NUCLEAR POWER TODAY

By Anna Turnage

The life of nuclear power in the United States has come full circle over the past 30 years. In fact, today's "renaissance" of nuclear energy is strangely reminiscent of its rise to popularity in the early to mid-1970s as a cheaper, cleaner energy source. Despite lingering reservations among some groups, the United States Nuclear Regulatory Commission (NRC) could begin the licensing process for 20 new nuclear plants over the next five years.

According to experts, the bottom line value for this particular source of energy still rests on its cost-efficiency and environmental benefits.

"Global warming, dependence on unstable nations for our oil and some of our natural gas supply, and economics are the main reasons for the resurgence of interest in nuclear power," says Dr. Paul J. Turinsky, a professor of nuclear engineering at N.C. State University.

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Nuclear power first became a popular alternative for the nation's energy demands as a result of the 1973 Arab Oil Embargo. Today, with continuing unrest in the Middle East and environmental concerns related to global warming, the United States again finds itself searching for ways to reduce its reliance on oil. Add that to the strong economic and safety performance of nuclear plants in the U.S. and an increasing demand for energy, and it adds up to a recipe for success that the industry has not seen since the 1980s.

But the road to this point has not been easy. As James A. Lake, associate director for the nuclear program at the Idaho National Laboratory, wrote in a State Department newsletter, "Nuclear power in the United States was born in the 1950s and 1960s to unreasonable and, as it turned out, unachievable expectations of being so inexpensive that it was 'too cheap to meter.'"

According to Lake, the first plants to come online experienced difficulties with rising construction costs and safety performance that eventually led to the accident at the Three Mile Island in 1979. The "fallout," so to speak, from this accident resulted in much tighter restrictions on construction from the NRC to increase plant safety. But the new regulations also led to delays and increased costs for the plants under construction. Progress Energy's Harris Nuclear Plant and Duke Energy's Catawba Nuclear Station were both caught in this wave of cost increases, and, as a result those plants cost much more than was originally anticipated.

"These higher fixed costs partially offset the lower energy cost of nuclear output," explains Joe Brannan, chief operating officer and senior vice president for power supply at North Carolina Electric Membership Corporation (NCEMC), the power supply cooperative owned by North Carolina's Touchstone Energy cooperatives. "But, there are three primary advantages to nuclear generation when compared to many other available sources of energy: nuclear generation generally has highly dependable output (high capacity factor); the generation process releases none of the greenhouse gases associated with fossil fired generation; and the energy price is stable and among the lowest of all sources of generation."

The Three Mile Island incident has become better known over the years as a safety success story rather than a disaster since there was little or no radiation leakage and no threat to the people living near the plant. Particularly when compared to the 1986 accident in Chernobyl, Ukraine, it became abundantly clear that nuclear plants in the United States were some of the best constructed and safely run in the world.

"Needless to say, there will always be folks who find fault in regard to nuclear safety," Turinsky says. "But I would say most folks are not greatly concerned about nuclear safety issues. Opinion polls and NRC design certification of nuclear plants indicate this."

Turinsky says that one of the bigger issues still unresolved today is that of nuclear waste storage. The United States government still has not designated a place to store high-level waste. For more than 20 years, the utility industry and federal government have been paying to study, plan and build a repository at Yucca Mountain in Nevada. While it remains the main candidate, Yucca Mountain is not expected to be prepared to accept waste until 2017. Spent fuel is currently stored at the respective power plant sites.

Despite the concerns, the benefits of nuclear energy are clearly winning out, particularly since safety has not proven to be a problem. The increasing need for energy, particularly in fast growing states like North Carolina, are leading many companies to consider constructing new plants. Duke Energy and Progress Energy are among those companies. Duke has chosen a site in Cherokee County, S.C., for a new nuclear plant, and Progress Energy is proposing to add a reactor to its Harris site to meet increasing energy demands.

For North Carolina's Touchstone Energy cooperatives, the potential for new nuclear plants in North Carolina all comes down to providing a reliable, low-cost and safe energy supply, Brannan says.

