions and our dangerous dependence on fossil fuel.

Essential Questions:

- To what extent should energy efficiency be a part of the solution? Will we need to suffer to become energy efficient? What does this mean to you and how might it affect others?
- Which measures can families, schools and communities start right now to live efficiently and to move toward sustainability? How realistic is this?
- What about the carbon dioxide already in the atmosphere?
- Are there guiding principles embraced by the model green communities of Samso, Denmark, and Greensburg, Kansas, that should be followed by others?
- What could be the ecological-economic consequences of ignoring the dangers of climate change and not developing renewable, energy efficient technologies?
- What should be done next at the City, State and Federal levels?



Dian Grueneich, Commissioner California Public Utilities Commission



"As individuals we need to make sure the homes that we live in and the places that we work are efficient and we're using renewable energy."

Improving Our Future

Enduring Understandings:

Renewable, clean energy technologies can improve our quality of life, our future, and create significant economic opportunities.

Essential Questions:

- Regarding excessive carbon dioxide in the atmosphere, do you agree that "We got into this situation because of the way we use energy, and the way we use energy is how we're going to get ourselves out of it"? Justify your answer.
- Why is renewable energy inherently more sustainable than fossil energy? Can it really be more profitable?
- Compare/contrast the primary benefit and primary risk among alternative ways to generate renewable energy (wind, solar, tidal, geothermal, and nuclear).
- Create/design the ideal mix of energy sources to meet 110% of America's energy needs.
- Prioritize in order which renewable, clean energy sources should be developed.
- Once renewable energy is generated how can it best be stored and distributed?



Bob Dixon, Mayor Greensburg, Kansas



"What are they going to say at the end of this 21st century about the people of this earth? My vision is they're going to say they changed their ways and they decided to take care of their environment."



Real Engineers Making a Difference

The Next Frontier: Engineering the Golden Age of Green features two real-life engineers putting their science and engineering skills to good use every day! Right now, these engineers and hundreds of others are working to prevent climate change and develop renewable energy technology. You could be the next generation of scientists and engineers working for a cleaner, brighter future for California!



Doug Grandt Air Resources Engineer California Air Resources Board

Grandt is among the men and women researching, developing and implementing California's landmark climate change law, AB 32. That means they're looking at the best ways to bring cap and trade and carbon capture and storage policies to California. They're also working to reduce toxic emissions from diesel vehicles in California.

Angela Tanghetti Electric Generation System Program Specialist California Energy Commission

Tanghetti is working to predict the future of energy. She's looking at the necessary mix of technologies and energy storage requirements to ensure that the lights stay on for millions of people in California. For example, she and her co-workers must figure out how to utilize wind technology but have a back-up system for when the wind isn't blowing.



Teacher Testimonials



"Perfect video for my Engineering students when we discuss energy production and conservation."

> -Todd VanderLoop Stevens Point Area Senior High, Wisconsin

"The Next Frontier logically laid out all the technologies for reducing carbon in the atmosphere. The presentation was entertaining and truthful. We had multiple levels of understanding at the movie from 10 year olds to university professors to seasoned environmentalists. We all got something out of that movie. Most environmental movies are "bummer" movies but not The Next Frontier. It left us with clear ideas of what the future could and should be. I highly recommend to all peoples from 10 year old and up. Thanks so much for this movie."

-Cathy Orlando, Science Outreach Coordinator, Dean of Science and Engineering at Laurentian University in Sudbury, Ontario, Canada

"(The Next Frontier) would be great to show to my Earth & Space class to expand their knowledge about energy. The documentary was extremely well done."

-Angie Ward, Beulah High School, Alabama

"This will be a great video for my students in my AP Environmental Science class and will be a good source of information for their quarter project on alternative energies."

-Mike Cooney, Mt. Ararat High School, Maine



Educational Resources



Energy Efficiency & Renewable Energy

U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) offers lesson plans, science projects, and other activities that can be done in the classroom or at home to get K-I2 students excited about clean energy and a greener future!

http://wwwl.eere.energy.gov/education/lessonplans/



The National Renewable Energy Laboratory (NREL) provides a variety of educational resources to help teachers and parents educate their kids about renewable energy and energy efficiency technologies, including handson projects and curriculum suggestions for elementary school, middle school, and high school students.

http://www.nrel.gov/education/educational resources.html



CoolCalifornia.org provides kits for schools that include ways to teach students about climate change and get them involved in the classroom. There are tools to help students learn what changes they can make to protect the environment.

http://www.coolcalifornia.org

The Next Frontier: Engineering the Golden Age of Green is the fourth educational documentary sponsored by the Professional Engineers in California Government (PECG). These documentaries can serve as additional tools in STEM (Science, Technology, Engineering & Math) education.



