

CURRENT TOPIC STUDY GUIDE

Renewable Energy for a Sustainable Future

There will be no oral presentation this year. The current topic portion of the competition will be a written test. All test questions will come from the material below.

OVERVIEW

Georgia has the largest land area of any state east of the Mississippi River. Located on the Atlantic coast at the southern end of the Blue Ridge Mountains in the Appalachians, elevations in northwestern Georgia rise to almost 5,000 feet. Between the mountains and the ocean are the rolling hills of the Piedmont region and Georgia's broad coastal plains.¹ Despite its location near the Appalachian coalfields and oil and natural gas basins, Georgia does not have any significant fossil fuel reserves.² Nuclear power supplies slightly more than half of the primary energy produced in Georgia, and the rest comes from renewable resources, specifically biomass, solar energy, and hydropower.³ Two-thirds of the state is forested and Georgia leads the nation in commercial timberland.^{4,5} The state has many wood processing mills, wood-fueled power plants, and wood pellet manufacturers.^{6,7} Although most of Georgia's natural lakes are in the southern part of the state, the larger, man-made lakes and reservoirs that provide hydroelectric power are concentrated in the river valleys of the north.⁸ Georgia's solar potential is among the highest in the Southeast, but the state has little onshore wind energy potential.^{9,10} However, there are large areas with substantial wind energy resources in the Atlantic Ocean off Georgia's coast.

Georgia ranks among the top 10 states in the nation in total energy consumption, but, with its large population (eighth-highest in the nation), the state's per capita energy consumption is lower than in three-fifths of the states.^{12,13,14} The transportation sector accounts for the largest share of Georgia's end-use energy consumption.¹⁵ Major interstate highways and Atlanta's international airport helped make Georgia's transportation sector fifth in the nation in energy consumption in 2020.¹⁶ The industrial sector accounts for the second-largest share of state energy use, followed closely by the residential sector.¹⁷ Georgia has several energy-intensive industries, including the manufacture of food, beverages, tobacco products, chemicals, and paper.^{18,19} With Georgia's warm and humid climate, air conditioning is widely used, and the residential sector's per capita energy consumption is above the national average.