"We will evaluate the total cost and strategic fit of each generation type or supply for our customers," he said. "Overall, however, the Carolina area will benefit from additional capacity to meet the area's growing demand. Clearly, having adequate supply is a key component to ensuring reliable delivery into the future. Additionally, increasing the capacity in the geographic area would lead to additional potential supply opportunities."

Anna Turnage is a writer and doctoral candidate at North Carolina State University in Raleigh.

North Carolina's electric cooperatives' interest in nuclear energy

Nuclear energy is a key component of North Carolina's Touchstone Energy cooperatives' power supply portfolio. As part owner of the Catawba Nuclear Station in York County, S.C., about half of the co-ops' annual energy needs are met through nuclear energy.

Catawba's Unit 1 and Unit 2 began commercial operation in 1985 and 1986, respectively. The 2,258-megawatt Catawba plant includes twin pressurized-water reactors (see diagram next page). Operated and co-owned by Duke Energy, the Catawba plant ran at an overall capacity factor of 97.5 percent in 2005. Capacity factor is the ratio of actual net electrical energy generation to the maximum possible energy that could have been generated if a plant operated at the maximum capacity rating for the same time period.

Through their power supply cooperative NCEMC, the state's Touchstone Energy cooperatives own 56.25 percent Catawba Unit 1. In 2003, that unit was re-licensed to operate until December 2043. The license renewal process considers safety and environmental reasons in granting additional years of operations. In addition to its share in the Catawba station, NCEMC also owns diesel-powered generation stations on the Outer Banks. Both the 15-megawatt station at Buxton and the 3-megawatt station at Ocracoke provide peak-load power, and they function as backup generators during outages on Hatteras and Ocracoke islands. Currently, long-term power supply contracts with regional power providers fills the rest of the co-op energy needs.

Nuclear energy will always be an important part of the co-ops' power supply needs, says Joe Brannan of NCEMC, mainly because diversity in energy supply helps ensure an adequate supply of electricity at a reasonable cost.

"If, as an industry, we should learn from our past, we certainly should have learned we need diversity in our fuel supply," he said. "Without diversity, we expose ourselves to unnecessary price and availability volatility. The greater the potential sources of generation, the less likely any one source could threaten the overall ability to generate electricity."

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Duke Energy

The Catawba Nuclear Station in York County, S.C., began commercial operation in the mid-1980s and recently was relicensed to operate through 2043. North Carolina's Touchstone Energy cooperatives own 56.25 percent of one of the two Catawba generating units.

▼ *This diagram shows the process of a pressurized water reactor (PWR) like the two at Catawba Nuclear Station. There are also boiling water reactors (BWR) at some plants. The primary difference is that the PWR uses heat exchangers called "steam generators" to separate the primary water that is heated in the reactor core from the secondary water which is turned to steam and turns the turbines. In the BWR, the primary water is converted to steam in the reactor core and passes directly to the turbine without a barrier.*

