Virginia's Mineral & Energy Resources

PART ONE: MINERAL RESOURCES

Minerals are the raw materials that support much of modern life — everything from transportation to the growing of food. Chemists, all sorts of manufacturers, farmers, and a variety of artisans depend upon minerals to conduct business. Virginia's mineral deposits are vast and varied, but coal remains most important to the Commonwealth.

Measuring Virginia's Geologic Wealth

In Virginia the dollar value of mineral resources produced has risen almost threefold in the past 25 years, from $540,595,000 in 1973 to $1,702,576,00 in 1997. Yet this figure tells only a small part of the story of the importance of the state's geologic resources. Soil and water, two of the most valuable resources, and without which there would be no life, are not included. Nor are parks and other scenic and recreational areas, most of which owe their natural beauty to the geology of their location. The Blue Ridge mountains, the caverns and caves, and the Shenandoah Valley are only a few examples.

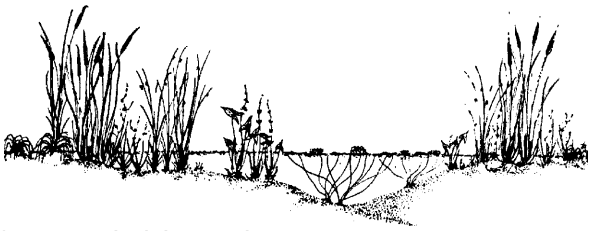
Geology and Mineral Exploration

The science of geology is the study of the earth and its history, and the processes and forces which are constantly at work changing the face of the earth. It is such a broad subject that it has been divided into a number of individual sciences: geophysics and oceanography for example. Geologists try to explain how the earth was formed and has changed through time.

Many industries rely upon a geologist to locate new sources of raw materials. Through the use of field mapping and specialized investigative techniques, geologists discover and develop such resources as petroleum, iron ore, copper, limestone, and sulfur.

Virginia Geology

Virginia can be divided into five physiographic provinces, based on the general configuration of the land surface. From east to west, they are the Coastal Plain, Piedmont, Blue Ridge, Valley and Ridge, and Appalachian Plateau. Each of these physiographic provinces is underlain by distinct combinations of rock types, and each had a somewhat different geologic history (which classifies them uniquely from Virginia's growing regions, or geographic provinces, discussed in the agriculture chapter).



The Coastal Plain Province

The Coastal Plain Province, extending inland for more than 100 miles, is predictably flat. The surface slopes gently eastward from elevations of less than 200 feet along its western margin to the Atlantic Ocean and Chesapeake Bay; then to Virginia's Eastern Shore—the southern portion of the Delmarva Peninsula. The Chesapeake Bay is the dominant topographic feature of the province. Throughout the region, younger sediments from the Cretaceous, Tertiary, and Quaternary ages (dating from 1 to 80 million years ago) lie atop older crystalline and metamorphic rocks of the Piedmont.

Economic materials mined in the Coastal Plain Province are sand, gravel, and clay. More recently, mining has begun for heavy mineral sands (ilmenite, leucoxene, and zircon) in deposits discovered in Dinwiddie, Sussex, and Greenville counties.

The Piedmont Province

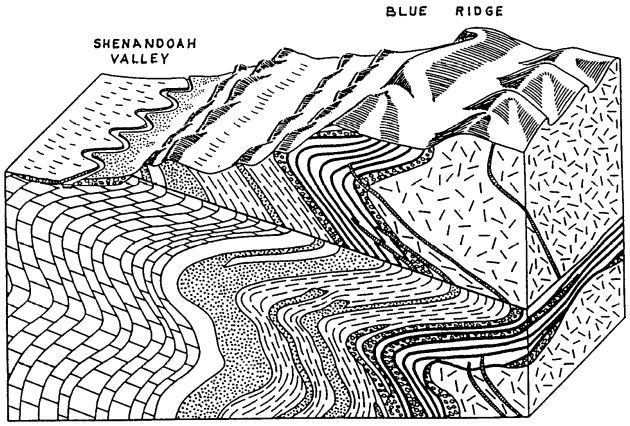
Largest of Virginia's physiographic provinces, the Piedmont extends from Virginia's "fall line" west to the Blue Ridge Mountains. Structurally, it contains a complex of metamorphic and plutonic rocks, overlain in a number of places by Triassic-age sedimentary beds (that are 200-230 million years old). Elevations range from around 100 feet in the east to more than 1,000 feet in the foothills of the Blue Ridge. Local relief generally is low but becomes less gentle to the west.

Metamorphosed rocks characterize this region: schists, gneisses, slates, phyllites, marble, and quartzites. In many areas, they have been altered by intruding granite and other igneous rocks. Mined in the Piedmont are kyanite, slate, vermiculite, granite, gabbro, diabase, and feldspar.

The Blue Ridge Province

The rocks that form the Blue Ridge Province or mountains include a basement complex of Precambrian (800-1,200 million years old) granite and granulites along with late Precambrian metamorphosed sedimentary rocks. This old terrain of Precambrian-age metamorphosed sedimentary and volcanic rocks contains the "oldest" rocks in Virginia—including Old Rag Granite, dating back approximately 1.2 billion years.

The Blue Ridge follows a northeast-southwest alignment of the Appalachians in the west-central portion of the state. The two highest mountains in the state, Mt. Rogers (elevation 5,720 ft.) and White Top (elevation 5, 520 ft.) are located in the southern reaches. Blue Ridge rocks are quarried for quartzite as crushed stone and, in the past, mining occurred for copper, iron, manganese, and a limited amount of tin.



Land Surface and Its Relation to Rock Formations and Structures

The Valley and Ridge Province

The Valley and Ridge Province exhibits great variation, both topographically and geologically. Thick sedimentary layers accumulated during the Paleozoic Era (and date back 570 to 320 million years). Strata consisting of shale, dolostone, and limestone dominate on the east and grade westward into strata comprised generally of sandstone, siltstone, and shale. Diabase and other dikes are present.

With the exception of the lower valley of the Shenandoah River, the Great Valley gives way westward to a complex of northeast-trending ridges and narrow valleys, with the ridges rather than the valleys dominating the landscape. Sandstones are the primary ridge formers, and the valleys are cut into less resistant limestone and shale formations. Several summits of more than 4,000 feet are found in this area. Resources currently extracted from this province are limestone, dolostone, sandstone, gypsum, iron oxides, clay, oil, natural gas, and shale.