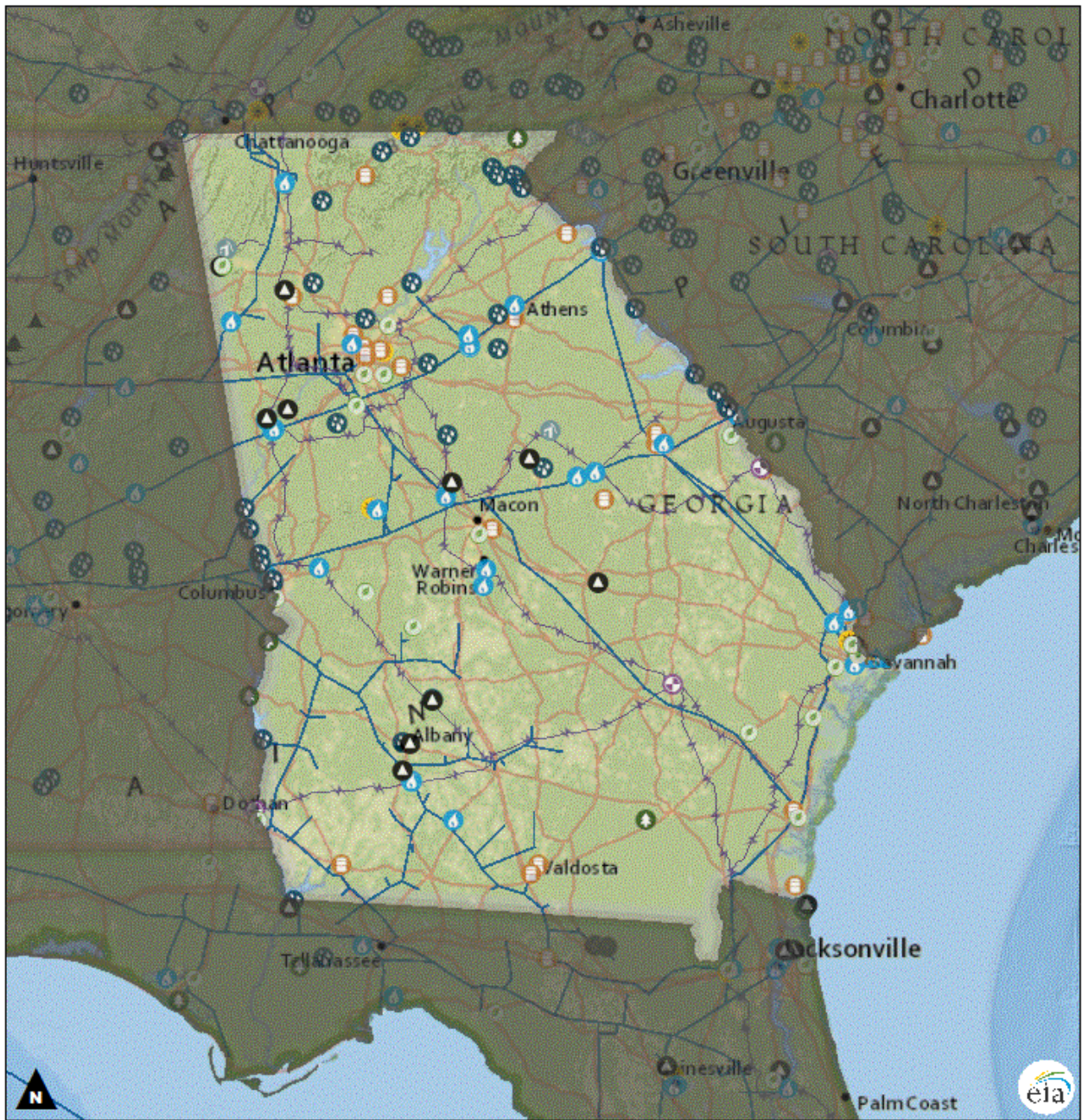
RENEWABLE ENERGY

In 2021, renewable resources accounted for more than one-tenth of Georgia's total in-state electricity net generation, and two-fifths of that generation came from biomass, primarily wood and wood-derived fuels.³⁸ The state led the nation in the use of wood and wood-derived fuels for electricity generation and in the amount of generation from all biomass resources.^{39,40} About 22 million acres of Georgia's 24 million acres of forest are available for commercial use, and there are many wood product manufacturing plants in the state. Georgia has 6 wood pellet manufacturing plants, including the nation's largest with a capacity of 826,733 tons per year. Georgia's combined wood pellet production capacity is more than 1.8 million tons per year.^{41,42,43} The state is also one of the nation's top wood pellet exporters. Most of the wood pellet exports go to Europe, where they are used as fuel for electricity generation.

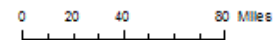
Solar energy provided more than one-third of Georgia's in-state renewable electricity net generation in 2021, almost all of it from utility-scale facilities with greater than 1 megawatt of capacity.⁴⁷ By late 2022, Georgia had nearly 3,300 megawatts of utility-scale solar PV capacity, and another 1,000 megawatts are expected to be operational by the end of 2024. The 14 largest solar facilities in the state each have capacities of 100 megawatts or more. The four largest came online since the beginning of 2020.⁴⁸ Electricity generation from utility-scale and small-scale (less than 1-megawatt) solar PV in combination more than doubled in the three-year period between 2019 and 2021. Less than one-tenth of the state's solar generation comes from small-scale customer-sited installations, such as roof-top panels.⁴⁹

With 14 river basins and thousands of dams, Georgia has abundant hydroelectric power resources.^{50,51} The state has 29 conventional hydroelectric power plants and 4 hydroelectric pumped storage facilities.⁵² In 2021, about one-fourth of Georgia's electricity generation from renewable resources came from conventional hydroelectric power.⁵³ The state was the sixth-largest hydroelectric power producer east of the Mississippi River and the 14th-largest producer of hydroelectricity in the nation.⁵⁴ Georgia's hydroelectric pumped storage facilities supplement state power in periods of high electricity demand. During periods of low demand for electricity, water is pumped from a lower reservoir to an upper reservoir using relatively inexpensive power. The water is released from the upper reservoir in periods of high demand, generating electricity as the water flows back through turbines on its way to the lower reservoir. Although pumped storage facilities use more power than they generate, they can supply power in periods of peak demand when it is needed.⁵⁵

Georgia has no utility-scale wind-powered electricity generation.⁵⁶ The state has limited onshore wind energy potential, all of it in small areas on the mountain ridges along the state's northern border and in a narrow strip along the state's 100-mile Atlantic coastline. However, Georgia has significant wind resource potential offshore in the Atlantic Ocean.^{57,58}