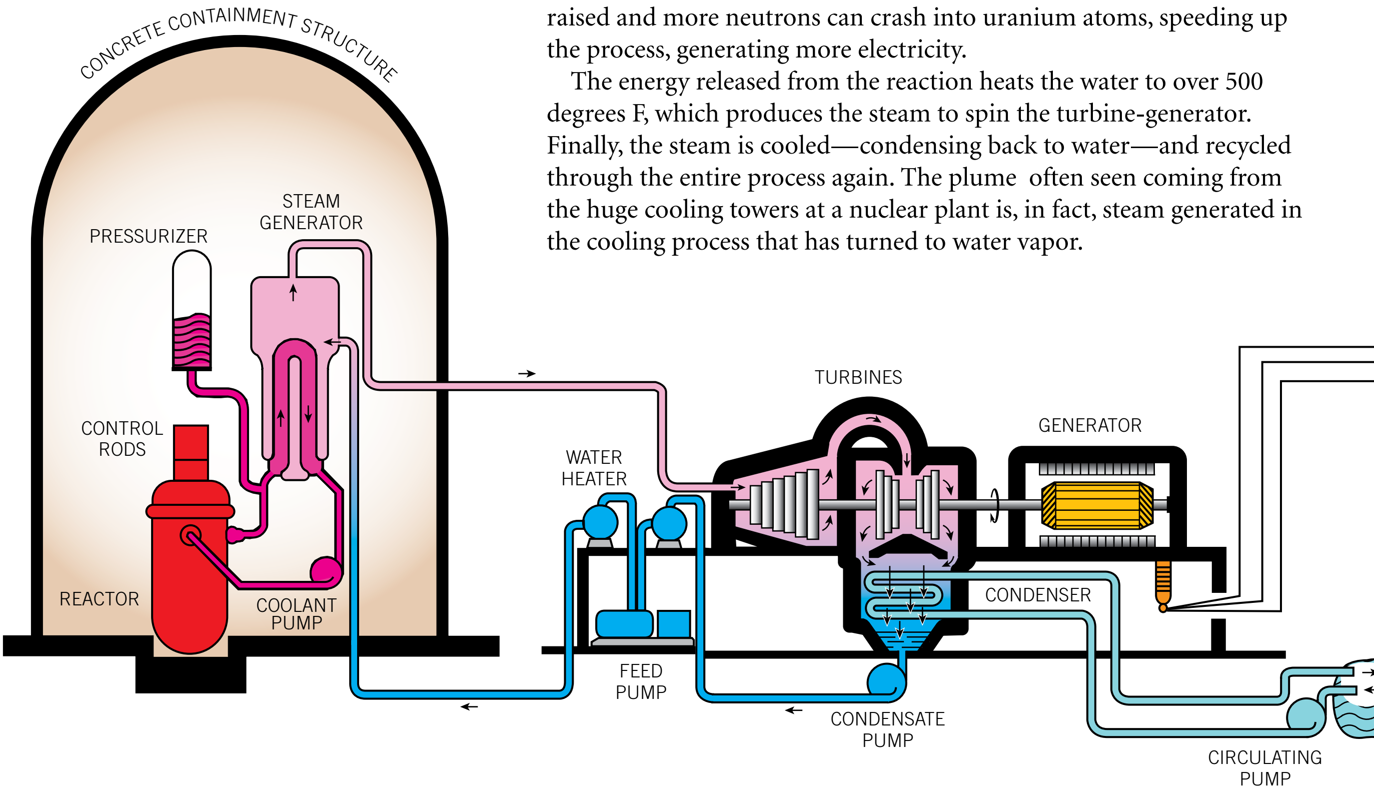
Steam leaves the containment structure (at left) and is used to turn the turbines. Condensed secondary water (shown below the turbine condenser) returns to the supply side of the steam generator. A cooling water supply—usually from a lake, river or the sea—quenches the steam after it passes through the turbine.

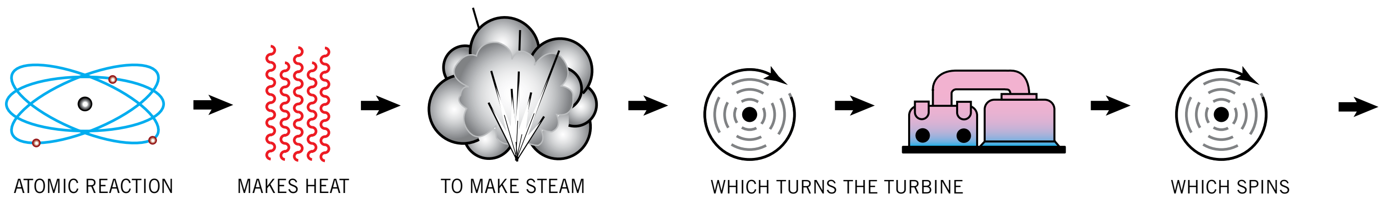
How a nuclear generator plant works

In most electric power plants, water is heated and converted into steam, which drives a turbine-generator to produce electricity. In fossil fuel plants, steam is generated using coal, oil or natural gas. Nuclear plants work much the same way, except that an atomic "chain reaction" inside the reactor makes the steam, which drives the turbine-generator.