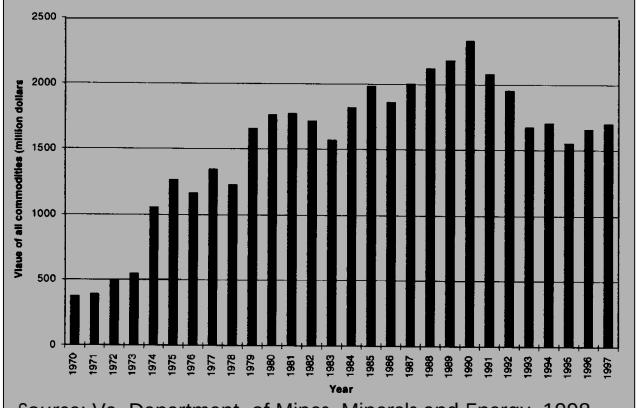
The Appalachian Plateaus Province

The Appalachian and Cumberland Plateaus fringe the Valley and Ridge along much of the western margin of the state. Toward the end of the Paleozoic, sedimentation increased and brackish to non-marine deposits spread westward across the older marine formations, similar to the present Coastal Plain. Large swampy areas provided the material for the coal strata in southwestern Virginia. In fact, the southwest Virginia coalfield is totally contained within this province. In addition to coal, this province contains valuable resources of methane, natural gas, and some oil, along with some crushed stone.

Adding it All Up

The most important mineral resources of Virginia are coal, crushed stone, sand and gravel, lime (from limestone and dolostone), and natural gas. Kyanite, which is mined in Buckingham County, is the only deposit currently being mined in the United States. Virginia is also the only producer of "Virginia Aplite" (used to make glass) and the second leading producer of vermiculite, used in insulation, packing, and potting soil.

Total Value of Mineral Production in Virginia, 1970-1997



Source: Va. Department. of Mines, Minerals and Energy, 1998.

Non-fuel Minerals

The non-fuel minerals industry is an important aspect of Virginia's economy. In 1997, Virginia ranked 22nd nationally in non-fuel mineral production. That year, there were 359 industrial mineral mining operations throughout the Commonwealth. At least 87

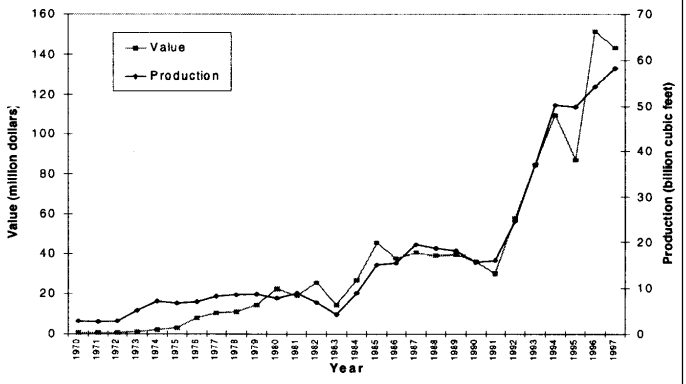
million tons of non-fuel minerals with a value of 600 million dollars were produced. Most of this production is from crushed stone quarries, and sand and gravel mining operations.

Fuel Minerals

The importance of the fuel minerals industry to Virginia's economy is best exemplified by the coal industry. In 1997, there were 92 surface coal mines and 264 underground coal mines in operation. Approximately 36.8 million tons of coal were mined in 1997 with a value of 959 million dollars. The coal was mined from 40 coal beds in Lee, Wise, Dickenson, Buchanan, Scott, Russell, and Tazewell counties. Virginia ranked 8th in national coal production that year.

Also in 1997, 18.1 billion cubic feet of conventional natural gas and 39.7 billion cubic feet of coal bed methane gas were produced from the southwest fields with a value of 143.5 million dollars. There were 62 producing oil wells in Lee and Wise counties in 1997, producing 10,337 barrels of oil. There were 1,017 conventional gas wells and 995 coal bed methane wells in production in 1997.

Trend in Natural Gas Production and Value, 1970-1997



Source: Va. Department of Mines, Minerals and Energy, 1998.

From the coal used to provide energy, to the aggregates used for our infrastructures, it is obvious that the state's mineral industry is extremely important to Virginia's economy and well-being. A grand total of 1.07 billion dollars of mineral commodities can be attributed to the Commonwealth in 1997.

Conservation of Virginia's Mineral Resources

Conservation of our mineral resources means efficient use of materials. Every year, mining companies improve methods of recovery to obtain as much as possible of the usable mineral from the ore that is mined. Likewise, petroleum and natural gas producing companies institute practices that lead to greater overall production. Another example of efficient use of mineral resources is the recovery of fly ash produced by the burning of coal from power generating plants. Fly ash (amounting to 2 million tons produced in Virginia in 1996) is used in structural fills, as a flowable fill in place of concrete, and also in lightweight concrete cinder block.

Mining and Mineral Facts - Historic Highlights

u In 1609, two years after the settlement of Jamestown, iron ore was being mined in eastern Virginia and shipped to England.

u In 1699, coal was discovered near Richmond. This coal fired the blacksmiths' forges and started the nation's coal industry.

u Thomas Jefferson wrote about the many valuable minerals found in Virginia. In his essay, "Notes on the State of Virginia," he mentioned the discovery of gold, coal, lead, copper, iron, graphite, marble, limestone, and other minerals.

u The lead and zinc mines at Austinville (Wythe County) closed in 1776 just after the Revolutionary War started. After the war, the mines were in almost continuous production until closed in 1980. The Austinville mines supplied lead for bullets for the Confederacy during the Civil War.

u Salt seepages and deposits were known to exist in the Saltville area (Smyth County) since 1760. The early settlers dug shallow wells and extracted the salt from the brine that flowed from the springs. In 1836 two wells were reported to be in operation. During the Civil War, the wells at Saltville were the main source of salt for the Confederacy.

u The Tredegor Iron Works in Richmond was almost the sole producer and manufacturer of iron during the Civil War. Iron from Tredegor outfitted the first ironclad vessel of American navies, the *Merrimac*.

u Gold was first reportedly discovered in Virginia in 1806 in Spotsylvania County; silver, in the late 1700s or early 1800s in Mecklenburg County.

u The caprock over the weathered pyrite (iron oxide) of the pyrite deposits in Louisa County (Gold-Pyrite belt) was first mined for iron in 1834.

u Copper mining in Virginia started about 1847-1848 in Floyd County. The last production was from Floyd County in 1947.

