Chapter 5: Virginia's Minerals & Energy Resources

Part 1: 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 estimated dollar value of mineral resources produced has increased almost sevenfold in the past 44 years, from $545 million in 1973 to $3.7 billion in 2012. Yet this figure tells only a small part of the story of the importance of the state's geologic resources. Soil and water, two 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.

Much of Virginia’s natural gas exists in hard-to-reach rock formations underneath the ground. The mining industry has long used hydraulic fracturing or “fracking” to release gases trapped inside these formations. By injecting a water-based fluid at high pressure, the rocks can be fractured to collect gases that are then used in energy production. And now, a new technique called horizontal drilling provides access to difficult to reach gas accumulations that are inaccessible to conventional vertical wells.

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.

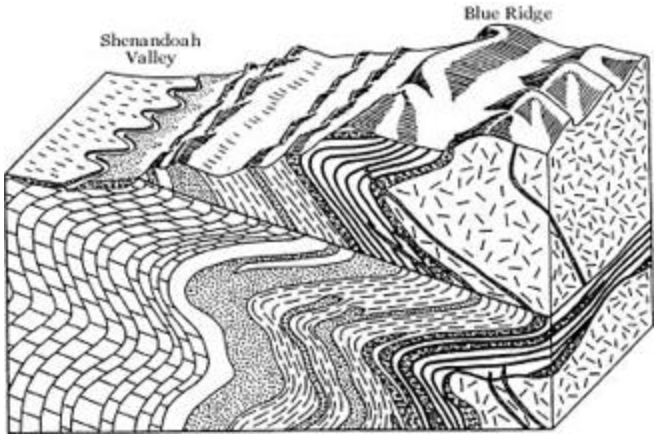
The Blue Ridge Province

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.

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.

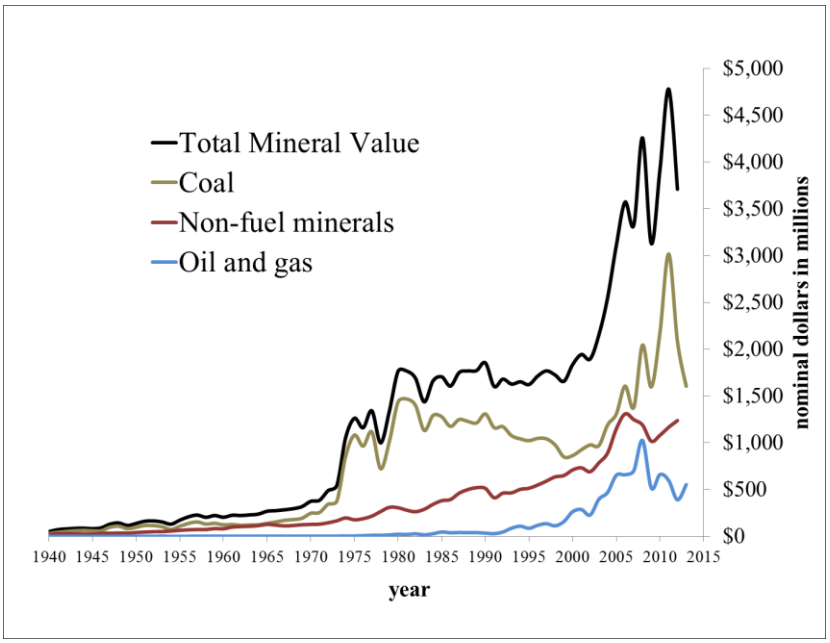
With the exception of the lower valley of the Shenandoah River, the Great Valley gives way westward to a complex of northeast-trending ridges and narrow valleys, with the ridges rather than the valleys dominating the landscape. Sandstones are the primary ridge formers and the valleys are cut into less 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.



Non-fuel Minerals

The non-fuel minerals industry is an important aspect of Virginia's economy. In 2012, Virginia ranked 19th nationally in non-fuel mineral production. That year, there were 424 industrial mineral mining operations throughout the Commonwealth. About 62 million tons of non-fuel minerals with an estimated value of $1.2 billion were produced. Most of this production was 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 2012, there were 39 surface coal mines and 57 underground coal mines in operation. Approximately 19 million tons of coal was mined in 2012 with a value of $2.1 billion. The coal was mined from coal beds in Lee, Wise, Dickenson, Buchanan, Scott, Russell and Tazewell counties. Among the coal producing states, Virginia currently ranks 15th in national coal production.