Grey Base: National Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, USGS,



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|--------------------------|----------------------------------|-------------------------------|
| ■ Mask | ⊗ Hydroelectric Power Plant | ⬆ Pumped Storage Power Plant |
| ▲ Surface Coal Mine | ⊕ Natural Gas Power Plant | ☀ Solar Power Plant |
| ▴ Underground Coal Mine | ⊕ Nuclear Power Plant | ⊗ Wind Power Plant |
| ⊕ Biomass Power Plant | ● Other Power Plant | ⊕ Wood Power Plant |
| ⊗ Coal Power Plant | ⊕ Other Fossil Gases Power Plant | ⊕ Petroleum Refinery |
| ⊕ Geothermal Power Plant | ⊕ Petroleum Power Plant | ⊕ Strategic Petroleum Reserve |

<http://www.eia.gov/state/>

[Solar Energy Basics | NREL](#) (watch video and be familiar with the basic information about the 5 solar technologies – Solar Photovoltaic, Passive Solar, Solar Water Heating, Solar Process Heat & Concentrating Solar Power)

Watch the following videos:

[Bing Videos](#) What is Renewable Energy

[Bing Videos](#) Why Small Towns are Fighting Renewable Energy Development

WIND ENERGY

Georgia's solar potential is among the highest in the Southeast, but the state has little onshore wind energy potential. However, there are large areas with substantial wind energy resources in the Atlantic Ocean off Georgia's coast.

[Wind Energy Explained - Knowledge Bank - Solar Schools](#) (be familiar with information on this website – students are not responsible for information under any links or tabs)

[Offshore Wind for America \(environmentamerica.org\)](#)

[11 Reasons Wind Energy Will Work for Georgia - SACE | Southern Alliance for Clean Energy](#)[SACE | Southern Alliance for Clean Energy](#) (be familiar with the 11 reasons)

[New report shows Georgia has significant offshore wind potential \(environmentamerica.org\)](#)

[Statement: Fed govt. approves nation's largest wind farm off Virginia's coast \(environmentamerica.org\)](#)

GEOTHERMAL ENERGY

[Geothermal Energy - Knowledge Bank - Solar Schools](#) (be familiar with facts on this site)

[Geothermal Energy Factsheet | Center for Sustainable Systems \(umich.edu\)](#) (be familiar with facts on this site)

[7 Examples Of Geothermal Energy \(Untapped Power\) \(surgeaccelerator.com\)](#) (be familiar with facts on this site)

[First Fully Geothermal Community in US Located in Georgia \(renewableenergymagazine.com\)](#) (news article)

<https://youtu.be/DFQrE91kZwk> (video)

[Climate change geothermal energy cost savings at GA military bases \(savannahnow.com\)](#) (news article)

[Jamie Beard: How can we tap into the vast power of geothermal energy? | Georgia Public Broadcasting \(gpb.org\)](#) (listen to TED Radio Hour Episode part 3)

[Giant solar farms proving a mixed bag for rural Georgia | Georgia Public Broadcasting \(gpb.org\)](#) (news article)

BIOMASS

<https://www.solarschools.net/knowledge-bank/renewable-energy/biomass>

What is biomass? Biomass is organic matter – anything that is alive or was a short time ago - that can be used as an energy source. Examples of biomass include wood, crops, seaweed and animal waste. Biomass gets its energy from the Sun and is a renewable energy source. Simply put, biomass is anything that is or once was alive (also known as 'organic matter'). So biomass can be wood from trees, plants such as crops and seaweed, or animal waste.

Where does biomass get its energy from?