Source: Va. Dept. of Mines, Minerals and Energy, 1998.

PART TWO: ENERGY RESOURCES

Energy does things for us. It moves cars along the road and boats along the water. It bakes a cake in the oven and keeps ice frozen in the freezer. It plays our favorite songs on the radio and lights our homes. Energy makes our bodies grow and allows our minds to think. Energy is a doing and moving thing. In essence, energy is the ability to do work.

Background

There are ten sources of energy commonly used to provide electricity, to move our vehicles from place to place, and to grow the food we need to survive. These energy sources are vital to Virginia's future. For many years, Virginians have released the energy from coal and natural gas reserves; used gasoline refined from petroleum to move cars, trucks, boats, and planes; and harnessed the energy in water. Virginia is also a leader in unleashing the power of nuclear energy — or energy that is locked in the nucleus of an atom.

SOURCES FOR ELECTRICITY
IN VIRGINIA, 1997

Coal - 50.3%
Nuclear - 45.9%
Natural gas - 2.2%
Petroleum - 1.5%
Hydro & Other - .1%

Energy Sources

Energy sources are classified as renewable or nonrenewable. Renewable resources can be re-used or replenished in a short amount of time. Nonrenewable resources such as fossil fuels, by contrast, can be used up and it will take millions of years and very special conditions to create them again. Fortunately for Virginians, the Commonwealth has a variety of both forms of energy resources.

Renewable

Renewable energy sources are in use everywhere.

u Water power *(hydropower)* is used to make electricity where rivers have been dammed to create reservoirs or lakes. The energy from falling water is very powerful, making inexpensive electricity.

u Industries and homes across the state unleash the power of the sun *(solar energy)* to make electricity from photovoltaic cells (solar cells) that heat water and grow crops.

u *Geothermal energy* is used by ground source heat-pump systems to heat and cool houses using the constant temperature of the earth just a few feet beneath the ground.

u Wood, garbage, and even agricultural waste (called *biomass*) is burned to generate electricity and to heat homes with wood stoves, or refined to make ethanol, a transportation fuel.

u *Wind energy* pumps water to feed crops and grind corn and other feed.

A unique property of energy is its ability to change forms. For example, the energy in water at the Bath County pumped storage hydropower facility changes from potential to kinetic energy as it is released during peak demand periods. Its potential energy is recharged as it is pumped back into the higher reservoir duirng low demand periods.

Today, hydropower is Virginia's leading renewable source of energy because of its value in generating electricity. Smith Mountain Lake in southwest Virginia is a vast hydroelectric reservoir generating electricity for customers in Virginia and surrounding states. Hydropower is supplemented by the use of other power: geothermal, biomass, solar, and wind. Together, these sources make up a very small portion of the energy used in Virginia each year — less than one percent.

Non-renewable

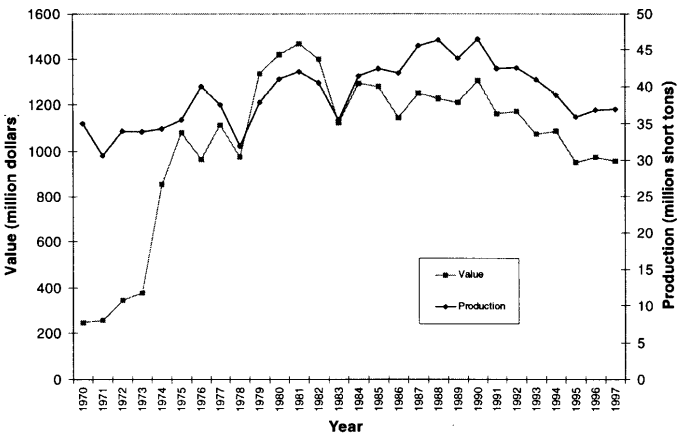
Virginia continues to get most of its energy from nonrenewable energy sources because the state has very large coal and natural gas deposits. Coal is the most valuable of Virginia's mineral resources and is used primarily to generate electricity. Virginia coal was first commercially produced near Richmond in 1738. Local industries at the time used it in iron foundries and blacksmithing. Later, when railroads linked southwest Virginia with other states and the port of Norfolk, the vast coalfields of southwest Virginia became major suppliers, producing coal not only for Virginia but for other states and countries.

Virginia continues to export large amounts of coal. In 1998, close to 11 million tons were loaded into rail cars for export by just one of Virginia's principal carriers—Norfolk Southern. Our coal is bituminous, mean-

ing that it has a resinous nature and is quite easy to burn. Over 80 percent is extracted from underground mines. Virginia coal is sought by many states because of its clean attributes. It has a low sulfur content and, therefore, produces very little sulfur dioxide when burned.

Virginia mimics the rest of the nation in its use of other nonrenewable energy sources. For example, we use petroleum to move ourselves and the goods we use from place to place. We use natural gas to generate electricity and to heat our homes and cook our food. Many a backyard barbecue depends upon the use of propane gas, which is produced from natural gas and petroleum. Much of this natural gas comes from the southwest corner of the state, the same region in which we find coal. In fact, with advancing technologies, Virginians are able to harvest natural (methane) gas in a process that takes it out of the coalbeds.

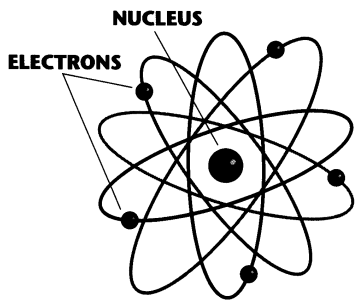
Trend in Coal Production and Value, 1970-1997



Source: Va. Department of Mines, Minerals and Energy, 1998.