Also in 2012, 28.4 billion cubic feet of conventional natural gas and 117.9 billion cubic feet of coal bed methane gas were produced from the southwest fields with a value of $389 million. There were 82 producing oil wells in Lee and Wise counties in 2012, producing 9,064 barrels of oil.

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

- In 1609, two years after the settlement of Jamestown, iron ore was being mined in eastern Virginia and shipped to England.
- In 1699, coal was discovered near Richmond. This coal fired the blacksmiths' forges and started the nation's coal industry.
- 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.
- 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.
- 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.
- 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.
- Gold was first reportedly discovered in Virginia in 1806 in Spotsylvania County; silver, in the late 1700s or early 1800s in Mecklenburg County.
- 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.

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

Source: VA Department of Mines, Minerals and Energy, 2016

Part 2: 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 cream 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.

Sources of Energy in Virginia, 2010

Coal - 9%
Nuclear - 13%
Natural Gas - 18%
Petroleum - 34%
Hydro, Biomass, & Other Renewables - 6%
Electricity from Other States - 20%

Background

Virginia's energy resources are commonly used to provide electricity, to move our vehicles from place to place and to grow the food we need to survive and are vital to Virginia's future. For many years, Virginians have released the energy from coal and natural gas reserves and nuclear power from the atom; used gasoline refined from petroleum to move cars, trucks, boats and planes; and harnessed the energy in water. Today, Virginia also uses more and more renewable energy resources.

Energy Sources

Energy sources are classified as renewable or non-renewable. Renewable resources can be re-used or replenished in a short amount of time. Non-renewable resources such as fossil fuels, by contrast, can be used up and will take millions of years and very special conditions to create them again. The Commonwealth has a variety of both forms of energy resources, most used to generate electric power.

Renewables

As Earth's supply of fossil fuels continues to decrease, people are turning to other sources of energy. Self-replenishing sources like sunlight, wind, tides, biomass and geothermal heat are all potential forms of renewable energy. These renewable sources of energy generally do not produce much if any pollution and they can contribute to energy security and independence, both from reliance on foreign oil and sometimes from reliance on the electric grid.

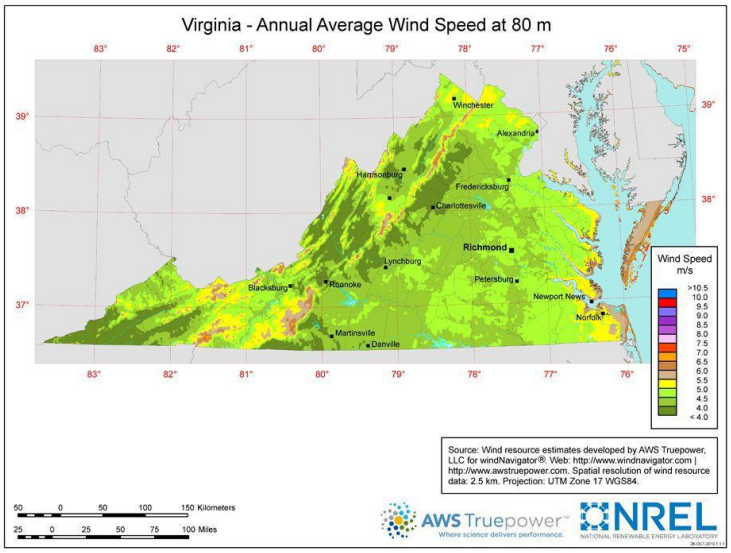
Virginia's viable and existing renewable resources include:

- Wind, both on-shore and off-shore
- Solar thermal for heating air and water
- Solar photovoltaic (PV)
- Biomass, waste-to-energy, landfill and waste water treatment gas
- Hydropower
- Low temperature geothermal

Wind Energy - ***Onshore*** wind is a well-established technology and industry. In 2013, the U.S. had 61,091 Megawatts (MW) of onshore wind capacity, second only to China. Wind only generates electricity when wind speeds are sufficient to turn the turbine blades and because wind is intermittent and unpredictable, sufficient other generation assets must be available to ensure that energy power requirements are met.

In general, wind speed increases as the height above the ground increases and the amount of clearance of obstructions like trees and buildings increases. Virginia has an onshore wind resource potential of 1,793 MW, capable of providing clean renewable power to thousands of Virginia homes and businesses. The most promising *onshore* wind resources are in the Western part of the State, along mountain ridges. Wind projects have relatively high capital costs, but benefits from low operating costs and zero fuel costs for the life of the project. Because the fuel (wind) is free, electricity from wind is not subject to escalating fuel costs.