The Bridge So Far – A Suspense Story

The Bridge So Far - A Suspense Story is an entertaining documentary that looks at the progress, delays, setbacks, and politics during the design and construction of a new, safe San Francisco Bay Bridge following the 1989 Loma Prieta Earthquake. It's a story about rebuilding after a disaster, getting the job done despite delays and wrong turns, and ultimately the very human process of using steel and concrete to make a dream a reality.

Amazing: The Rebuilding of the MacArthur Maze

Amazing: The Rebuilding of the MacArthur Maze focuses on the remarkable rebuilding of a key piece of the San Francisco Bay Area freeway system. Following a fiery collapse of a section of the MacArthur Maze, state engineers and private contractors teamed up to reopen the critical overpass in just 26 days.





A Span in Time

A Span in Time follows engineers and construction crews during the 2007 Labor Day weekend Bay Bridge construction project. During a three-day bridge closure, crews demolished and removed a football field-size bridge, rolled in a new pre-constructed replacement span, and finished the job eleven hours ahead of schedule.

For more information about PECG's educational documentaries please contact:



Professional Engineers in California Government 455 Capitol Mall, STE 501 Sacramento, CA 95814 www.pecg.org (916) 446-0400 Email: pecg@pecg.org



U.S. DEPARTMENT OF

Energy Efficiency & Renewable Energy

get current switch on clean energy

EVERYBODY NEEDS POWER. But some of the ways we generate and use power can have a dramatic effect on the environment. This *Energy Awareness Activity Book* provides a number of clues and tips on how to make smart energy choices, save money, and reduce our impact on the environment. Before you begin, here are a few concepts to keep in mind.

Energy Efficiency: More than 90% of the energy we use comes from fossil fuels that are nonrenewable and cause pollution. One of the greatest energy resources we have at our fingertips is energy efficiency, or the energy that would otherwise be wasted. Choose the most energy-efficient equipment. Look for the ENERGY STAR[®] label.

Renewable Energy: Renewable energy does not pollute the environment and can be continually replenished. Here are some of the major renewable resources being used today:



Biomass is any organic material that can be burned or converted to ethanol or methane. Ethanol is used as a vehicle fuel, and methane is captured from decaying garbage and waste to produce energy.



Wind energy is used to turn the blades connected to a turbine to produce electricity. Many places have wind resources powerful and steady enough to harness.



Solar energy is the Sun's radiant energy that can be absorbed, stored, and released by substances or converted directly into electricity using photovoltaic (PV) cells.



Geothermal energy is produced in the Earth's core. Low-temperature geothermal can be used to heat and cool building interior spaces. High-temperature geothermal resources are recovered with wells or pipes deep underground and can be used to heat buildings or produce electricity.

www.energy.gov/kids

1



CLEAN & GREEN JOIN THE SEARCH FOR RENEWABLE AND EFFICIENT ENERGY! U W B T C T N E I C I F F E T W D E T I E C C C P L B L Z U W I S A A Y F O O R I E N Z R J R N W T L G W N O U E A E B G B F D I H F B M S G O I N I
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BIOMASS HYBRID SUSTAINABLE
CFL HYDRO TURBINE
CLEAN HYDROGEN WATT
CONSERVE KILOWATT WEATHERIZE
EFFICIENT PHOTOVOLTAIC WIND
ELECTRICITY POWER
FUEL SAVE
GENERATE SCIENCE
GEOTHERMAL SOLAR
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ENERGY FACT: Wind turbines are available in a variety of sizes. The largest machine has propellers that span more than the length of a football field, stands 20 building stories high, and produces enough electricity to power 1,400 homes.



Find the two that match. Discover the savings. Plug your devices and chargers into a power strip and turn them all off at once.

Unplug that energy drain!













5

ENERGY FACT: Use power strips to switch off TVs, game systems, home theater equipment, and stereos when you're not using them. Even when you think these products are turned off, together, their "standby" consumption can be equivalent to that of a 75 or 100 watt light bulb running continuously.

Do the Math!

If every American home replaced just one light bulb with an ENERGY STAR® qualified bulb, we would save enough energy to light more than 3 million homes for a year.



Fit the numbers 1 - 9 in each 3 x 3 square, row and column. No repeats!

	7			4	2		5	
	4	1	1	8		1	7	
	9		1	5			6	
7					9			2
	5	6			4	3		9
		4			5			7
5		Å	3			1	9	
3				6		8		
4		F	5					6

ENERGY FACT: Compact flourescent bulbs use about 1/4 the energy and can last 10 times longer than incandescent bulbs. Remember – turn off unnecessary lighting! When buying bulbs, look for a CFL bulb with wattage that is one-quarter of the incandescent you're replacing.

5



Turn into an Energy Champion! Save fuel by **planning** your route, **combining** trips, and **sharing** rides. **START** END **ENERGY SAVING TIPS:** Drive a fuel-efficient car Avoid fast accelerations **Reduce idling time** Keep tires properly inflated Take public transportation when possible

MAKE THE CONNECTION! Efficiency = Savings!

