Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Energy Sources Websites**

**Part 1: Nonrenewable Resources**

***Website #1:*** *Power Profiler* website from the EPA: <http://oaspub.epa.gov/powpro/ept_pack.charts>

Put in your zipcode, click enter, and click “View Report”. (SDG&E is the only option on the drop-down menu for your utility company.)

Mouse over the bar graphs of “Fuel Mix Comparison” to find these answers.

**Sources that generate electricity in our region**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Non-Hydro Renewables | Hydro | Nuclear | Oil | Coal |
| Our Region |  |  |  |  |  |
| National |  |  |  |  |  |
| *In a sentence, describe what you see as the most major difference between our energy source percentages and the national energy source percentages.* | | | | | |

*Continue scrolling down:*

**How our emission rates compare**

**🡪** What’s the unit for emissions rates? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

🡪 What does that stand for? (need to look up elsewhere)

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |
| --- | --- |
| **Type of Emission** | **Approximately how we compare to national** *(Write “3x greater”, or “10x lower”, etc.)* |
| 1. |  |
| 2. |  |
| 3. |  |

**Website #2:** US Energy Information Association <http://www.eia.gov/kids/index.cfm>

Click on “Energy Sources”.

|  |
| --- |
| What are the two main categories of energy? |
| What are two secondary sources of energy? *(these first require energy produced from the above categories)* |

|  |  |
| --- | --- |
| **Nonrenewable Energy Sources**  1.  2.  3.  4. | **Renewable Energy Sources**  1.  2.  3.  4.  5. |

*Click on the individual sources to answer these questions*

***OIL***

|  |  |
| --- | --- |
| What is crude oil? | |
| What five states do 65% of U.S. oil production come from?  1.  2.  3.  4.  5.  *What would rank #2 if it was a state?* | What five countries produce half the world’s oil?  1.  2.  3.  4.  5. |
| What is the region around the US coastline called that is where offshore drilling occurs? | |

|  |  |  |
| --- | --- | --- |
| How many gallons are in a barrel of crude oil? | Of those gallons,  19 become 🡪  12 become 🡪  4 become 🡪 | What are the “three basic steps” to oil refining?  1.  2.  3. |
| *(Bulletpoints)* Negative effects on the environment: | | |
| *(Bulletpoints)* Ways technology may help to mitigate effects of oil drilling and refinement: | | |
| Two major oil spills and what governmental actions occurred as a result:  1.  2. | | |
| What is the Rigs-to-Reefs Program? | | |

|  |  |
| --- | --- |
| *Click on “gasoline” on the sidebar panel*  What are “grades” of gasoline? What do they represent? *(Define “anti-knock properties” in this answer)* This is something you can teach your parents about next time you get gas! | |
| How much gasoline do Americans use every day? | What law seeks to reduce emissions?  When was it passed? |

*Click on Natural Gas from sidebar*

|  |  |  |
| --- | --- | --- |
| What does natural gas mostly consist of? | Where is it found? | |
| Sometimes wells are drilled and natural gas flows up directly to the surface. What is the **other** way natural gas can be extracted? Describe this process. *(paragraph 3 under “How do we get natural gas”)* | | |
| Natural gas is moved around the country through interstate and intrastate \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | |
| What are three ways natural gas is stored?  1.  2.  3. | | 5 states that account for 2/3rds of natural gas production:  1.  2.  3.  4.  5. |
| What does it mean that the US is a **net importer** of natural gas, and where does most of it come from? | | |
| Top three uses in the US for natural gas: (pie chart)  1.  2.  3. | | |
| *(Bulletpoints)* Negative effects on the environment: | | |
| *(Bulletpoints)* Ways technology may help to mitigate effects of natural gas extraction: | | |

*Click on* ***Coal*** *from sidebar*

|  |  |  |
| --- | --- | --- |
| What is coal? | | |
| What are the four types of coal? **Star** the one with the highest heating value and **circle** the two that make up over 90% of U.S. coal production. | | Two methods to remove coal: |
| Top 5 states for coal production:  1.  2.  3.  4.  5. | What is the largest coal-producing **region?** | |
| 93% of the coal used in the U.S. is used for 🡪 | | |
| *(Bulletpoints)* Negative effects on the environment: | | |
| *(Bulletpoints)* Reducing the environmental impacts of coal use: | | |

*Click on Uranium (Nuclear)*

|  |  |
| --- | --- |
| Nuclear fission: | |
| Why is uranium used? | |
| What is the produced heat used for? | |
| Where does the hot water go? | |
| Which country has the most nuclear power and capacity? | How much of our electricity is generated by nuclear power? |
| Reasons why nuclear energy is “cleaner” than fossil fuel: | |
| Negative environmental impacts (don’t forget getting the uranium): | |

# Fukushima's Radioactive Water Leak: What You Should Know

By **Patrick J. Kiger**, [National Geographic News](http://news.nationalgeographic.com/)

PUBLISHED AUGUST 9, 2013

**Tensions are rising in Japan over radioactive water leaking into the Pacific Ocean from Japan's crippled Fukushima Daiichi nuclear plant, a breach that has defied the plant operator's effort to gain control.**

