

Teacher's Guide For

Life After Oil:

The New Energy Alternatives

For grade 7 - College

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LINKS TO CURRICULUM STANDARDS

The design for this program includes the following curriculum correlations: National Science Education Standards, Content Standard B - Properties and changes of properties in matter, motions and forces, transfer of energy: Content Standard D – Structure of the Earth system, Earth's history, Earth in the solar system and the McRel K-12 Science Standards and Benchmarks, Level III (Grades 6-8) and Level IV (Grades 9-12). There are also many correlations to the standards of Astronomy, Chemistry and Geology. The content of this program presents the discoveries and principles of alternative energy technologies.

MATERIALS IN THE PROGRAM

Teacher's Guide -This Teacher's Guide has been prepared to aid the teacher in utilizing materials contained within this program. In addition to this introductory material, the guide contains the following:

- Suggested Instructional Notes
- Student Learning Goals
- Test Questions on Blackline Masters A for duplication and handout to students
- Timeline of important events in the history of chemistry

INSTRUCTIONAL NOTES

It is suggested that you preview the program and read the related Student Goals and Teacher Points. By doing so, you will become familiar with the materials and be better prepared to adapt the program to the needs of your class. You will probably find it best to follow the programs in the order in which they are presented in this Teacher's Guide, but this is not necessary. The program can be divided into chapters accessed through the DVD's Menu Screen under Chapter Selects. It is also suggested that the program presentation take place before the entire class and under your direction. As you review the instructional program outlined in the Teacher's Guide, you may find it necessary to make some changes, deletions, or additions to fit the specific needs of your students. After viewing the programs you may wish to copy the Test Questions on Blackline Master 1A, and distribute to your class to measure their comprehension of the events.

INTRODUCTION AND SUMMARY OF PROGRAM

Life After Oil: The New Energy Alternatives presents in a clear way the primary alternative energy technologies, including wind power, fuel cells, hydrogen fuel, ethanol, biomass and solar. These technologies in combination can free us from dependence on oil. Presented in an effective format designed to promote successful student learning, these alternative technologies are discussed in a way that is easy for students to understand. *Life After Oil: The New Energy Alternatives* opens with the most basic of alternatives to coal and oil, wind power, a technology that has been around for centuries but can be used to generate electricity directly. The program continues with the advanced technologies of fuel cells, hydrogen fuel, and then moves on to bio-fuels, starting with ethanol, which is already interfacing with the existing gasoline supply system to meet the nation's

transportation needs. Next is the use of biomass to produce other liquid and gaseous fuels, and finally, solar, which harnesses the world's most available source of energy – the sun.

Below is a list of the program and its chapters. Using this program, teachers can create a lesson plan to cover the specific concepts and themes mentioned.

Life After Oil: The New Energy Alternatives

- Wind Power
- Fuel Cells
- Hydrogen Fuel
- Ethanol
- Biomass
- Solar

SUMMARY OF PROGRAM

Life After Oil: The New Energy Alternatives

This program *Life After Oil: The New Energy Alternatives* presents the smorgasbord of alternative energy technologies that will be needed to free us from dependence on oil. In addition, it shows how all of these ideas can be achieved if the United States has the will and drive to implement a Manhattan style project to make them a reality.

Chapter one investigates modern improvements in one of the world's oldest forms of energy technology - the windmill, and how modern wind turbines can produce enough electricity to meet a big part of consumer demand.

Next, chapter two explores the creation of fuel cells using hydrogen to produce electricity that could be used to power cars and even homes.

The process of using common pond algae to produce all the hydrogen the world would need for fuel cells, indeed all energy needs, is explored in chapter three.

Chapter four follows the science and technology behind the production of ethanol, a sustainable and earth friendly substitute for gasoline.

Then, chapter five explains the conversion of biomass, such as wood chips or waste material that is normally hauled away to garbage dumps, to useful liquid or gas fuels.

The use of photovoltaics, which use sunlight to produce electricity, is discussed in chapter six. This chapter ends with new possibilities from quantum mechanics, which shows how capturing solar radiation can be improved by a factor of 10.