CLEAN	1 a	Monitor setting
GREEN	2 b	Update with efficient equipment
RESOURCE	3 с	Produce power
OFF-PEAK	4 d	Healthy, efficient, sustainable
GENERATE	5 е	Insulate and prevent air leaks
ALTERNATIVE FUEL	6 f	Produce more work with less energy
BIOMASS	7 g	Renewable energy resources
EFFICIENT	8 h	Organic matter to produce energy
WEATHERIZE	9 i	Inefficient light bulb
FOSSIL FUEL	10 j	Efficient vehicle with advanced technology
	11 k	Hydrogen and Ethanol
RETROFIT	12 I	A natural material
HYBRID	13 m	A unit of electrical power
('_' WATT	14 n	Coal, oil, and gas
SLEEP	15 o	Time of lower energy demand

ENERGY FACT: Replacing one incandescent light bulb with an energy-saving compact fluorescent bulb prevents 1,000 pounds of carbon dioxide from being emitted into the atmosphere from power plants.



ACT !

ENERGY FACT: Even when equipment is off, it still drains some energy in standby mode.

Plug equipment into a power strip, and turn off all the juice at once!

Watt a Difference!

•

Find the energy-smart improvements. The changes are as clear as night and day.

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Puzzle Solutions



Page 6: Don't Be Clueless About Energy Efficiency: Clean and Green Save Energy At Home, At School, And On The Road. Page 7: Turn Into an Energy Champion!



Page 8: Make the Connection!

1, G; 2, D; 3, L; 4, 0; 5, C; 6, K; 7, H; 8, F; 9, E; 10, N; 11, I; 12, B; 13, J; 14, M; 15, A;

Page 9: WATT a Difference!



What You Need to Know

Alternative-Fuel Vehicle (AFV) - A vehicle designed to operate on an alternative fuel (e.g., compressed natural gas, methane blend, electricity).

Biomass - Any organic (plant or animal) material which is available on a renewable basis.

Energy - The ability to do work or the ability to move an object. Electrical energy is usually measured in kilowatt hours (kWh), while heat energy is usually measured in British thermal units (Btu).

Energy Efficiency - Activities aimed at reducing the energy used by substituting technically more advanced equipment, typically without affecting the services provided.

Ethanol - A colorless liquid that burns to produce water and carbon dioxide. The vapor forms an explosive mixture with air and may be used as a fuel in internal combustion engines.

Fossil Fuels - Fuels (coal, oil, natural gas, etc.) that result from the compression of ancient plant and animal life formed underground over millions of years.

Generator - A device that turns mechanical energy into electrical energy. The mechanical energy is sometimes provided by an engine or turbine.

Geothermal Energy - Heat energy that is produced by natural processes inside the Earth. It can be taken from hot springs, and reservoirs of hot water deep below the surface of the Earth.

Hydrogen - A colorless, odorless, highly flammable gaseous element. The lightest of all gases and the most abundant element in the universe.

Hydropower - Energy that comes from moving water.

Kilowatt - A unit of power, usually used for electric power or energy consumption (use). A kilowatt equals 1000 watts.

Nonrenewable - Fuels that cannot be easily made or "renewed"; oil, natural gas, and coal.

Nuclear Energy - Energy that comes from splitting atoms of radioactive materials, such as uranium.

Petroleum - Refers to crude oil or the refined products obtained from the processing of crude oil (gasoline, diesel fuel, heating oil, etc.).

Photovoltaic Cells - A device, usually made from silicon, which converts some of the energy from light (radiant energy) into electrical energy.

Power - The rate at which energy is transferred. Electrical energy is usually measured in watts.

Radioactive Waste - Materials left over from making nuclear energy. Radioactive waste can harm people and the environment if it is not stored safely.

Solar Energy - Radiant energy of the Sun that is converted into other forms of energy, such as heat or electricity.

Turbine - A device whose blades, turned by a force like wind, water, or high pressure steam, has its mechanical energy converted into electricity by a generator.

Waste Energy - Municipal solid waste, landfill gas, methane, digester gas, paper pellets, sludge waste, solid byproducts, tires, agricultural byproducts, and straw used as fuel.

Wind - The term given to any natural movement of air in the atmosphere; a renewable source of energy used to turn turbines to generate electricity.

Cool Web Sites!

DOE Lose Your Excuse

http://www.loseyourexcuse.gov

EERE Kids Campaign http://www.eere.energy.gov/kids/ Energy Information Administration "Energy Kids" http://www.eia.doe.gov/kids

Energy Star® Kids http://www.energystar.gov/kids 12



STAY CURRENT ON CLEAN ENERGY! Check out www.energy.gov/kids

For more information contact: EERE Information Center 1-877-EERE-INF (1-877-337-3463) www.eere.energy.gov

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