Virginia Wind Resources Map



Offshore wind has the potential to provide the largest renewable energy resource for Virginia. The State is unique with a shallow continental shelf that extends out 30 miles. With its nearness to power users, a trained work force and good sea ports, offshore wind can provide substantial benefits to the State.

The State is currently working with partners to develop and test its first utility-scale wind power operation. In 2013, Dominion Virginia Power won the opportunity to lease 112,800 acres off the Virginia coast to develop offshore wind power with the potential to generate up to 2000 megawatts, or enough to electricity to power 500,000 homes. This project is currently under development.

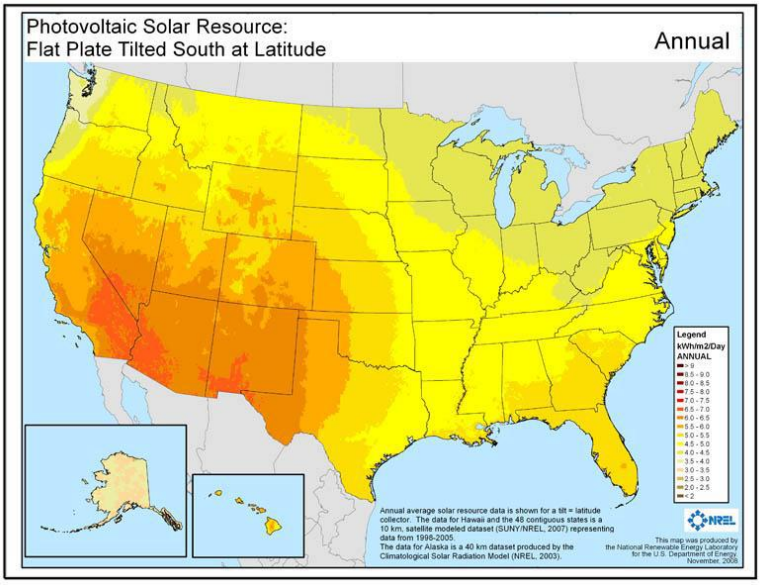
Solar Thermal Energy – Solar heating & cooling (SHC) technologies collect the thermal energy from the sun and use this heat to provide hot water, space heating, cooling and pool heating for residential, commercial and industrial applications. The SHC technologies displace the need to use electricity or natural gas. Large community swimming pools normally heated using oil or propane and institutional facilities such as college dormitories and health care facilities are ideal applications of solar thermal systems.

Photovoltaic (PV) Energy - Photovoltaics are a well-established, commercial technology that converts sunlight into direct current (DC) electricity. PV devices generate electricity directly from sunlight via an electronic process that occurs naturally in certain types of material, called semiconductors. Specially treated semiconductor materials interact with photons from the sun to free up electrons to flow in an electric current. There are numerous semiconductor technologies used to manufacture PV

products. The most common is silicon, which is a primary component in sand and the second most common element on earth.

PV is an evolving technology, with incremental efficiency gains each year. As technology and manufacturing methods improve, costs continue to come down. PV industry jobs include work in cell and module manufacturing; assembly and installation, sales and distribution; and project development. In 2013, the U.S. solar industry directly employed over 142,000 people, with the largest concentration in installation (21 percent), sales and distribution (14.2 percent), manufacturing (8.6 percent), project development (3 percent) and the remainder in various supporting activities (16.1 percent).

Solar Resources Map



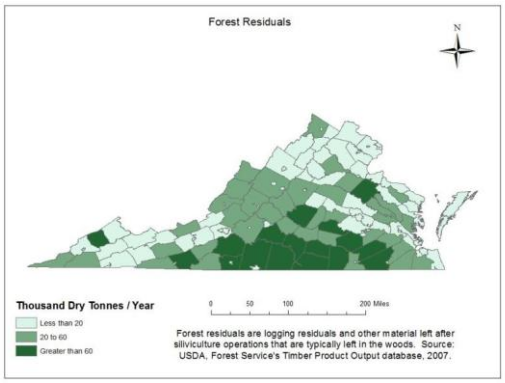
Biomass Energy - Biomass is any organic material that can be used as a bioenergy feedstock. The *Code of Virginia* defines biomass as agricultural and forest-related materials, animal wastes, mill residues, urban woody wastes, purpose grown energy crops, landfill and wastewater gas, biosolids and municipal solid waste. The moisture content of the material typically determines the way it can best be used. The higher the moisture content, the lower the heating value when used in combustion processes, as a portion of the energy in the fuel is expended in driving off the water. High moisture content feedstocks are more suitable for anaerobic digestion to generate biogas.