Chapter 1: Wind Power

Student Goals - In this *Life After Oil: The New Energy Alternatives* chapter the students will learn:

- The modern wind machine is based on an early technology — the windmill
 - Windmills use blades to intercept the wind
 - The air movement is converted to mechanical energy used to spin a turbine
- A single wind machine can produce enough electricity to power 300 American homes for a year
 - The future of wind as a clean alternative source of energy is in large wind farms
 - The best place for wind farms is the ocean where large scale constant winds exist

Chapter 2: Fuel Cells

Student Goals - In this *Life After Oil: The New Energy Alternatives* chapter the students will learn:

- Hydrogen is the smallest and the most common element in the universe
- On earth free hydrogen is rare
- It is almost always found in combination with other elements such as the hydrocarbons that make up oil, or the molecules that make up good old water: H₂O
- A fuel cell combines hydrogen and oxygen to produce electricity and water
- Hydrogen production storage and transportation cry out for innovation and new technology to make a better and cheaper fuel cell
- What is needed is a Manhattan style project to make the efficient use of fuel cells a part of America's energy supply

Chapter 3: Hydrogen Fuel

Student Goals - In this *Life After Oil: The New Energy Alternatives* chapter the students will learn:

- Green algae can be biologically engineered to produce cheap hydrogen
- Using the maximum potential of the engineered algae to produce hydrogen, an area of 100 kilometers by 100 kilometers, covered with algae, can produce enough fuel to completely displace gasoline usage in the United States
- It's estimated that in five years photo biological hydrogen could be scaled up into a reality... and along the way open new possibilities in bio-energy
- What is needed is a Manhattan style project to make the production of hydrogen from algae a reality

Chapter 4: Ethanol

Student Goals - In this *Life After Oil: The New Energy Alternatives* chapter the students will learn:

- Ethanol: C₂H₅OH is a light hydrocarbon otherwise known as booze

- Currently ethanol plants in the U.S. use corn to create ethanol
 - It is a growing industry
- Ethanol from corn has many advantages
 - It is a liquid like gasoline and it easily interfaces with the present-day gasoline infrastructure
 - There really are no technological obstacles to running all our cars and trucks on ethanol
 - Biomass - prairie grasses, agricultural waste and dedicated energy crops - can be the starting point for ethanol production
 - The process - from corn or biomass to the final ethanol product - takes about three days and could be scaled up easily
- The next step in the process is learning how to convert any biomass into ethanol
- But the challenge is in breaking down the cellulose into sugars and lignin
- The steps in converting biomass to these two products are
 - First scientists use acid catalysts to break down the biomass into its component parts: sugar and lignin
 - The next step is adding enzymes that will separate out the biomass's fermentable sugars from the lignin
 - Lignin has all the chemical possibilities of crude oil
 - The final step is to change the sugars into ethanol as is done with corn and cane sugar already
- What is needed is a Manhattan style project to make converting biomass such as prairie grass, corn stalks and garbage, a part of America's energy supply

Chapter 5: Biomass

Student Goals - In this *Life After Oil: The New Energy Alternatives* chapter the students will learn:

- The principle of thermal chemical conversion is so simple it's like turning straw into gold
 - Use any biomass - wood chips, or all that waste material that is normally hauled away to garbage dumps
 - Then use a small part of that material and to heat the rest
 - Heat the remaining materials in the absence of oxygen
 - Depending on how hot you cook this biomass, the result is either a liquid fuel or a gas - energy products that can do everything fossil fuels are doing today
- How a conversion plant works
- Thermal chemical conversion of biomass can easily interface with the industrial world's energy infrastructure
 - Liquid fuels for transportation
 - Gas for heating
 - Fuel to power electrical generators

Chapter 6: Solar

Student Goals - In this *Life After Oil: The New Energy Alternatives* chapter the students will learn:

- The sun is the source of everything
 - In 20 days enough solar energy falls on the Earth to match the total reserves of fossil fuels worldwide
 - That's a thousand watts of energy for every square meter
 - That's more than enough for all of our energy needs
- Photovoltaic, or solar cell are everywhere
 - They convert sunlight directly into electricity in the form of direct current that can be used to charge batteries or power a motor
 - With a converter unit, PV systems can produce AC current that is compatible with conventional appliances or tied directly into the larger power grid
 - At the heart of the solar cells are silicon-based semiconductors, the same thing found in modern computers
- How Solar cells work
 - At the atomic level what happens is an electron from an atom's lower orbit is pushed by the energy source, say a photon of light, to the outer orbit
 - That electron is now free to move through a wire
- New advances in solar technology that will capture a wider range of the sun's output
- What is needed is a Manhattan style project to make this incredible technology of using the sun to power our homes a part of America's energy grid

Answers to Blackline Master 1A Quiz

1-a; 2-b; 3-b; 4-c; 5-d; 6-a; 7-d; 8-b; 9-d; 10-b