Another nonrenewable energy source harnessed by Virginians is nuclear power. Uranium atoms are used to generate electricity when a process called nuclear fission is used at Virginia's two nuclear power plants: North Anna Nuclear Power Station on Lake Anna, and Surry Nuclear Power Station in Surry. These power plants split atoms of uranium to create large amounts of electricity, used by residential and commercial customers throughout the state.

Parts of an Atom



Graphic Courtesy of The NEED Project.

Conservation is Key

The Commonwealth is home to tremendous natural energy resources, making our energy inexpensive and fairly easy to use. And because Virginia has an extensive distribution network—railroads, pipelines, and rivers—criss-crossing the state, we'll continue to have energy within our borders for many years to come. But all of us can take steps to conserve energy and ensure its availability to future Virginians.

Although coal production in Virginia remains strong, between 1984 and 1997 trends reveal that:

- the number of tons mined annually is slightly down;
- the number of employees has been cut in half; and
- the number of mines has also been cut roughly in half.

VIRGINIA'S 5 LARGEST POWER PLANTS BY CAPACITY*

Bath County, Hydropower Plant	2100 megawatts
North Anna Nuclear Power Stn.	1790 megawatts
Chesterfield Power Station, Coal Fired & Gas Fired	1776 megawatts
Surry Nuclear Power Station	1602 megawatts
Possum Point Power Station, Coal Fired & Oil Fired	1329 megawatts

NOTE:one megawatt = 1,000 kilowatts, or 1 million watts

*All are owned by Virginia Power and, together, account for over 65 percent of generating capacity in the state. Net summer capability shown.

Conservation in Action

Here are some ways to become a wise energy-miser:

Save Electricity

t Use only what you need. Don't turn on two lights if you only need one.
t Turn lights, video games, and the television off when you leave a room.
t On a sunny day, read by a window.
t Keep the refrigerator door closed, and know what you want before you open it.
t If the air conditioner is running, close doors and windows.
t When you can, use a fan and wear light clothes.

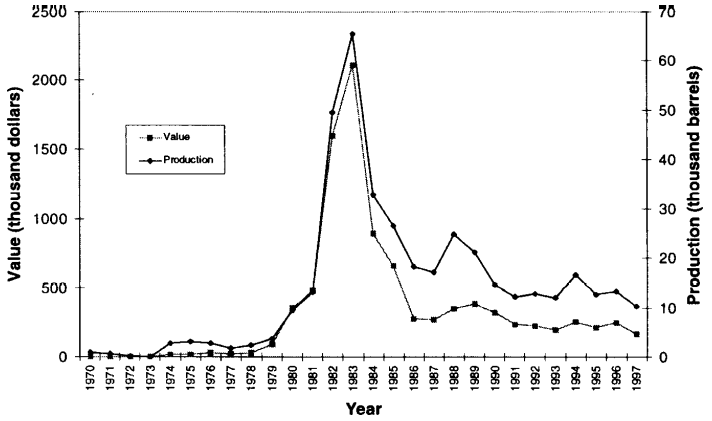
Save Heat

t If the heat is running, keep doors and windows closed.
t Wear warm clothes instead of turning up the thermostat.
t At night, use blankets to stay warm.
t When you take a bath, use only the water you need.
t Take a quick shower. (Heating water uses energy.)

Save Gasoline

t It takes a lot of energy to operate a car. Try walking or riding your bike when you can.
t If you and your friends are going to the same place, go together.
t Take the bus instead of asking for a ride to school.

Trend in Oil Production and Value, 1970-1997



Source: Va. Dept. of Mines, Minerals and Energy, 1998.

Additional Resources

Geology & Minerals

Web Sites:

u College of William and Mary; www.wm.edu/CAS/GEOLOGY/virginia
u University of North Carolina, Chapel Hill; www.geolab.unc.edu/Petunia/IgMetAtlas/mainmenu.html
u U.S. Geological Survey; www.usgs.gov/

Other Resources:

u Va. Division of Mineral Resources, Pub. 151. 1998. *Coal, Oil and Gas, and Industrial and Metallic Minerals Industries in Virginia, 1997.* Charlottesville: Va. Department of Mines, Minerals and Energy.

Energy

Web Sites:

u National Energy Information Center; www.eia.doe.gov/kids
u Minerals Management Service; www.mms.gov/mmskids
u The NEED Project; www.need.org/need
u National Science Teachers Association; www.nsta.org/energy

Other Resources:

u The NEED Project. Contact for curriculum resources at (703) 471-6263 or on-line above.

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Teaching about energy is not easy. There are many advantages as well as disadvantages to using the resources we count upon each day. Educating people about the trade-offs of energy decisions, specifically their impacts upon the environment and the local economy, will help all of us become better consumers while extending the lifespan of Virginia's energy resources.

Fundamental Learnings Related to Mineral Resources

R Mineral resources are the raw rock and mineral deposits extracted from the earth to produce industrial and consumer goods.

R Virginia's geology and mineral resources are intertwined. Virginia's mineral resources are the result of ancient geologic processes, and the presence of minerals can be predicted by understanding those processes.

R From riding a bicycle to salting a french fry, we depend upon mineral resources every day of our lives.

R Mineral resources are not replaceable. Once they are removed, they cannot be replaced in the earth, so it is vital that we use mineral resources efficiently.

Fundamental Learnings Related to Energy Resources

R Energy is involved in everything we do.

R There are basic advantages and disadvantages of using the ten major energy sources, including environmental and economic trade-offs.

R We use a lot of energy to support our lifestyle in the United States.

R Analysis of economic and environmental impacts helps determine the energy sources we use.

Energy in the Balance
Adapted from The NEED Project

Grade Levels: 4-6

Science SOLs: 4.8, 5.7, 6.3, 6.5, 6.11, PS.6, ES.7

Materials Needed:
- **Rating sheets, sets of 5**
- **Transparencies (5)**
- **Pens and markers**

Objectives:
This cooperative activity encourages students to evaluate the advantages and disadvantages of the major energy sources through a series of rating activities.

Vocabulary Words:
atom
advantage / disadvantage
biomass
carbon dioxide
coal
electricity
fission / fusion
geothermal energy
greenhouse gas
hydroelectric power
import / export
kinetic
mining
natural gas
nuclear energy
nucleus
petroleum
photovoltaic cell
potential
propane
reclamation
renewable / nonrenewable
reservoir
solar energy
uranium
wind energy

Preparation
Make enough copies of the five Energy Source Rating Sheets so that each group of three students has a complete set. Make one transparency of each rating sheet on which to record a class summary of the group results.