Biomass resources in Virginia include:

- *Forest residues*, most plentiful in Southside Virginia and in the Coastal Plain are the tops and branches of trees harvested for timber, along with dead, diseased, poorly formed and other non-merchantable trees that would otherwise be left in the woods;
- *Mill residuals*, left over after mills take harvested logs and process these into primary wood products such as pulp, lumber, plywood, posts, etc. Primary mill residues include the coarse and fine wood material (slabs, edgings, trimmings and sawdust) and bark remaining after initial processing. The greatest volume of residues production is concentrated in Alleghany, Amelia, Greensville, Hanover and Isle of Wight Counties. Primary mills will either use their residues as fuel in their own boilers or have secondary markets for fuel or raw materials at other locations. Recently harvested wood that is green has a relatively high moisture content and consequently lower energy content.
- *Urban Wood Wastes,* Yard and other wood residues derived from municipal solid wastes (MSW), highway rights-of-way and utility clearings, debris from private tree companies and construction and demolition (C&D) sites.
- *Agricultural Crop Residues* are another sizable source of potential biomass fuels, comprised of post-harvest residuals are generated annually from the production of barley, corn, oats, peanuts, sorghum, soybeans and wheat. These residues include corn, peanut, sorghum and soybean stover (leaves and stalks) and barley, oats and wheat straw. Crop residues are typically used for grazing, animal bedding and silage and, like forestry residuals, retention of crop residues on the land is important for soil health.
- *Energy Crops*, grown specifically for use in energy generation, including energy tree crops like hybrid willows and poplars that can be produced on rotations as short as four to six years; and annual native warm season grasses, primarily switchgrass and the exotic miscanthus. In Southside Virginia, a nascent energy crop industry is developing in and around Nottoway County, led by the bioenergy pioneers at the Piedmont Geriatric Hospital (PGH). PGH, which has been heating with sawdust in its boilers, sourced from local mills for several decades, is switching to pelletized native warm season grasses, bringing considerable cost savings to the Commonwealth. Grasses grown and harvested within 50 miles of Blackstone are brought to a processing center located just outside of Fort Pickett where they are aggregated, ground and pelletized for use as boiler fuel and animal bedding. New markets for energy crops, whether grasses or trees, can expand acres of perennial land cover. In areas of the Commonwealth within the Chesapeake Bay Watershed, where local

governments must develop strategies to meet total maximum daily load (TMDL)42 targets, bioenergy production could synergize with their compliance efforts (through establishment of riparian buffers and conversion of row crops to permanent land cover, as the most effective practices for improving water quality).

- *Wet Biomass* - Since wetter material has a lower heating value when combusting, high moisture content biomass feedstocks are more appropriately suited for anaerobic digestion. Animal manures, the wet portion of municipal solid waste and waste water treatment plant effluent can be anaerobically digested to produce a biogas that can be burned directly to generate heat or run through an internal combustion engine to generate electricity.



Hydroelectric Power - Hydropower projects are long-lived assets, with a few projects operating for 100+ years. Nationally, water is currently the leading renewable energy source used by electric utilities to generate electric power. Like solar and wind they have no direct fuel costs, so delivered energy costs depend on the capital equipment and water availability. Once installed, these generators emit no greenhouse gas or other pollutants and do not generate solid or hazardous wastes.

