Title:	Arkansas--An Oasis of Energy	
Author:	Kim Murie University of Arkansas Fayetteville	
Courses: **Grades:**	Earth Science, Environmental Science, Geology, Biology, Arkansas History, Economics, Quantitative Literacy, Integrated Physical Science 9-12	**Duration:** Three to four 50-minute class periods: - Two to three classes for research and presentation of background knowledge - One 50-minute class period for presentations and assessment. (Depending on the group, some research could be done as homework.)

Objective:
Students will research the five geologic energy sources in Arkansas (coal, gas, brine, lignite, oil). This will include where the resource is located, how it is formed, and uses of the resource.

Summary of Lesson:
The students will work in groups to become experts on one of the five energy sources naturally occurring in Arkansas. Students will create a public service announcement as a culminating project to share the information they have learned.

Arkansas State Standards:

Subject:	Grade Levels:	CODE(s):	STANDARD:
Quantitative Literacy	**9-12**	**M. 1. QL. 2**	Analyze mathematical models, describe limitation, and suggest improvements
		ES-ESS2-7	Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.
Environmental Science		**ES-ESS3-1**	Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influence human activity.
		ES-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

	9-12	**EVS-ESS3-2**	Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
		EVS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
Biology	**9-12**	**BI-ESS3-2**	Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
		BI7-ETS1-1	Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
Integrated Physical Science	**9-12**	**PSI-ESS3-1**	Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity
		PSI-ESS3-2	Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
Arkansas History	**9-12**	**Era1.AH.9-12.3**	Analyze reasons for migration to pre-territorial Arkansas using a variety of sources (e.g., physical geography, natural resources)
Economics	**9-12**	**EDM.1.E.1**	Evaluate the roles of scarcity, incentives, trade-offs, and opportunity cost in decision making
		EM.2.E.2	Demonstrate changes in supply and demand (e.g., shifts shortages, surpluses, availability) that influence equilibrium price and quantity using a supply and demand model
Language Arts	**9-12**	**RI.9-10.1**	Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as implicitly.
		RI.11-12.1	Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.
		RI.9-10.2	Examine a grade-appropriate informational text. ● Provide an objective summary of the text. ● Determine a central idea of a text and analyze its development over the course of the text, including how it emerges and is shaped and refined by specific details.
		RI.11-12.2	Examine a grade-appropriate informational text. ● Provide an objective summary of the text. ● Determine two or more central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to provide a complex analysis.
		RI.9-10.4	Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and

			technical meanings; analyze the cumulative impact of specific word choices on meaning and tone.
		RI.11-12.4	Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text, including words with multiple meanings or language that is particularly fresh, engaging, or beautiful.
		W.9-10.2 **W.11-12.2**	Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.
		W.9-10.4 **W.11-12.4**	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
		W.9-10.7 **W.11-12.7**	Conduct short as well as more sustained research projects to answer a question, including a self-generated question, or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
		W.9-10.8 **W.11-12.8**	Gather relevant information from multiple credible print and digital sources, using advanced searches effectively. ● Assess the usefulness of each source in answering the research question. ● Integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism. ● Follow a standard format for citation.
		W.9-10.9 **W.11-12.9**	Draw evidence from literary and/or informational texts to support analysis, reflection, research, and synthesis.
		SL.9-10.1 **SL.11-12.1**	Initiate and participate effectively in a range of collaborative discussions • one-on-one • in groups • teacher-led with diverse partners on Grades 9-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
		SL.9-10.2 **SL.11-12.2**	Integrate multiple sources of information that is gained by means other than reading (e.g., texts read aloud; oral presentations of charts, graphs, diagrams; speeches), evaluating the credibility and accuracy of each source.
		SL.9-10.4 **SL.11-12.4**	Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can

			follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.
		SL.9-10.5 **SL.11-12.5**	Make strategic use of digital media (e.g., textual, graphical, audio, visual, interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

Teacher Excellence and Support System (TESS):
Domain 1d: By using the Arkansas Geological Survey website the teacher will demonstrate knowledge of resources.
Domain 3b: Teacher will use questioning, prompts and discussion by posing probing questions to encourage high level thinking.
Domain3e: Teacher will demonstrate flexibility and responsiveness by allowing students choices in how they divide their group tasks and submit their culminating project.

Instructional Strategies and Practices:
Cooperative learning, technology-based instruction

Bloom's Level: Highest Level Only
Analysis and evaluation

Materials and Resources:
- Arkansas Geologic Survey https://www.geology.arkansas.gov/index.html or conduct an internet search for the most recent web address.
- Computer with internet access
- Art supplies, as needed for maps and illustrations (Can be supplied by students.)

Formative Assessment:
The teacher will monitor students as they are conducting research and pose probing questions to ensure students are taking their learning deeper. Descriptive feedback and self and peer assessment will also be utilized.

Notes to Teacher:
Students should have previous knowledge of fossil fuels as well as the rock cycle and geologic time scale. It might be helpful for the teacher to select groups based on the Kagan cooperative grouping model. Depending on the technology available at your school, teachers could encourage final projects to be anything from apps to blog pages. For a lower age group or lower ability group of learners the research could be focused on one specific resource and divided among the whole class. The classroom should be arranged so students can easily work in groups and freely collaborate.

Key vocabulary**:**
Conventional gas
Unconventional gas

Natural resources
Coal
Lignite
Brine
Oil
Natural gas

Student Activity

1. Students will be divided into five to six groups (depending on the size of the class, natural gas can be divided into either wet and dry or conventional and unconventional).

2. Students will research the resource they have been given focusing on the following items:
    a. Formation of the resource: diagram and explain the geologic process that created the resource, referencing the approximate time on the geologic time scale.
    b. Location of the resource: create a map which shows the location of the resource in Arkansas, these could be created on tracing paper so a layered map could be created showing all of the resources students are investigating.
    c. Commercial Use of the resource: groups will showcase the commercial uses of the product
    d. Production: The actual production process for extracting and using the resource will be explained, being sure to mention any potential harm to the environment
    e. Improvements: After becoming experts on the resource, its uses and production, students will present improvements on any step of the process to mitigate impact to the environment keeping cost/benefit analysis ratios in mind. Students should be encouraged to create models to explain their design changes.

3. Culminating Project: Students will present their findings to the class in any media forum they desire. Students could be encouraged to make a Public Service Announcement sharing information they have learned with a community close to one of the resources, students could also be asked to reach out to a group or company involved in the mining process of their resource and share their design improvement idea(s).