**Prime Minister Shinzo Abe on Wednesday called the matter “an urgent issue” and ordered the government to step in and help in the clean-up, following an admission by Tokyo Electric Power Company that water is seeping past an underground barrier it attempted to create in the soil. The head of a Nuclear Regulatory Authority task force**[told Reuters the situation was an "emergency."](http://www.reuters.com/article/2013/08/06/us-japan-fukushima-panel-idUSBRE97408V20130806)

It marked a significant escalation in pressure for TEPCO, which has come under [severe criticism](http://www.nytimes.com/2013/07/27/world/asia/operator-of-fukushima-plant-criticized-for-delaying-disclosures-on-leaks.html) since what many view as its belated acknowledgement July 22 that contaminated water has been leaking for some time. The government now says it is clear that 300 tons (71,895 gallons/272,152 liters) are pouring into the sea each day, enough to fill an Olympic-size swimming pool every eight days. While Japan grapples with the problem, here are some answers to basic questions about the leaks:

**Q: How long has contaminated water been leaking from the plant into the Pacific?**

Shunichi Tanaka, head of Japan’s[Nuclear Regulation Authority](http://www.nsr.go.jp/english/), has told reporters that it’s probably been happening[since an earthquake and tsunami touched off the disaster](http://www.nytimes.com/2013/07/11/world/asia/japanese-nuclear-plant-may-have-been-leaking-for-two-years.html?_r=3&) in March 2011. According to a[report](http://www.irsn.fr/FR/Actualites_presse/Actualites/Documents/IRSN-NI-Impact_accident_Fukushima_sur_milieu_marin_26102011.pdf) by the French Institute for Radiological Protection and Nuclear Safety, that initial breakdown caused "the largest single contribution of radionuclides to the marine environment ever observed."

But even after the immediate crisis eased, scientists have continued to find radioactive contamination in the waters off the plant. [Ken Buesseler](http://www.whoi.edu/profile/kbuesseler/), a senior scientist with the Woods Hole Oceanographic Institution who has analyzed thousands of samples of fish from the area, said he’s continued to find the high levels of cesium-134, a radioactive isotope that decays rapidly. That indicates it’s still being released. "It’s getting into the ocean, no doubt about it," he said. "The only news was that they finally admitted to this."

**Q: How much and what sort of radiation is leaking from the plant into the Pacific?**

TEPCO said Monday that [radiation levels in its groundwater observation hole](http://www.tepco.co.jp/en/press/corp-com/release/2013/1229511_5130.html) on the east side of the turbine buildings had reached 310 becquerels per liter for cesium-134 and 650 becquerels per liter for cesium-137. That marked nearly a 15-fold increase from readings five days earlier, and exceeded Japan’s provisional emergency standard of 60 becquerels per liter for cesium radiation levels in drinking water. (Drinking water at 300 becquerels per liter would be approximately equivalent to one year’s exposure to natural background radiation, or 10 to 15 chest X-rays, [according to the World Health Organization](http://www.who.int/hac/crises/jpn/faqs/en/index8.html). And it is far in excess of WHO’s guideline advised maximum level of radioactivity in drinking water, [10 becquerels per liter.](http://www.who.int/water_sanitation_health/dwq/GDW9rev1and2.pdf))

Scientists who have been studying the situation were not surprised by the revelation, since radiation levels in the sea around Japan have been holding steady and not falling as they would if the situation were under control. In a[2012 study](http://www.nature.com/news/ocean-still-suffering-from-fukushima-fallout-1.11823), Jota Kanda, an oceanographer at Toyko University of Marine Science and Technology, calculated that the plant is leaking 0.3 terabecquerels (trillion becquerels) of cesium-137 per month and a similar amount of cesium-134. While that number sounds mind-boggling, it’s actually thousands of times less than the level of radioactive contamination that the plant was spewing in the immediate aftermath of the disaster, estimated to be from 5,000 to 15,000 terabecquerels, according to Buesseler. For a comparison, the atomic bomb dropped on Hiroshima released 89 terabecquerels of cesium-137 when it exploded.

**Q: Why is the plant continuing to leak?**

Most experts seem to think that ordinary movement of groundwater probably is the real culprit. An estimated 400 tons (95,860 gallons/ 362,870 liters) of water streams into the basements of the damaged reactors each day. Keeping that water from continuing to flow into the ocean is crucial. As the IAEA noted in its report, "the accumulation of enormous amounts of liquids due to the continuous intrusion of underground water into the reactor and turbine buildings is influencing the stability of the situation."

"Big surprise—water does flow downhill," said[Dr. Janette Sherman](http://janettesherman.com/about/), a medical expert on radiation and toxic exposure who once worked as a chemist for the Atomic Energy Commission, the forerunner of today’s U.S. Nuclear Regulatory Commission. "If you’ve ever had a leak in your house during a storm, you know how hard it is to contain water. There’s a lot of water going into the plant, and it’s got to go someplace. It’s very hard to stop this."