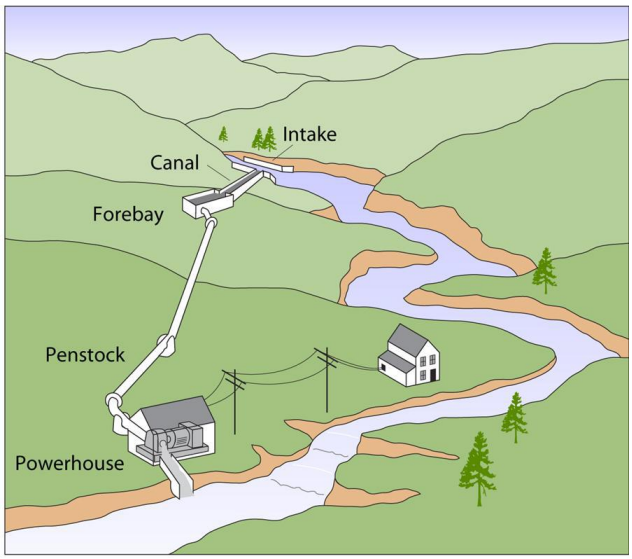
There are several types of hydroelectric facilities currently used. The most common hydroelectric plant uses a dam across a river to create a reservoir at a higher elevation than that of the undammed river. This height differential allows water to flow at high pressure and velocity through the blades of a turbine connected by a shaft to an electric generator that creates electricity. The water then exits the facility at the lower elevation of the original river.

Another type**,** a pumped-storage plant, uses two reservoirs at different elevations. To generate electricity, water flows through the turbine to turn a generator and exits into the lower reservoir. During periods of low electric

demand, however, such as at nights, the turbines, using electricity from the grid, act as pumps to move water from the lower back up to the upper reservoir. Because power, typically from non-renewable energy sources, is used for pumping mode, only the net generation over and above what is used to pump the water can be considered renewable. Pumped storage is a way to smooth out the intermittent nature of other renewables like solar and wind.

A third type of hydroelectric plant is called —run-of-river, in which a portion of a river is diverted to flow through a channel or a pressurized pipeline, or *penstock*, to turn a turbine. Because run-of-river plants typically do not involve large dams, they are considered more environmentally-friendly because they don't require flooding valleys to create large reservoirs.

Run-of-River Power Plant



Generating electricity using water has several advantages. A major advantage is that water is a source of cheap power. Like solar and wind power, the —fuelǁ is free and since there is no fuel combustion, there is no air pollution. Like other energy sources, the use of water for generation has limitations, including environmental impacts caused by damming rivers and streams, which affects the habitats of the local plant, fish and animal life.

Virginia is home to 24 conventional hydropower facilities with a combined capacity of 439 megawatts and two pumped storage facilities with a combined capacity of 3659 megawatts. The Bath County Pumped Storage Facility, jointly owned by Dominion and the operating companies of the Allegheny Power System, make up the bulk of Virginia's pumped storage and is the second largest pumped storage facility in the world.

Geothermal Energy - Geothermal energy is the heat produced by and contained within the earth. It can be used as a clean, reliable and renewable energy resource. It is an efficient heating and cooling alternative for residential, commercial and industrial applications and is potentially a significant source for electrical power generation in some regions of the United States.

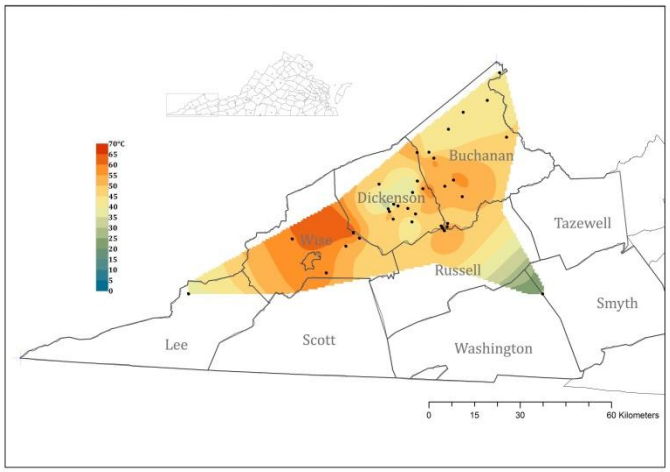
In the western United States, geothermal energy is commonly associated with hot springs and geysers where high-temperature geothermal reservoirs form in areas of relatively recent volcanic and earthquake activity. In these locations, groundwater circulates deep into permeable bedrock picking up heat and bringing it close to the surface creating a high geothermal gradient. Several of these reservoirs have been developed for commercial applications including direct heating, food dehydration, aquaculture and electrical power generation.

In the relatively stable geologic environment of the eastern United States, heat-generating rocks are much deeper and geothermal gradients tend to be lower. Yet opportunities exist for developing lower-temperature geothermal resources that may include direct use, geo-exchange systems, co-produced geothermal with oil and gas resources and enhanced geothermal systems (EGS).