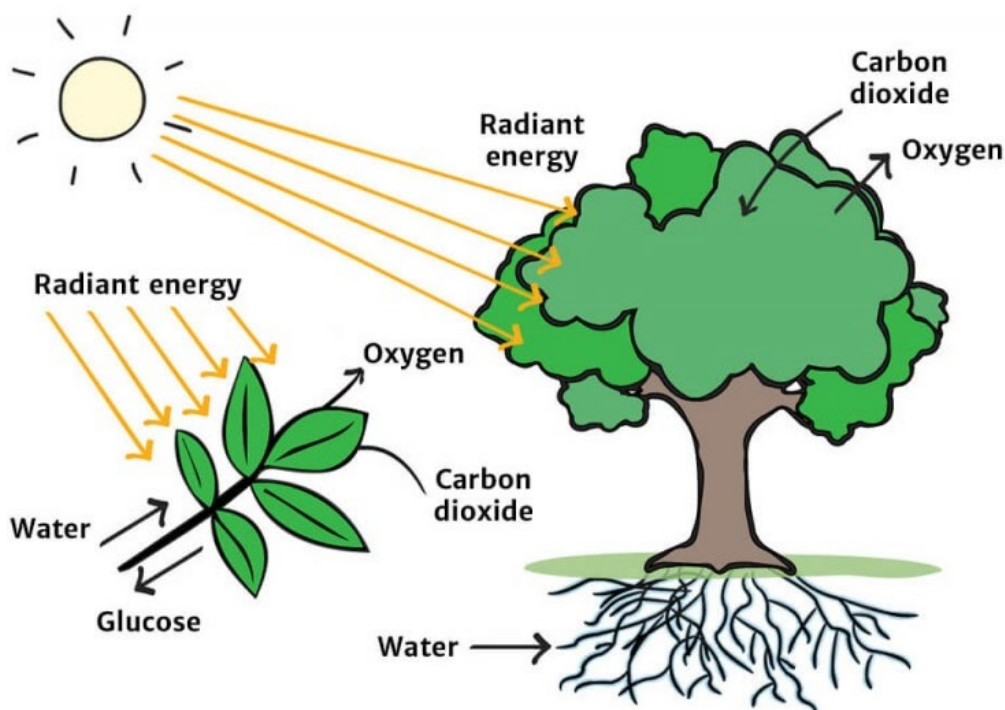
All organic matter contains energy stored from the sun – this is where the energy in biomass comes from. Plants store energy from the sun in their leaves, stems, fruit and roots. When humans eat food that comes from plants, we use the energy they contain to move and grow.

How is biomass used?

Burning biomass – such as wood and garbage – produces heat, which can be used in homes, for cooking, and for industrial purposes. Burning biomass can also generate electricity. In 'waste-to-energy' plants, organic waste is burned to provide electricity – by removing the waste products, this also saves on landfill space. It's a biomass bonus! Biomass can be used to produce a gas called methane, which is used in stoves and furnaces. Biogas is a gas produced from burning waste products, which can be used to light homes and cook food. Biomass can also be turned into fuels called ethanol and biodiesel, which can be used in many types of vehicles

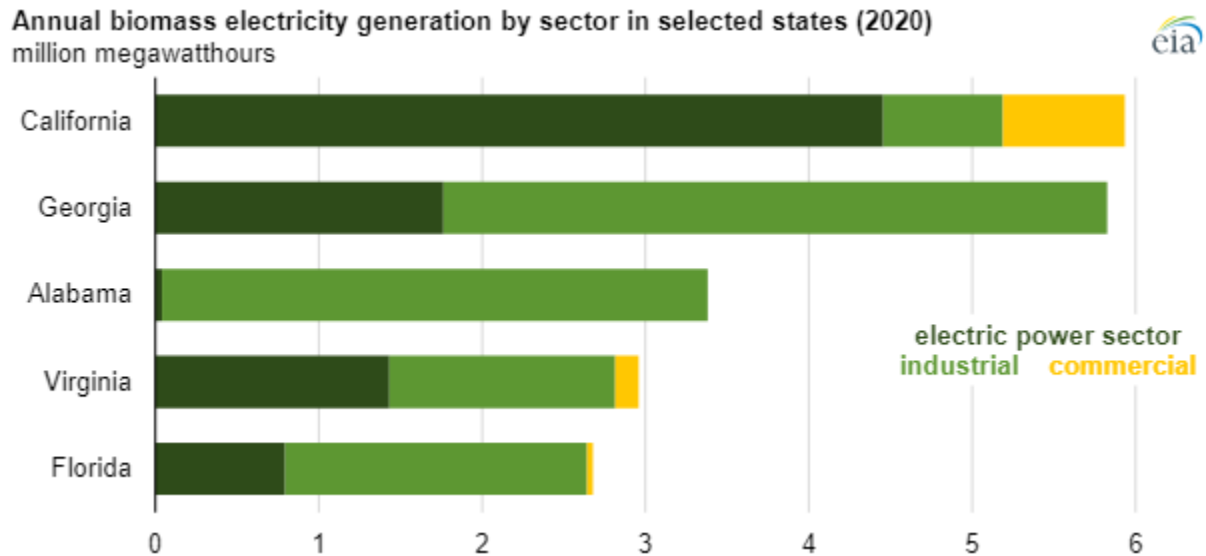
Biomass is 'organic matter' – anything that is or was alive. This includes trees, plants, crops and animal waste. Biomass energy comes from the sun. Photosynthesis is the process used by plants to convert sunlight into the chemical energy they need to grow. Renewable energy comes from a source that will never run out. Biomass energy is renewable because we can grow more plants to produce it.