Procedure
Divide your class into groups of three students. Provide one set of rating sheets to each group. For younger students, you may want to complete the first rating sheet with the students as a class.

Explain to the students that they will be working in groups to complete rating sheets about the ten major sources of energy used in the United States. They will complete the rating sheets by reading each statement and deciding as a group if it is:

u *Fact:* If the statement isn't a good or a bad thing about the source, then it's a fact. For Example: We're going on a field trip today.

u *Advantage:* If the statement is a good thing about the energy source, then it's an advantage. For example: We'll have cake and ice cream on the field trip.

u *Disadvantage:* If the statement is a bad thing about the energy source, then it's a disadvantage. For example: The bus for the field trip is late.

Tell the students to disregard the Rating column as they complete the forms. They will complete this column later, after they have read all of the rating sheets.

u *Disagreements:* If the students in the group cannot agree on a statement after a brief discussion, they should note that on the sheet and move on to the next statement.

u *Finish:* Have the groups write their names on the back of the rating sheets, collect them, and explain that the students will work in the same groups the next day.

Have the students return to their groups. Explain that they will begin deciding how important the advantages and disadvantages are by rating them. The groups will complete the rating sheets one at a time, then compile a class average, before moving on to the next rating sheet. Give the students the following explanations:

u *Fact:* If the group decided the statement is a fact, the rating for that statement is a zero. There is no rating (0) to a fact that is neither an advantage nor a disadvantage.

u *Advantage/Disadvantage:* If the group decided that the statement is an advantage or a disadvantage, they must decide the importance of the advantage or disadvantage—its rating.

Write the scale below on the chalk board for the students to use as a guide:

Disadvantage	-10	-8	-6	-4	-2	0	+2	+4	+6	+8	+10	Advantage

Notice that all advantages are positive numbers—they add to the value of the energy source; while all disadvantages are negative numbers—they subtract from the value of the energy source.

Explain that the groups can decide on any number between –10 and +10 as the rating. For example:

- Our basketball team is playing our big rival on Friday night. (Fact)
- Our coach has a cold. (Disadvantage -1)
- Their best player broke his leg yesterday. (Advantage +8)
- We're playing in their gym. (Disadvantage -4)
- We've beaten them twice this year. What do you think?

u *Rate the Sources:* Once all of the students understand the rating system, they should begin to rate the first energy source—Biomass. For younger students, you may want to complete the first sheet as a class. Each group should try to reach a consensus on the rating, but if they cannot, they should compromise by calculating the average rating for the group. Emphasize that there are no right or wrong answers in the ratings and that it is all right for different people and groups to place different values on the advantages and disadvantages.

u *Total the Rating:* After the groups have completed each sheet, they should calculate the total rating for the sheet by adding the positive numbers together and subtracting the negative numbers. The total can be a negative number.

Summarize

Using the transparency of the rating sheet and the overhead projector, tally the results of all the groups, statement by statement, as shown in the sample here:

BIOMASS*energy*	FACT	ADVANTAGE	DISADVANTAGE	RATING
Biomass is plants, trees, garbage, waste - anything that was alive a short time ago.	1111			0
Biomass is a renewable energy source. We can grow biomass in a short period of time.		1111		+5 +6 +3 +8
Biomass doesn't have as much energy as fossil fuels. We have to burn more biomass to get the same amount of energy.			1111	-5 -6 -3 -2

u *Disagreements:* If there is disagreement about whether a statement is fact, an advantage or a disadvantage, have one student from each opposing group give the rationale for their decision. The rating scores can also be discussed, if there is a marked disparity in the scores and you wish to expand the unit.

u *Average the Results:* Work with the students to average the rating for each source by adding together all of the scores and dividing by the number of groups. Each group should write the average score next to their group's rating for comparison.

Discussion

Ask the students if they notice a trend in their group's ratings, compared to the average. For example, are some groups more concerned about environmental impacts than economic impacts?

Finish

Follow the procedure above for the remaining rating sheets.

Energy Source Rating Sheet

BIOMASS *energy*

	FACT	ADVANTAGE	DISADVANTAGE	RATING
1. Biomass is plants, trees, garbage, yard waste—anything that was alive a short time ago.				
2. All biomass contains energy. Biomass absorbs its energy from the sun and stores it as chemical energy.				
3. Biomass is a renewable energy source. We can grow biomass in a short period of time.				
4. We can burn biomass to make heat. We can use the heat to make products, heat buildings, and make electricity.				
5. Biomass doesn't have as much energy as fossil fuels. We have to burn more biomass to get the same amount of energy.				
6. Burning biomass can pollute the air, but not as much as burning fossil fuels. Biomass can also smell bad when it is burned.				
7. We can also use biomass to make a fuel called ethanol. It is a cleaner fuel than gasoline, but more expensive to use.				
8. Biomass can be made into a gas called methane and burned like natural gas to make heat.				
9. We transport biomass mostly by trucks.				
10. About three percent of the energy we use in the U.S. is from biomass. Industry makes products with most of the biomass we use.				

TOTAL RATING _____

COAL *energy*

	FACT	ADVANTAGE	DISADVANTAGE	RATING
1. Coal is shiny black rock that is buried underground.				
2. Coal contains energy—chemical energy. It was formed long ago from ancient plants. Coal is called a fossil fuel.				
3. Coal is a nonrenewable energy source. We can't make more in a short period of time.				
4. We burn coal to make heat. We use the heat to make electricity. Industry also burns coal to make steel and other products.				
5. We have a lot of coal in the U.S. Burning coal is a cheap way to make electricity. Most of our electricity comes from coal.				
6. Burning coal can pollute the air. It also produces carbon dioxide—a greenhouse gas.				
7. Power plants and industry work hard to reduce the amount of air pollution from burning coal.				
8. We dig coal from huge coal mines. Coal mines can pollute our water if they are not carefully managed.				
9. We transport coal mostly by trains and, sometimes, by barges and trucks.				
10. About 23 percent of the energy we use in the U.S. is from coal. We use most of the coal to make electricity.				