In Virginia, thermal springs in Bath and Alleghany Counties have long been utilized as spas and resorts, providing a direct use geothermal resource to the public since the 1760s. These hot springs originate from water that was heated deep within the Earth's crust and transported relatively quickly to the surface along geologic faults and fractures.

In Virginia's coal and gas producing regions, warm water is often a by-product of fossil fuel production and is generally considered a waste product. New developments in binary geothermal power generation utilizing lower temperature resources may make it feasible in the near future to co-produce geothermal energy along with traditional fossil fuel resources. Generally, the amount of water produced with natural gas in the Southwest Virginia Coalfield region is very small, yet the possibility of geothermal co-production from wells with higher water volumes, depleted gas wells, or underground mine sites remains untested.

Ground Temperature Gradient in Southwest Virginia

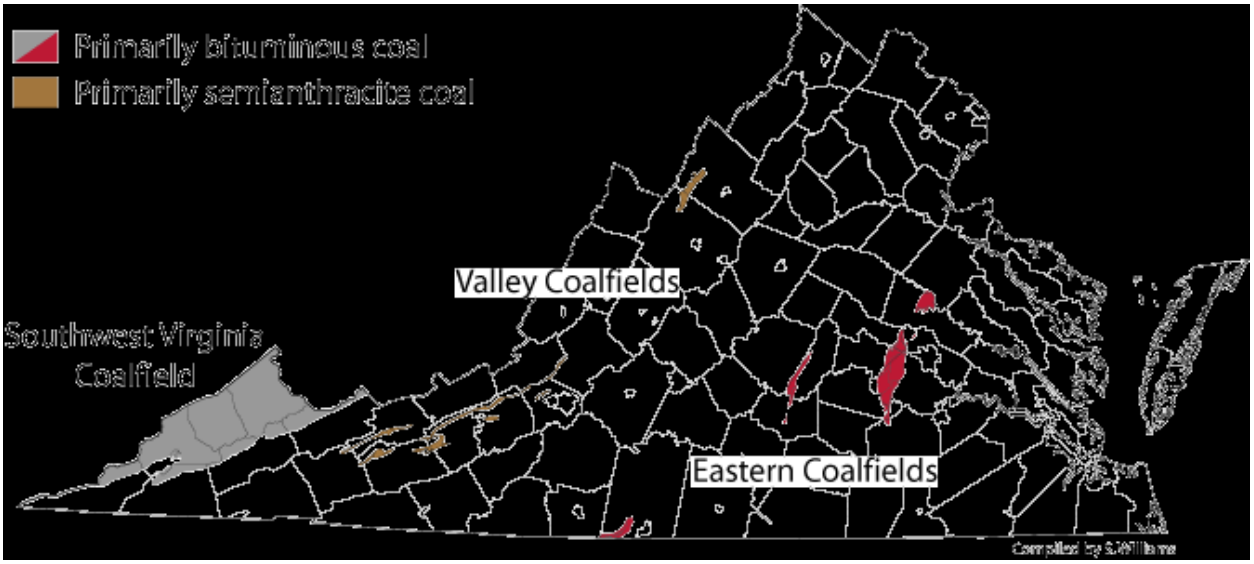


Non-Renewables

Virginia continues to get much of its energy from non-renewable energy sources. The State has large coal and natural gas deposits, used primarily to generate electricity.

Coal - Virginia coal was first commercially produced near Richmond in 1738. Local industries at the time used it in iron foundries and black-smithing. 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's Coalfields



Virginia coal production peaked at 46.6 million tons in 1990. Production decreased in Virginia from 30 million tons in 2002, to 19 million tons in 2012. The gradual decline is the result of the depletion of the more productive (thick) and easily-mined coal seams that have lower mining costs. In 2013, fifty-one Virginia mining companies produced 17 million tons of coal, ranking the State 14th in production, nationwide. Two companies produced nearly eight million tons, accounting for 45 percent of 2013 production. Virginia coal is exported from terminals in the Port of Hampton Roads to Europe, South America and the Far East.

Natural Gas – There are three types of natural gas produced in Virginia. Virginia produces both conventional natural gas and coal bed methane (CBM) in the Central Appalachian Basin, which covers the State's western panhandle. Conventional gas is produced from Devonian (354 to 417 million years old) shales and Mississippian (323 to 354 million years old) limestones and sandstones of the Appalachian Basin. CBM is produced from coal seams in the Norton, Lee (New River) and Pocahontas Formations of Pennsylvanian Age (290 to 323 million years old) in the same region. Most of Virginia's natural gas production comes from coal bed methane fields, two of which are among the 100 largest natural gas fields in the United States.
Virginia's 21 natural gas exploration and production companies produced 147.3 BCF of natural gas from 7,400 wells in 2013. This amount is equal to 39 percent of the natural gas consumed in Virginia in 2010.