Bioenergy Photosynthesis



<https://www.eia.gov/todayinenergy/detail.php?id=47516>

More electricity is generated in Georgia from biomass than in any state except California.



In 2020, Georgia generated 5.8 million megawatt hours (MWh) of electricity from biomass, or about 10% of the nation's total, the second most of any state according to EIA's Electric Power Monthly. Almost 5% of Georgia's in-state electricity generation in 2020 came from biomass, mostly wood and wood-derived fuels, a share that ranked sixth in the nation. Biomass accounted for nearly half of Georgia's total renewable electricity generation in 2020.

Generation of electricity using biomass in Georgia has grown by over 80% since 2010; almost 400 megawatts of capacity has come online at 16 different facilities in the past 10 years. Nearly 70% of Georgia's biomass electricity generation came from the industrial sector, compared with 47% of industrial sector biomass generation as a national average in the United States. Many industrial sector generators use lumber and paper mill waste to produce steam and electricity to reduce the amount of other fuels and electricity needed to operate their facilities. The rest of Georgia's electricity generation from biomass came from the electric power sector.

Biomass is renewable organic material that comes from plants and animals. In addition to using wood, agricultural waste, municipal solid waste, and animal manure are biomass materials that can be used to generate electricity. Biomass contains stored chemical energy from the sun. Biomass can be burned directly for heat or converted to renewable liquid and gaseous fuels through various processes.

Georgia's 25 million acres of forested land covers two-thirds of the state. About 24 million acres of this land is available for commercial use. Biomass resources contribute to Georgia's economy in many ways, including many wood processing mills, wood pellet manufacturers, and paper mills.

Wood solids primarily consist of residues from forestry, lumber production and manufacturing, paper mills, and other allied industries, and they are used to produce heat and electricity in the electric power and industrial sectors. Georgia is a leading exporter of wood pellets, sent mostly to Europe, where wood pellets are used to generate electricity as an alternative to coal.

Bio Mass Videos

<https://www.youtube.com/watch?v=uqbdQXvwr-U>

https://www.youtube.com/watch?v=nVl17JLn_u0

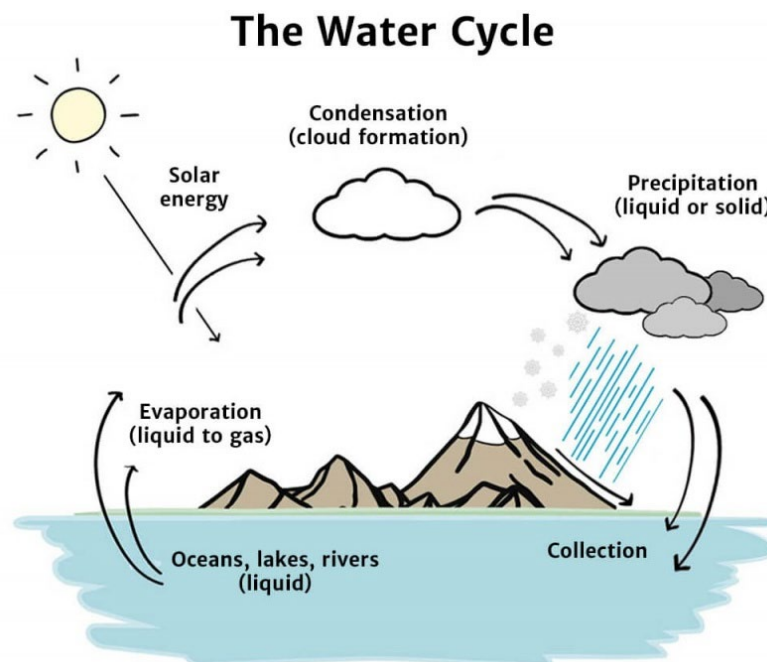
HYDROPOWER ENERGY

Hydropower is energy produced from the force of moving water. This force can be extremely powerful and is driven by gravity. Hydropower plants use this energy to produce electricity. Hydropower comes from the Greek word "hydro", which means "water". The energy in hydropower comes from the force of moving water.

What is the Water Cycle?

The Water Cycle is a continuous natural cycle that involves the fall and movement of water.

Here's how it works: The Sun's energy evaporates water from oceans and rivers, drawing it upwards as water vapor. As the water vapor rises and reaches cooler air, it condenses and forms clouds. The moisture in the clouds eventually falls back down to Earth in the form of rain or snow, replenishing the water in the oceans and rivers.