In a nuclear power plant, the "fission" of uranium atoms in the reactor provides the heat that produces steam for generating electricity. "Fission" is the splitting of atoms into smaller parts. Some atoms split when they are struck by even smaller particles, called neutrons. Each time this happens more neutrons come out and strike other atoms. This process of energy release is the "chain reaction." Operators in the plant control the chain reaction to keep it from releasing too much energy too fast so that the reaction can continue for a long period of time. The chain reaction is controlled with "control rods," that contain the chemical element boron which naturally absorbs neutrons. When the rods are lowered into the reactor, they absorb more neutrons and the fission process slows down. To generate more power, the rods are raised and more neutrons can crash into uranium atoms, speeding up the process, generating more electricity.

The energy released from the reaction heats the water to over 500 degrees F, which produces the steam to spin the turbine-generator. Finally, the steam is cooled—condensing back to water—and recycled through the entire process again. The plume often seen coming from the huge cooling towers at a nuclear plant is, in fact, steam generated in the cooling process that has turned to water vapor.





Illustrated by Ed Vernon for Carolina Country

Learning about nuclear energy at Catawba Nuclear Station

By Jennifer Kearney

Wayne Kearney

Jennifer Kearney teaches high school physics in Southern Pines.

I have been teaching high school physics in Southern Pines for more than 10 years. Although I was trained to teach math, I really enjoy teaching physics because students in that class want to know what is in the world around them and how it works. I teach a unit on "Nuclear Reactions and Power." Several of my former students went on to study nuclear engineering in college, and one did research at Los Alamos National Laboratory in New Mexico.

One desire of mine has been to tour a nuclear power plant and see how it really works. I have all kinds of graphs and information I share with students, but my explanation had been based mostly on what I have read or seen at the North Carolina State University Reactor.

Last summer, the North Carolina Electric Membership Corporation invited me to visit Catawba Nuclear Station, which is operated by Duke Energy in York County, S.C. NCEMC has a 56.25 percent ownership of the Catawba Unit No. 1.

The control room operators at Catawba and other Duke plants work for 10 weeks and then go for two weeks of refresher training. This helps Duke maintain its accreditation with the federal Nuclear Regulatory Commission. I was very impressed with that amount of training. The training is enhanced by an exact replica of the actual control room, and computers maintain data from the plant so they can give an actual scenario of what happens.

Catawba has two reactors in operation. I was able to touch the huge containment building where the nuclear fission reaction takes place. Water under pressure circulates in the reactor housing and is heated to about 550 degrees F by the reaction. The water then circulates around other water that does not come in contact with the reaction and is heated to about 545 degrees F under pressure of 962 pounds-per-square-inch. The steam it produces turns the high-pressure turbines that generate electricity. The turbines are housed in a large building about 20 feet from the reactors.

After the steam has been through the turbine, reheated and exhausted, its heat energy declines to about 114 degrees F. The water is sent to four cooling towers where it is cooled for re-entry to Lake Wylie. Water drops from the top of the towers, while fans circulate, to cool it down to about 89 degrees.

The plant is very neat and clean. I was impressed by the organization and safeguards in place to maintain security and safety. An engineer from the Nuclear Regulatory Commission is on site and has complete access to the operation.

The reactors are re-fueled every 12 to 18 months, and Catawba has set records for its quick refueling. Spent fuel is stored right there on the Catawba site until a permanent storage facility is completed.

Catawba has been recognized by the Nuclear Regulatory Commission as one of the most efficient power plants in the United States. It was put into operation in 1985 and recently qualified for relicensing to 2043. All reports tell us we are going to need new energy supplies and efficient ways to produce electricity in the coming years so that we can gradually replace our dependence on fossil fuels. Nuclear energy and Catawba fit into that future.