TOTAL RATING _____

Energy Source Rating Sheet

GEOTHERMAL *energy*

	FACT	ADVANTAGE	DISADVANTAGE	RATING
1. Geo means earth; therme means heat. Geothermal means earth-heat.				
2. The center of the earth is very hot. This heat warms water and rocks near the surface. We can use this heat as energy—thermal energy.				
3. Geothermal energy is renewable energy. Rocks in the center of the earth produce more heat all the time.				
4. Very hot geothermal steam can heat buildings and make electricity. Hot steam reservoirs are found in Western states and in Hawaii.				
5. Geothermal power plants are built on top of steam reservoirs. They are expensive to build, but the fuel is free.				
6. Geothermal steam can contain dangerous chemicals. Power plants clean the steam or put the chemicals back into the earth.				
7. Low temperature geothermal energy is found everywhere in the U.S., just a few feet underground.				
8. Low temperature geothermal energy can be used to heat and cool buildings. The systems are expensive to build, but cheap to run.				
9. Geothermal energy is used where it is found. We don't transport it long distances.				
10. Geothermal energy provides the U.S. with about 0.5 % (one half of one percent) of the energy we use, mostly to heat and cool buildings.				

TOTAL RATING _____

HYDROPOWER *energy*

	FACT	ADVANTAGE	DISADVANTAGE	RATING
1. *Hydro* means water. Hydropower is the energy of moving water.				
2. Gravity pulls water from high ground to low ground. There is energy in moving water—mechanical energy.				
3. Water is a renewable energy source. Rain will fall as long as the sun shines and evaporates water from the oceans, rivers, and lakes.				
4. Dams can be built across rivers to harness the energy in water. Turbines at the bottom of the dams make electricity.				
5. Hydropower is the cheapest way to make electricity. The fuel, water, is free to use and you don't need to transport it. Gravity moves it.				
6. Hydropower plants do not pollute the air since no fuel is burned.				
7. Hydropower dams can flood a lot of land when they are built. They can also disturb fish and wildlife habitats.				
8. The lakes made by the dams can be used for fishing, boating and other sports. They can also help prevent floods.				
9. Most of the good places to put hydro dams have been used. The U.S. will not build many more hydro dams.				
10. Hydropower provides the U.S. with about four percent of the energy we use.				

TOTAL RATING _____

Energy Source Rating Sheet

NATURAL GAS *energy*

	FACT	ADVANTAGE	DISADVANTAGE	RATING
1. Natural gas has no taste, color, or smell. A smell, like rotten eggs, is added so we can tell if there is a gas leak.				
2. Natural gas contains energy—chemical energy. It was formed long ago from tiny sea plants and animals. It is a fossil fuel.				
3. Natural gas is buried underground in pockets of rocks. It is a nonrenewable energy source and took a very long time to form.				
4. We can burn natural gas to make heat. We can use the heat to make products, warm buildings, and make electricity.				
5. We have a 35-year supply of natural gas at the price we pay today. There is plenty more in the U.S. if we want to pay more to get it.				
6. Natural gas is a clean-burning fossil fuel, but burning it does produce some air pollution and carbon dioxide—a greenhouse gas.				
7. Cars with special engines can run on natural gas. Natural gas is cleaner than gasoline, but more expensive to use.				
8. We dig wells deep into the ground to get natural gas. It is sent to a plant to be cleaned after it is pumped out of the ground.				
9. We transport natural gas across the country through pipelines. There are more than a million miles of pipelines in the U.S.				
10. About 23 percent of the energy we use in the U.S. comes from natural gas. Mostly, we use natural gas to make products and heat our homes.				

TOTAL RATING _____

PETROLEUM *energy*

	FACT	ADVANTAGE	DISADVANTAGE	RATING
1. Petroleum is oil that is buried underground in pockets of rock. We drill wells into the ground and under the oceans to reach it.				
2. Petroleum contains lots of energy—chemical energy. It was formed long ago from tiny sea plants and animals. Petroleum is a fossil fuel.				
3. Petroleum is a nonrenewable energy source. We can't make more petroleum in a short period of time.				
4. We can burn petroleum for energy. We use petroleum mostly for transportation fuels. It can also heat buildings and make electricity.				
5. Petroleum is also used to make plastics, medicines, paint, soaps, and many other products.				
6. Burning petroleum can pollute the air. Burning it also produces carbon dioxide—a greenhouse gas.				
7. Drilling for oil and transporting it can harm the land and water if the oil spills. Oil companies work hard to keep oil from spilling.				
8. We don't drill enough petroleum to meet our needs. We buy about half of the petroleum we use from other countries.				
9. We transport petroleum by pipelines, oil tankers and trucks.				
10. About 37 percent of the energy we use in the U.S. comes from petroleum. We use more petroleum than any other energy source.				

TOTAL RATING _____

Energy Source Rating Sheet

PROPANE *energy*

	FACT	ADVANTAGE	DISADVANTAGE	RATING
1. Propane is a gas with no color, taste, or smell. It is buried underground with petroleum and natural gas.				
2. Propane contains energy—chemical energy. It was formed long ago from tiny sea plants and animals. Propane is a fossil fuel.				
3. Propane is a nonrenewable energy source. We can't make more propane in a short period of time.				
4. We can burn propane for energy. We use propane to heat buildings in rural areas. We also use it in grills and as a clean fuel for vehicles.				
5. Propane turns into a liquid under pressure. It takes up less space as a liquid. A one-gallon tank can hold 270 gallons of propane gas.				
6. Propane is a portable fuel. As a liquid, trucks can carry propane to rural areas that don't have natural gas pipelines.				
7. Propane is a cheap and clean-burning fuel. We use propane to fuel vehicles that we operate inside buildings—like forklifts.				
8. Propane produces some air pollution and carbon dioxide when it is burned.				
9. We transport propane by pipelines and trucks. We store propane in tanks under pressure—as a liquid.				
10. One and a half (1.5%) percent of the energy we use comes from propane. We use propane mostly in rural areas to heat buildings.				