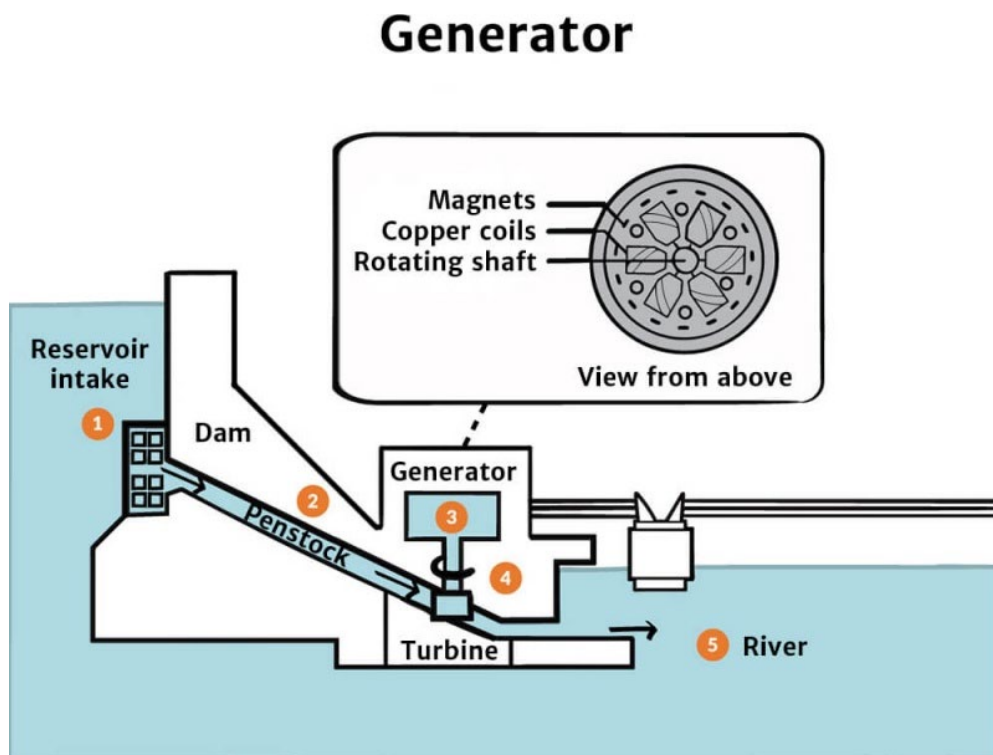


What causes water to move?

The reason that water moves from high ground to low ground is due to gravity, which drives the movement of water. The force of moving water can be extremely powerful.

How is hydropower converted to electricity?

Hydropower is used to generate electricity in hydropower plants. A typical hydropower plant system has three parts: A power plant where the electricity is produced. A dam that can be opened or closed to control the flow of water. A reservoir where water is stored



What affects the amount of electricity that can be generated in a hydropower plant?

This is determined by two factors: head and flow. Head is how far the water drops. Picture it as the highest level of the water in the dam, to the point where the water enters the power-producing turbine. Flow is how much water moves through the system – the more water, the higher the flow. Generally, a hydropower plant with a high head needs less water flow than a plant with a low head to produce the same amount of electricity. Hydropower is energy that comes from the force of moving water. Hydropower plants convert the energy in moving water to electricity.

The Water Cycle is a continuous natural cycle involving the fall and movement of water. Evaporation is the process of liquid turning to gas. The sun evaporates water (liquid) from the oceans and rivers and turns it into vapour (gas).

Condensation is the process of gas turning to liquid. As it cools, water vapour (gas) turns to moisture (liquid) to form clouds. Precipitation is when rain, snow or sleet falls to the ground from clouds

<https://www.youtube.com/watch?v=rnPEtwQtmGQ>

<https://www.energy.gov/energysaver/articles/energy-101-video-hydroelectric-power>

Hydropower in Georgia

<https://www.georgiapower.com/company/energy-industry/generating-plants.html>

Hydro was once the principal source of power in the United States. These facilities played a significant role in spurring Georgia's industrial development and continue to produce power today.

Georgia Power owns 15 lakes for hydroelectricity generation which, combined, offer thousands of acres of shoreline with public access areas. Enjoy everything from swimming to hiking trails, and see the beauty of our state.

Georgia Power sources about 2% of its electricity from hydropower plants.