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## Reviving Cold Fusion

After 20-plus years of outcast status, unconventional heat-producing nuclear reactions still seem plausible

By [Stephen K. Ritter](#)

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#### E-CAT EXHIBIT

Rossi poses with a set of E-Cat demonstration reactors; his coinventor, Focardi, is in the background.  
 Credit: Mats Lewan/Ny Teknik

In March 1989, electrochemists B. Stanley Pons and Martin Fleischmann announced at a press conference at the University of Utah that they had tamed the power of nuclear fusion in a benchtop electrolysis experiment. The discovery of cold fusion, as it came to be called, held the promise of endless amounts of pollution-free energy being generated from the natural deuterium in water.

Seeking an explanation to Pons and Fleischmann's observations, the scientific community came to a consensus within months that the scientists had made experimental errors. Their research was summarily condemned, and cold fusion became a synonym for junk science.

In January 2011, Italian engineer [Andrea Rossi](#) of [Leonardo Corp.](#) and his colleagues announced at a press conference in Bologna, Italy, that they had built a related tabletop reactor that produces copious amounts of excess energy via a nickel-hydrogen fusionlike process.

Given the stigma still attached to cold fusion, Rossi's energy catalyzer, or **E-Cat**, as he calls it, has received little attention from the mainstream media compared with what happened in 1989. Scientists are once again looking for answers. For now, they aren't forthcoming because Rossi has been unable to patent the invention and he is reluctant to divulge scientific details. His actions are fueling speculation in some quarters that he is a con artist trying to pull off an elaborate get-rich-quick scheme.

In Pons and Fleischmann's experiments, the researchers used an electrochemical cell to carry out electrolysis of deuterium-enriched water. When they applied a current, deuterium atoms that had penetrated into the palladium

cathode were fusing to form helium atoms, they believed. The excess energy from the process dissipated as heat, they suggested. If true, the heat could be converted to useful work, such as generating steam to power a turbine to make electricity.

But when scientists tried to independently reproduce the experiments, heat production was inconsistent or nonexistent. And no one consistently observed telltale signs of nuclear fusion, such as helium formation or any radiation. Scientists became frustrated because they had no generally accepted theory to guide them and explain the proposed phenomenon—physicists like to say that no experiment should be believed until it has been confirmed by theory. Although scientists wanted to believe in cold fusion, their collective gut instinct was telling them it was all wrong.

**Rossi's announcement** is giving many scientists the same queasy feeling. Rossi says he originally tried to repeat the Pons-Fleischmann palladium-deuterium experiment years ago, but without success. He then turned to research on nickel and hydrogen, which was based on work by Italian physicists Francesco Piantelli and [Sergio Focardi](#). In 2007, Rossi teamed up with Focardi; Piantelli continues to work independently at [nicHenergy](#), a company he founded.

In the E-Cat, hydrogen at high pressure flows through a mixture of nickel powder and a proprietary catalyst packed into a 50-mL

reaction chamber. Rossi isn't certain of the mechanism, but he assumes a self-sustaining nickel-hydrogen low-energy fusion process is taking place that is transmuting nickel to copper. The excess energy is given off as heat and some residual radiation, he says.

Most cold-fusion-like experiments generate only milliwatts of excess heat. But Rossi reports kilowatts of excess heat with his E-Cat, quantities that would be sufficient for practical applications. He says the energy density of the nickel powder by weight is about 200,000 times that of crude oil.

Besides word of mouth, the only source of information about the E-Cat process is a languishing [world patent application](#) and an [unreviewed paper](#) by Rossi and Focardi. These documents, both short on details, are posted on one of Rossi's websites called the [Journal of Nuclear Physics](#), which is more of a blog than a journal.

To substantiate his discovery, Rossi has held E-Cat demonstrations for potential investors and members of the media. In videos of the demonstrations, the devices appear to be crudely built from plumbing supplies that can be bought in any hardware store. The reactor cores typically are covered up so no one can see the inner workings—the devices are essentially a black box with water going in and steam/hot water coming out.

The lack of information about the E-Cat process is one reason many people are having trouble believing Rossi. Another is his checkered past.

According to an Italian television [investigative report](#), Rossi invented an incineration process for converting household and industrial waste into a liquid fuel in the 1970s. He started a company called Petrodragon to commercialize the process. But Petrodragon reportedly never produced any oil. Rossi was tried 56 times in Italian courts, and acquitted 51 times, for various tax fraud and business fraud charges, as well as for environmental damage stemming from storing toxic industrial waste. Petrodragon went bankrupt in the 1990s, and the Italian government has since spent tens of millions of dollars to clean up the waste. When reporters ask about his past, Rossi says it is just that—his past—and he doesn't want to talk about it.

Before Rossi came along, the few cold fusion researchers still standing after the dust settled on the Pons-Fleischmann episode remained cautiously optimistic about the science. They have pushed on while distancing themselves from cold fusion; some of them started calling their research [low-energy nuclear reactions](#) (LENR), condensed-matter nuclear science, or chemically assisted nuclear reactions. But the field is still an outcast from the scientific establishment.