TOTAL RATING _____

SOLAR *energy*

	FACT	ADVANTAGE	DISADVANTAGE	RATING
1. *Sol* means sun. Solar energy is energy from the sun.				
2. The sun is a big ball of gas. It produces energy all the time. The sun's energy reaches the earth in rays—radiant energy.				
3. Solar energy is a renewable energy source. We will have solar energy as long as the sun shines.				
4. We get light from the sun every day. We can also capture the sun's energy to heat water and buildings and to make electricity.				
5. Photovoltaic (PV) cells can change solar energy directly into electricity. PV cells are used in places with no power lines.				
6. Electricity from PV cells is more expensive than from power plants.				
7. Solar energy is free to use. It is also a clean energy source—no fuel is burned to make the heat or electricity.				
8. The sun's energy is spread out and hard to capture. The energy is only available when the sun is shining, not 24 hours a day.				
9. We don't transport solar energy. We use it where we find it.				
10. Solar energy provides the U.S. with 0.5 % (one-half of a percent) of the energy we use, not counting the light we use every day.				

TOTAL RATING _____

Energy Source Rating Sheet

U^{235} **URANIUM** ***(nuclear) energy***	FACT	ADVANTAGE	DISADVANTAGE	RATING
1. Everything in the universe is made of tiny particles called atoms. In the center of every atom is a nucleus, with even smaller particles.				
2. The nucleus has energy that holds it together—nuclear energy. The nucleus of a uranium atom has lots of energy holding it together.				
3. Uranium is a mineral buried underground. It is a nonrenewable energy source—we can't make more uranium.				
4. We have a lot of uranium in the U.S. It is a cheap energy source.				
5. We can split atoms of uranium into two smaller atoms. When we split atoms of uranium, some of the nuclear energy is set free as heat.				
6. We can use this heat to make electricity. The uranium isn't burned, so there is no air pollution.				
7. When we split uranium, rays of energy—called radiation—are also produced. This radiation can be very dangerous.				
8. The waste from nuclear plants produces radiation for a long time. Many people are concerned about how to store this waste.				
9. We transport uranium mostly by truck.				
10. About seven percent (7 %) of the energy we use in the U.S. comes from uranium. It is used to make electricity.				

TOTAL RATING _____

 **WIND *energy***	FACT	ADVANTAGE	DISADVANTAGE	RATING
1. Wind is moving air—air in motion—mechanical energy.				
2. The sun heats the earth unevenly. The warm air rises and cool air rushes in—that's wind.				
3. Wind energy is a renewable energy source. We will have wind as long as the sun shines.				
4. Windmills can capture the energy in wind to make electricity. Many windmills together are called a wind farm.				
5. Windmills take up a lot of land, but the land can also be used for farming or grazing animals.				
6. Wind energy is free to use. It is also a clean energy source—no fuel is burned to make electricity.				
7. Electricity from new windmills is almost as cheap as electricity from coal power plants.				
8. Many places don't have enough wind to make electricity, and the wind doesn't blow all the time.				
9. We don't transport wind energy. We use it where we find it.				
10. Wind energy provides the U.S. with 0.5 % (one-half of a percent) of the energy we use.				

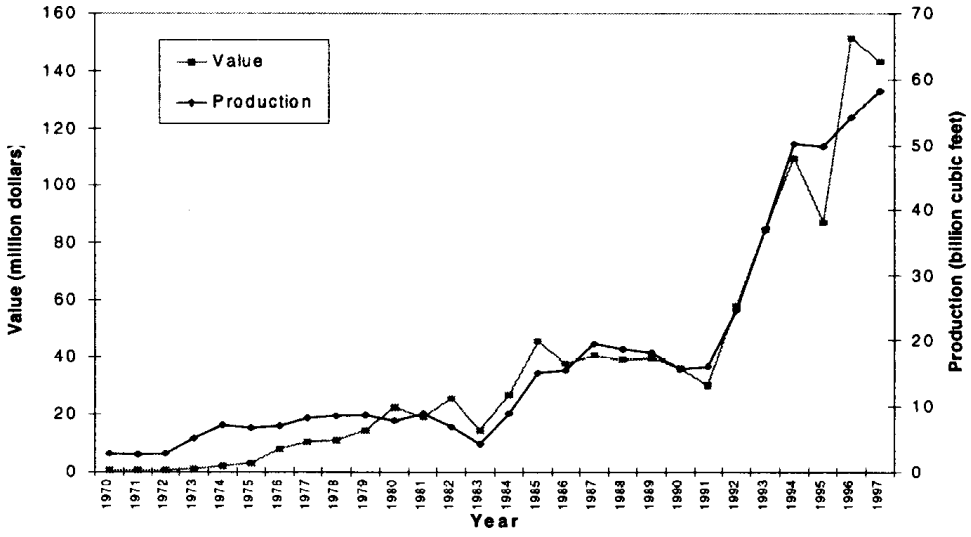
TOTAL RATING _____

Coal Mine Production (Short Tons) in Virginia by County and Mining Method, 1997

	Buchanan	Dickenson	Lee	Russell	Scott	Tazewell	Wise	Total
Number of Mines								
Auger	9	6	4	1	0	0	11	31
Strip	11	13	4	5	0	0	28	61
Surface Total	20	19	8	6	0	0	39	92
Undg. total	123	24	15	9	0	35	58	264
Total	**143**	**43**	**23**	**15**	**0**	**35**	**97**	**356**
Tonnages								
Auger	23,615	46,270	34,007	4,199	0	0	297,608	405,698
Strip	974,615	1,206,756	217,442	237,421	0	0	5,858,587	8,494,642
Surface Total	998,230	1,253,026	251,449	241,440	0	0	6,156,195	8,900,340
Undg. total	12,976,600	2,107,139	1,297,364	767,590	0	2,285,455	8,554,679	27,988,826
Total	**13,974,830**	**3,360,165**	**1,548,813**	**1,009,030**	**0**	**2,285,455**	**14,710,874**	**36,889,166**
Mining Method (tonnage)								
Underground								
Longwall	7,884,760	0	0	0	0	0	0	7,884,760
Continuous miner	5,083,122	2,044,045	1,297,364	767,590	0	2,284,614	8,535,817	20,012,552
Other	8,718	63,094	0	0	0	841	18,861	91,514
Undg. total	**12,976,600**	**2,107,139**	**1,297,364**	**767,590**	**0**	**2,285,455**	**8,554,678**	**27,988,826**
Surface								
Auger	23,615	46,270	34,007	4,199	0	0	297,608	405,698
Strip	974,615	1,206,756	217,442	237,241	0	0	5,858,587	8,494,642
Surface total	998,230	1,253,026	251,449	241,440	0	0	6,156,195	8,900,340
Total	**13,974,831**	**360,165**	**1,548,813**	**1,009,029**	**0**	**2,285,455**	**14,710,874**	**36,889,166**