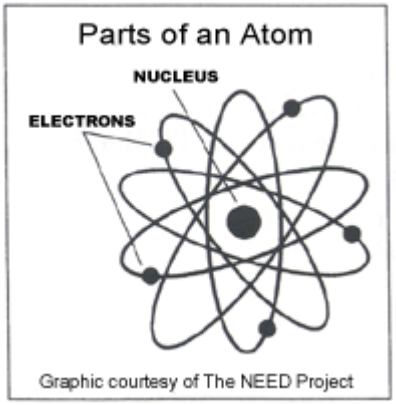
The third type is landfill gas. Virginia currently has 33 landfills that are capturing, converting and using landfill gas (LFG) as an energy source. Twenty-five of these landfills are generating electricity and have a combined capacity of 94.5 megawatts. Three LFG projects are under construction and 38 landfills are either candidates or potential sites for projects. LFG projects are operational, under construction or planned in 54 counties from Eastern Shore to Southwest Virginia.

Petroleum - Petroleum is a broadly defined class of liquid hydrocarbon mixtures which includes crude oil, lease condensate, unfinished oils, refined products from the processing of crude oil and natural gas plant liquids. Although Virginia oil and gas operators produced 11,508 barrels of oil in 2010 from wells located in Lee, Wise and Russell Counties, this is equivalent to less than one percent of the State's annual consumption and this production is typically shipped to refineries in Kentucky for processing.

Most of the petroleum consumed in Virginia comes from other states and countries. Approximately 92.9 million barrels of motor gasoline, including ethanol blends, were used in 2012, which comprised 60.9 percent of the total petroleum usage for the year. Heating oil was the second largest use, with approximately 34.3 million barrels or 21 percent of the total. Smaller amounts were used for aviation (16.9 million barrels or 11 percent) and residual fuel oil (1.9 million barrels or 1.3 percent), while propane accounted for the remainder of just over 3 percent or 4.8 million barrels.

Nuclear Energy - Another non-renewable energy source harnessed by Virginians is nuclear power. Processed Uranium fuel is used to generate electricity at four nuclear units in operation in Virginia. All four are operated by Dominion. Two units are located at the North Anna Power Station in

Louisa County and two are located at the Surry Power Station in Surry County. These two nuclear plants provided 38 percent of the net electricity generated in Virginia during 2013. These power plants utilize nuclear fission reactions to generate heat that drives steam turbines to create large amounts of electricity, used by residential and commercial customers throughout the State.



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 and rivers crossing the State, we will 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.

Conservation in Action

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

Save Electricity

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

Save Heat

- If the heat is running, keep doors and windows closed.

- Wear warm clothes instead of turning up the thermostat.
- At night, use blankets to stay warm.
- When you take a bath, use only the water you need.
- Take a quick shower. (Heating water uses energy.)

Save Gasoline

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

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.

Additional Resources

Geology & Minerals

Web Sites:

- **College of William and Mary**
- **University of North Carolina, Chapel Hill**
- **U.S. Geological Survey**
- **Virginia Division of Geology and Mineral Resources**
  https://www.dmme.virginia.gov/DGMR/divisiongeologymineralresources.shtml

Energy

Web Sites:

- **Virginia Energy Plan**
  https://www.dmme.virginia.gov/DE/2014_VirginiaEnergyPlan2.shtml

Fundamental Concepts Related to Mineral Resources

- Mineral resources are the raw rock and mineral deposits extracted from the earth to produce industrial and consumer goods.
- Virginia's geology and mineral resources are intertwined. Virginia's mineral resources are the result of ancient geologic processes and and

the presence of minerals can be predicted by understanding those processes.

- From riding a bicycle to salting a French fry, we depend upon mineral resources every day of our lives.
- 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 Concepts Related to Energy Resources

- Energy is involved in everything we do.
- There are basic advantages and disadvantages of using the ten major energy sources, including environmental and economic trade-offs.
- We use a lot of energy to support our lifestyle in the United States.
- Analysis of economic and environmental impacts helps determine the energy sources we use.