**One thing is certain**, says [Steven B. Krivit](#) of the [online magazine and blog](#) *New Energy Times*: Multiple labs have detected excess heat that is too large to be explained by any chemical process. As before, the experiments are only occasionally reproducible, and scientists have not determined how to consistently turn reactions on, off, up, or down. A [variety of companies](#), most of them no longer in existence, have tried to develop a practical commercial technology, adds Krivit, who has closely followed the history of cold fusion/LENR. So far, none of the companies have struck pay dirt.

Some researchers contacted by C&EN still believe deuterium fusion might be taking place—Pons-Fleischmann cold fusion. A second camp believes the excess heat isn't coming from fusion. Instead, these researchers posit that electromagnetic interactions and weak interactions (which govern radioactive decay) might be coupling to lead to previously unknown types of nuclear processes. Rossi says his E-Cat falls into this category.

Cold fusion/LENR researchers say they are optimistic that the excess heat's commercial applications are still on the horizon. They point out that, realistically, the applications might be only for small-scale heating and not massive energy production as originally envisioned.

With the possibility for applications, various federal agencies within the Departments of Defense and Energy and at the National Aeronautics & Space Administration have maintained an interest. Scientists at these agencies don't like talking about the topic, but when pressed they acknowledge that studying cold fusion/LENR is part of carrying out their missions of exploring all options for developing new energy and weapons technologies. These agencies remain cautious in funding any research, preferring instead to wait and see how developments play out in the private sector first.

"From more than two decades of experiments producing heat and transmutations, 'something' is real and happening," says [Dennis M. Bushnell](#), chief scientist at NASA's Langley Research Center. He adds that NASA scientists are "evaluating the many extant devices to determine their correspondence, or not, with the weak-interaction theories."

Physicist Robert V. Duncan of the University of Missouri, Columbia, is one scientist who unexpectedly found himself enveloped in the world of cold fusion/LENR research. In 2009, CBS's show "60 Minutes" was preparing a [segment](#) on the reality of cold fusion/LENR and asked Duncan, an expert in calorimetry and the university's vice chancellor of research, to be an independent expert. Duncan traveled to Israel to visit Energetics Technologies, a company that has reported some of the largest energy gains using a palladium-deuterium system.

Duncan found the experiments to be carefully done and was surprised that the excess heat seemed to be real. "I never thought I would say that," he said on "60 Minutes."

When asked today, Duncan is even more convinced the heat effects are real. "I like to call it an anomalous heat effect rather than cold fusion or a low-energy nuclear reaction," Duncan says, "because we still don't know exactly what the mechanism is."

By coincidence, Energetics Technologies was looking to relocate to the U.S., and after Duncan's visit, the company decided to move to a technology incubator at the University of Missouri. In February, philanthropist Sidney Kimmel, who financially supports

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Energetics Technologies, pledged \$5.5 million to fund research at the university, suddenly making Missouri a leading center for LENR research.

“Our focus is in no sense to try to bring a product to market,” Duncan notes, “but rather to carefully design experiments that will help us understand the scientific origins of these anomalous heat effects and systematically home in on the real mechanism.”

Asked what he thinks about Rossi’s device, Duncan says: “I don’t need to have an opinion about the E-Cat. Nobody does. Rossi is claiming to be going commercial with it. If he does deliver to the marketplace, then the marketplace will decide the efficacy of the technology.”

Krivit, who has interviewed both Piantelli and Rossi in person and witnessed a demonstration of the E-Cat, is more succinct in his analysis: “Rossi has no credible evidence for his extraordinary claims,” Krivit says. “I have stopped paying attention to him.”

Meanwhile, Rossi seems oblivious to skeptics and critics. He says he is already taking orders for a 1-MW system, which could be used to heat or power large buildings such as factories. Each unit costs \$1.5 million. Rossi says a 10-kW system, about the size of a laptop computer, will be available for domestic use. These devices will sell for \$600 to \$900 each, he notes. The small E-Cats need to be refueled roughly every six months using interchangeable nickel hydride cartridges, which will cost about \$10 each. Rossi says a factory producing 1 million 10-kW units per year will be operating in 2013.

Rossi hasn’t explained how the units would be integrated into an existing structure, other than they will come with a water inlet and outlet. And it’s not clear what the applications might be. According to Rossi’s statements on his websites, the 10-kW E-Cat will initially produce only heat, not electricity. One possible use might be as a replacement for a hot-water heater.

Despite these grand plans, Rossi reiterated at C&EN’s press time that he can’t disclose any further details about the E-Cat. But he emphasized that commercialization is on track.

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**Comments**

**art stewart (May 14, 2012 1:04 PM)**

Beautifully balanced! I hope that this might incite some interagency efforts to really work out the details of what is going on.

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**Jacques Read (July 9, 2012 4:51 PM)**

Luis Alvarez achieved very cold fusion in 1957, using liquid deuterium in a bubble chamber being bombarded by mu-minus mesons. Since the meson weigh hundreds of times more than electrons, if a mu meson is captured by a deuterium molecule the strength of the D-D bond is similarly increased, and the meson chemically catalyzes the fusion reaction. One meson was even observed to cause two D-D fusions before decaying. It is possible that an occasional cosmic ray-induced meson causes excess heat to be released in any deuterium sample, regardless of whether it’s in an electrolytic cell. The Widom-Larsen theory advanced to explain cold fusion is that electrons in the Pd are captured by the deuterons using a weak interaction, yielding neutrons which then either decay or are caputed by the Pd.

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