**Q: What can be done to stop the leaking?**

According to TEPCO’s[latest full status report](http://www.tepco.co.jp/en/nu/fukushima-np/roadmap/conference-e.html) on the cleanup of Fukushima Daiichi, issued in October 2012, the utility company already had put in place an array of measures to try to control the radioactive water. It built a groundwater bypass system, which tries to siphon off and reroute groundwater flowing down from the mountain side of the complex, before it can get into the basements of the reactor buildings and be contaminated. But that doesn’t seem to have made much of a dent in the problem.

Plant workers also tried to create an underground barrier by injecting chemicals into the soil to solidify the ground along the shoreline of the Unit 1 reactor building. But TEPCO officials Tuesday said the water was seeping under or past this barrier. Officials also believe the water is rising to the surface, which is a troubling development because it could hasten leakage into the sea.

The company also continues to add to a massive tank farm on the site, with capacity to store about 400,000 tons (95 million gallons/360 million liters) of contaminated water, and is planning to add an additional 300,000 tons of capacity over the next three years. Unfortunately, TEPCO must deal with an ever-increasing amount of contaminated water—nearly 150,000 tons (35.9 million gallons/136 million liters) a year—so it’s inevitable that the company is going to run out of storage space.

That’s why TEPCO seems to be betting heavily on another solution—an elaborate state-of-the art system for filtering the accumulated water and removing radioactive materials from it. According to New Scientist, the new system supposedly can filter out 62 different radioactive substances. However,[the April IAEA report noted](http://www.iaea.org/newscenter/focus/fukushima/missionreport230513.pdf) that the filtering system is still a work in progress, and that in tests so far, "it has not accomplished the expected result" in terms of removing radioactive material from the water. Additionally, the system doesn’t remove tritium, which isn’t as radioactive as other materials in the water, but which still is a health hazard if it is inhaled or ingested. The Wall Street Journal recently[reported](http://online.wsj.com/article/SB10001424127887324879504578597323434402096.html)that TEPCO hopes eventually to be able to discharge the cleansed water into the ocean, though that plan would likely meet intense opposition from local fishermen. Sherman, who has a chemistry background, said she’s skeptical that such a process could work on the enormous scale required. "You can precipitate these things out in the laboratory, but you’re talking about millions of gallons here," she explained.

**Q: How far is the radiation spreading, and how fast does it travel?**

The initial gigantic deluge of contaminated water dispersed through the immediate Fukushima coastal area very quickly, according to a[2012 report](http://fukushima.ans.org/report/Fukushima_report.pdf) by the American Nuclear Society. But it takes years for the contamination to spread over a wider area. A mathematical model developed by Changsheng Chen of the University of Massachusetts at Dartmouth and Robert Beardsley of the Woods Hole Oceanographic Institute found that radioactive particles disperse through the ocean differently at different depths. The scientists estimated that in some cases,[contaminated seawater could reach the western coast](http://web.mit.edu/newsoffice/2011/modeling-radioactivity-spread-seawater.html) of the United States in as little as five years. Buesseler thinks the process occurs a bit more rapidly, and estimates it might take three years for contamination to reach the U.S. coastline.

**Q: What are the potential risks to humans, and who might be affected by the contamination?**

This is a murky question, because it’s not that easy to determine whether health problems that may not show up for decades are caused by exposure to radioactive contamination. A[report](http://apps.who.int/iris/bitstream/10665/78218/1/9789241505130_eng.pdf) released in February by the World Health Organization, which was based upon estimates of radiation exposure in the immediate wake of the accident, concluded that it probably would cause "somewhat elevated" lifetime cancer rates among the local population. But figuring out the effect of years of exposure to lower levels of radioactive contamination leaking into the ocean is an even more complicated matter.

Minoru Takata, director of the Radiation Biology Center at Kyoto University, told the Wall Street Journal that the radioactive water doesn’t pose an immediate health threat unless a person goes near the damaged reactors. But over the longer term, he’s concerned that the leakage could cause higher rates of cancer in Japan.

Marine scientist Buesseler believes that the leaks pose little threat to Americans, however.  Radioactive contamination, he says, quickly is reduced "by many orders of magnitude" after it moves just a few miles from the original source, so that by the time it would reach the U.S. coast, the levels would be extremely low.

**Q: Will seafood be contaminated by the leaks?**

As Buesseler’s[research](http://blogs.nature.com/news/2012/10/fukushima-fish-still-hot.html) has shown, tests of local fish in the Fukushima area still show high enough levels of radiation that the Japanese government won’t allow them to be caught and sold for human consumption—a restriction that is costing Japanese fishermen billions of dollars a year in lost income.

Buesseler thinks the risk is mostly confined to local fish that dwell mostly at the sea bottom, where radioactive material settles. He says bigger fish that range over long distances in the ocean quickly lose whatever cesium contamination they’ve picked up. However, the higher concentration of strontium-90 that is now in the outflow poses a trickier problem, because it is a bone-seeking isotope. "Cesium is like salt—it goes in and out of your body quickly," he explains. "Strontium gets into your bones." While he’s still not too concerned that fish caught off the U.S. coast will be affected, "strontium changes the equation for Japanese fisheries, as to when their fish will be safe to eat."