Browns Ferry Nuclear Reactor and the EPA

Lesson Outline

* Formative Assessment
	+ Twitter Board
		- The students will get a sheet of paper and make it into three small strips
		- On the first strip, students will answer “What do you think TVA does and why is it important?”
		- The students will have to answer in 140 characters or less just like Twitter.
		- Next, the students will use another strip of paper and answer “What does the Environmental Protection Agency do?” in 140 characters or less.
		- Lastly, the students will use their last strip of paper and answer “How could these two organizations be linked together?”
		- Pin the small strips of paper to a poster or cork board to resemble a Twitter feed.
		- This will get the students active and involved in the lesson to get them prepared for the day.
1. TVA
	1. TVA officially was organized after the Great Depression. TVA helped improve the life of people living in the Tennessee Valley by providing flood control, navigation, and affordable electricity.
	2. President Roosevelt created a New Deal plan and within this plan included the Tennessee Valley Authority Act.
		1. TVA acquired the government facilities at Muscle Shoals when the TVA Act was signed in 1933. The facilities included Wilson Dam, Wilson Steam Plant and two nitrate plants.
	3. TVA was officially designed to help modernize and rejuvenate this area into an industrial region.
		1. Why was TVA so beneficial to these areas? What people did they help?
	4. TVA was the first hydroelectric federal power source and today is the nation’s largest federal power system.
		1. Why were Nuclear Power Plants created?
2. TVA Browns Ferry
	1. TVA Browns Ferry began construction in 1966 and the first unit began providing electricity in 1974.
		1. Browns Ferry was TVA's first Nuclear Power Plant.
		2. Browns Ferry is TVA's largest nuclear site and is the first to have boiling water on site.
	2. It is located between Wheeler Reservoir and Athens, Alabama.
		1. Browns Ferry employs more than 1,400 people. TVA employs more than 10,000 people.
		2. Browns Ferry got its name from a family in Lawrence County.
	3. There are two types of nuclear power plants that can make energy
		1. What are the two types of nuclear power plant reactors? Pressurized and Boiling water
		2. TVA Browns Ferry is a boiling water reactor.
	4. TVA's nuclear power plants generate almost 40% of all TVA electricity.

Watch the Nuclear Reactor Animation here

 <https://www.tva.com/Energy/Our-Power-System/Nuclear/Browns-Ferry-Nuclear-Plant>

* + 1. Nuclear Power is produced when the atoms are split.
		2. How do you think TVA gets these atoms to split? They throw neurons at them.
		3. This process is called nuclear fission.
			1. This process creates steam which is used to turn the turbine blades, which spins the plant generator to create the energy.
	1. At Browns Ferry nuclear plant, there are 3 units that are operating and creating energy.
		1. All three of these units can produce 3,400 megawatts of power.
		2. How many homes do you think that can power? 2 million.
	2. TVA Browns Ferry is very successful, however, there are always risks involving this type of energy creation.
		1. Environmentalists were concerned with what this type of process what doing to the surrounding environment.
		2. What do you think some of the main concerns were?
1. EPA
	1. The EPA was officially organized on December 2, 1970, and was put in place by President Richard Nixon.
		1. It was created to ensure that the environment was being monitored and protected by a specific organization.
	2. TVA and the EPA are in partnership as they work together to make sure that this area has clean, reliable, and affordable power.
		1. The project of the EPA and TVA Browns Ferry working together was prompted by the Clean Water Act in 1972.
		2. Why do you think the water needs to be clean?
	3. EPA wanted to find out how the release of the wastewater heat was affecting the fish and their food organisms.
		1. There were 3 water temperature types. What fish was the main concern for Alabama? The smallmouth bass.
	4. The EPA had a Clause put in the Clean Water Act, called the 316A Clause. With the increase of energy production facilities, specifically nuclear, the clause made sure that the facilities either put in cooling towers (which were very costly to run) or they could use the river water to cool the heated water.
		1. Why did there need to be cooling towers in the facilities?
	5. Even after the EPA was no longer involved, TVA continued to collect data.
		1. Where did the money for this project come from? Congress.
		2. They were able to use the river to cool the water instead of using cooling towers. This saved TVA about $15,000,000 - $20,000,000 a year for this one facility.
		3. Do you think changing the water temperature would help the environment?
2. Browns Ferry affecting water.
	1. The EPA did an experiment to test and see how much water temperature and what change in degrees affects the environment.
	2. In this study, they had 12 different channel streams which slightly changed the temperature and to record the change in the environment and wildlife.
		1. They had 3 channels at the same starting temperature.
		2. The next 3 they increased by 2 degrees for each different water channel.
			1. How could the Global Warming effect what TVA was doing at Browns Ferry?
	3. Because Browns Ferry Nuclear plant is an example of a large thermal discharge into a varying river environment, the EPA did several studies on the river water.
	4. How could warmer water affect algae growth?
		1. The EPA conducted a study also to observe how the thermal discharge of water affected the algae in these 12 channels.
	5. The EPA has identified several solutions to these problems if global warming continues to increase the river water temperature.
		1. What are some solutions that these facilities can do if global warming continues? Salt-Water facilities and Gas-powered plants.
3. Algae Project

First, we will discuss the history of Browns Ferry and why they needed to build the nuclear plant.

