



## News &amp; Highlights

## Amid Uncertainty for US Nuclear Power, Three Mile Island Shuts Down

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At 3:55 a.m. on 28 March 1979, a noise that sounded like “the biggest jet at an airport” woke a woman living near the Three Mile Island nuclear power plant in Pennsylvania. “It shook the windows, the whole house,” she recalled [1]. The United States’ worst civilian nuclear accident had begun. “We are still dealing with the consequences,” said James Miller, a nuclear engineer and professor in the Department of Mechanical and Nuclear Engineering at Virginia Commonwealth University in Richmond, Virginia.

The accident, which destroyed one of the reactors at the plant, was a turning point for nuclear power in the United States and the world. Now, 15 years ahead of schedule, the other undamaged reactor at Three Mile Island has closed, reflecting the declining fortunes of nuclear power that many believe began with the accident 40 years ago.

But the legacy of Three Mile Island is more complex than most people think, according to Miller and other experts. “Although it is commonly heard that the stagnation of the nuclear power industry in the United States can be traced to Three Mile Island, other factors were involved,” he said. These factors, as well as new economic challenges, remain obstacles to future reliance on nuclear power in the United States—largely shutting this relatively clean power option out of efforts to further reduce the country’s carbon emissions.

When the two reactors, Unit 1 and Unit 2, at Three Mile Island (Fig. 1) were commissioned, respectively, in 1974 and 1978, nuclear power appeared to be on the upswing in the United States. During the 1970s, more than 50 new reactors went online [2], and the share of the country’s electrical power generated by nuclear plants increased nearly six-fold, reaching 12.5% in 1978 [3].

Caused by equipment failures and plant operators’ mistakes [4], the accident at Three Mile Island’s Unit 2 did not result in an explosion—the roar the neighbor heard was steam venting from the turbine building after the reactor shut down. However, about one-half of the fuel in the reactor melted, although it did not seep through the floor of the containment building [4]. The plant also released radioactive gases, and more than 80 000 people temporarily fled the area [4,5]. The US Nuclear Regulatory Commission later estimated radiation exposures due to the accident to be less than that of a chest X-ray for the two million people living within an 80 km radius of the plant [6]. Two more serious nuclear accidents have occurred since Three Mile Island. In 1986, a reactor exploded and caught fire at Chernobyl in the Soviet Union, spewing

radioactive material into the atmosphere [7]. Much of the reactor’s nuclear fuel melted and burned through the floor of the building [8]. Today, an area of about 2600 km<sup>2</sup> around the plant remains largely uninhabitable because of radioactive contamination [9]. The most recent disaster occurred in 2011, when a tsunami hit the Fukushima Daiichi power plant in Japan, leading to meltdowns in three reactors and hydrogen gas explosions that allowed radioactivity to escape into the atmosphere [10,11]. Of the total 164 000 people evacuated in the vicinity of the plant after the accident, as of April 2019 some 43 000 remained unable to return to their homes because of the lingering radiation risk [12].

The Three Mile Island accident did not end nuclear power in the United States, which still generates more nuclear energy than any other country, with more than 90 reactors in operation [13]. These reactors furnish about 19% of the country’s power and are its largest low-carbon source; in contrast, all renewable sources, including solar, wind, and hydroelectric, together account for 17% [14].



**Fig. 1.** This aerial photograph taken in 2010 shows the cooling towers of the Three Mile Island nuclear plant in Pennsylvania, on the Susquehanna River just south of the city of Harrisburg. In March 1979, the worst nuclear accident in US history left one reactor disabled and non-functional, Unit 2, on the left. Unit 1, on the right was unaffected by the accident but was decommissioned for economic reasons in September 2019, 15 years ahead of schedule. Credit: Wikimedia Commons (CC0).

Still, the nuclear industry has undergone a dramatic downturn since the 1970s. After Three Mile Island, utilities canceled plans for 39 nuclear reactors [15]. Only two have gone online in the last 25 years, both at the Watts Bar Nuclear Plant in Tennessee [16]. Some other countries remain committed to constructing new nuclear power plants. China, for instance, has opened 48 reactors and is building another nine [17]. But only two new reactors—at the Vogtle site in Georgia—are under construction in the United States, and work on them has continued only because the US Department of Energy provided 12 billion USD in loan guarantees [18].

Three Mile Island did help spur the decline in nuclear power in the United States. Remedial changes implemented to prevent future accidents affected everything from plant design and operating procedures to personnel training and government oversight. Examples of these measures include installation of reactor simulators at every plant, upgraded control rooms, better safety systems, and increased sharing of information among plant operators, Miller said. The accident also provoked much stricter regulation of the industry, he said.

These measures increased the safety of nuclear power plants, but they also raised the cost of generating electricity, said Robert Brecha, a professor of physics at the University of Dayton in Ohio. But perhaps most important, the accident had a powerful impact on the public's perception of nuclear energy, he said. "An industry that had billed itself as extremely safe and under control was shown to be like many other technologies—human and engineering errors happen, and engineers often underestimate the potential risks."

However, other trends that began before the accident also contributed to nuclear power's troubles in the United States. Soaring construction costs, high interest rates, and declining power consumption had already prompted utilities to begin scaling back their nuclear ambitions by the time of the accident [19]. A 2013 study, for example, found that of the planned reactors cancelled between 1960 and 2010, 40% were abandoned before Three Mile Island [19]. "The slowdown in new plant orders and plant construction, along with an increase in plant costs, were already a reality at the time of the accident," said Miller.

Nuclear power now faces an even tougher financial situation. Hydraulic fracturing, or fracking, has slashed the costs of natural gas by two-thirds, and plants fueled by this cheap gas are undercutting nuclear reactors in power markets [20]. The most recent victim of this low-price electricity was the undamaged second reactor at Three Mile Island, which closed on 20 September 2019 because it was no longer economical to operate [21]. Reactors in other states have remained open only because of government subsidies or tax credits [22]. The cost of energy from renewable sources is also falling [23], making the nuclear power option even less attractive from an economic perspective.

Experts have predicted that one-fifth to one-third of the nuclear plants in the United States could shut down by mid-century [20]. What role nuclear power should play in future power generation and in efforts to rein in carbon emissions remains controversial. But Brecha, who favors shifting from nuclear power to renewable sources, said he hopes that the closure of the Three Mile Island plant will spur a deeper examination of the country's energy future "We need to do some careful thinking about where we want to be in 20 or 30 years."

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