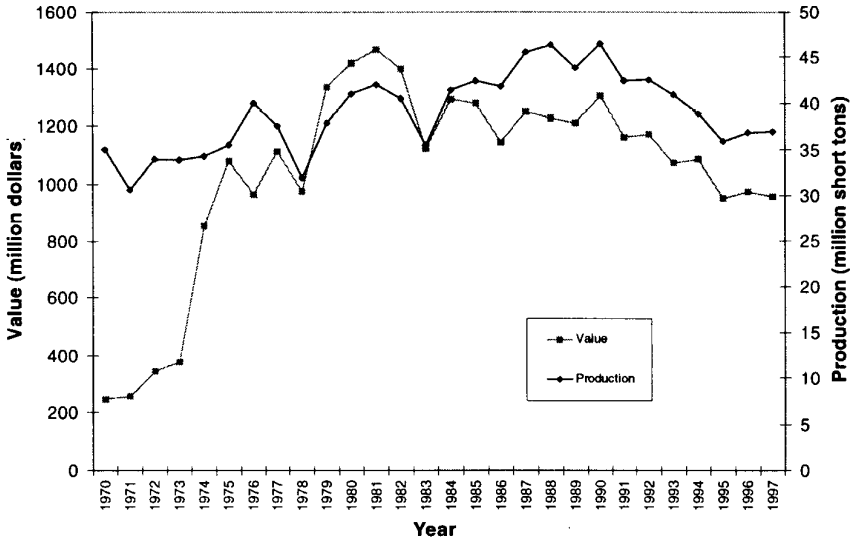
Source: Virginia Division of Mines.

Trend in Natural Gas Production and Value, 1970-1997



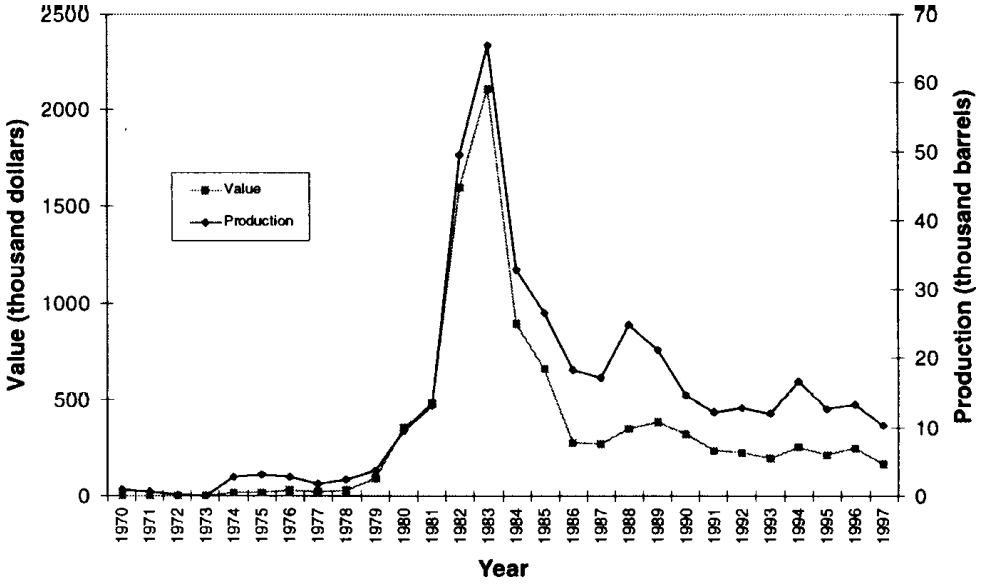
Source: Va. Department of Mines, Minerals and Energy, 1998.

Trend in Coal Production and Value, 1970-1997



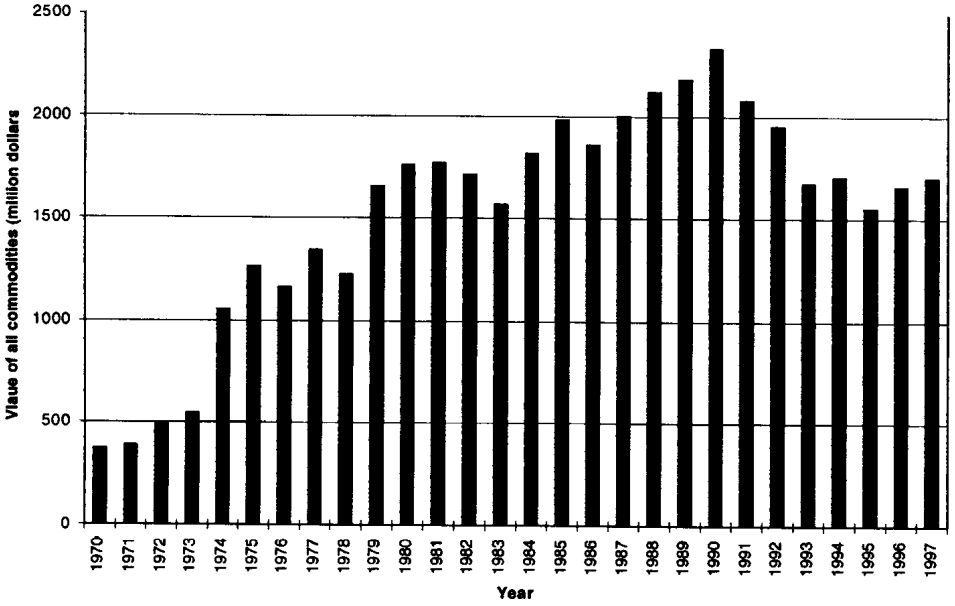
Source: Va. Department of Mines, Minerals and Energy, 1998.

Trend in Oil Production and Value, 1970-1997



Source: Va. Department of Mines, Minerals and Energy, 1998.

Total Value of Mineral Production in Virginia, 1970-1997



Source: Va. Department of Mines, Minerals and Energy, 1998.