-Why was it important for the nuclear plant to be built?

Then we will talk about some of the effects the nuclear plant had on the environment

-Fish

-Macroinvertebrates

-Algae

We will discuss that it was important for the EPA to regulate this to make sure the nuclear plants were not harming the environment. What steps did they take to ensure this? (Without going into too much detail about their results)

In class, we will conduct our own experiment to see how temperature affects the growth of algae.

Algae growth in the classroom.

For the activity, we will split the students into groups of four or five.

Each group will prepare their bottles of algae. Once they have prepared their algae they will draw popsicle sticks to determine which groups get placed in which temperatures. The students will then write a hypothesis about their specific bottle and what they expect will happen once the week is over.

-Room temperature

-In a dark cabinet

 -Heat Lamp – direct light for 4 hours a day

-Sunlight – In the windowsill

Every morning the students will take notes on their bottles and write what the changes are or if they noticed any at all (1-3) sentences. The students will keep these notes for their records.

Once the week is up, we will discuss what the students hypothesized would happen, and finally what did happen. We will talk about how this relates to our previous topic.

-Which scenario had the most overgrowth of algae?

How is this like the algae growth with the nuclear plants?

-What would happen when the seasons change?

-What is Alabama weather like that could increase or decrease this?

Now that they can see the algae and how it grows, we will talk about the negative effects of it and how it could be cleaned up.

-What are some negative effects that could come from the overgrowth of algae?

-What do you think would be impacted the most?

-What is positively affected by this?

At this point, I would discuss the results found by the EPA during their study.

-Were these results the same as what we experienced in the classroom?

The students will then take what they have learned about nuclear energy along with algae and create a presentation about how they would effectively prevent the algae from overgrowing.

- Each group must explain their hypothesis

- Explain their results

- Was it what they expected, or did it differ?

- In a real case scenario, how would they get rid of the overgrowth of algae in the river?

- Come up with an actual solution to the problem.

**ALGAL BLOOMS**

1. What is an algal bloom?
	1. It is a rapid increase or accumulation in the population of algae in a water system.
	2. Algal blooms can occur in freshwater as well as marine environments
2. What causes algal blooms?
	1. Sunlight
	2. Slow-moving water
	3. Nutrients (nitrogen & phosphorus)
	4. Pollution makes the problem worse
3. The effects of algal blooms?
	1. Some can be harmful and toxic that can kill fish or other animals
	2. They can block sunlight
	3. Clog fish gills
	4. Create dead zones (areas in water with little or no oxygen)
4. How do algal blooms create dead zones?
	1. The more algal blooms grow, others in the water system will die
	2. The dead organic matter becomes food for the bacteria
	3. With more food the bacteria increase in number
	4. They use more oxygen
	5. The amount of oxygen in water decreases and many fish or aquatic insects cannot survive
5. How would a nuclear plant contribute to algal blooms?
	1. Increased water temperature
	2. They reach an optimum temperature threshold which increases photosynthetic rates & increases growth.
	3. An increase in temperature increases respiration.
6. What were the EPA results?
	1. On a community scale the thermal additions have led to the following:
		1. Changes in species compositions
		2. Changes in species diversity
		3. Changes in species dominance
		4. Increases in standing crop and growth rate
		5. Acceleration in light-independent succession
		6. Changes in abundance and nutritional value of algae grazed by herbivores
	2. Changes in dominance occurred first in +6 treatment.
	3. Greater monthly and total biomass were observed in the +4 & +6 treatments versus the +2 and the ambient temperatures.
	4. Algal export provided the best indication of thermal enhancement
	5. Succession and shifts in dominance were accelerated in the +6 channels
	6. More algal biomass was exported monthly by the +6 treatment
	7. The examination of nutrient indicated phosphorus and nitrate.
	8. Nutrient-rich sediment inputs following heavy rain and anaerobic release from pool sediments provided additional nutrient resources.
	9. The difference in magnitude was attributed to temperature related stimulation.

Sources

Wren, Bill. Project Manager TVA Browns Ferry. February 28, 2019

“Browns Ferry Nuclear Plant.” TVA - Browns Ferry Nuclear Plant, [www.tva.gov/Energy/Our-Power-System/Nuclear/Browns-Ferry-Nuclear-Plant](http://www.tva.gov/Energy/Our-Power-System/Nuclear/Browns-Ferry-Nuclear-Plant).

“Algal Bloom.” ScienceDaily, ScienceDaily, [www.sciencedaily.com/terms/algal\_bloom.htm](http://www.sciencedaily.com/terms/algal_bloom.htm).

EPA, Environmental Protection Agency, www.epa.gov/.