Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
2011 Volume IV: Energy, Environment, and Health

The Future of Nuclear Energy: Forbidden Joules

Guide for Curriculum Unit 11.04.05
by Kenneth William Spinka

What happens inside a nuclear power plant is part marvel, part mystery – and occasionally a source of misery. Imagine tracing a volt of electricity back through the wall outlet, all the way across miles of power lines to the nuclear reactor from which it was generated. The nuclear reactor would be adjacent to a spark-producing generator, a generator-revolving turbine, a turbine-revolving steam jet, and finally the nuclear reactor core that heats water into steam from radioactive uranium. While some water is destined to become steam, other water in the reactor serves as a liquid coolant for the management of nuclear fission, preventing radioactive material from overheating and reaching critical limits.

On March 11, 2011, the world witnessed catastrophic consequences at the Fukushima-Daiichi nuclear facility in Japan, after the most powerful earthquake ever recorded and the ensuing tsunami irreversibly damaged the nuclear plant and several of its reactor units. Among the tragically resulting events, water drained from the reactor core, initiating an uncontrollable increase in core temperatures, resulting in overheating, a partial nuclear meltdown, and the evacuation of tens of thousands of Japanese citizens from the surrounding area. As of March 1, 2011, there were 443 operating nuclear power reactors spread across the planet in 47 different countries. Atomic energy accounts for 14 percent of the world's electrical production.

While the portion of electricity generated from nuclear energy varies dramatically by country, the percentage reaches as high as 76.2 for Lithuania and 75.2 for France. The United States is also substantially invested in nuclear energy generated electricity: 104 nuclear power plants supply approximately 20 percent of the electricity consumed in the United States, or about as much as the electricity used in California, Texas and New York, the three states with the most people. In this curriculum unit, the potential of nuclear power plants will be explored and evaluated by comparing and contrasting the benefits and risks associated with what is contained and what is released from atomic reactions within nuclear reactors.

(Recommended for Mathematics and Physics, grades 9-12)