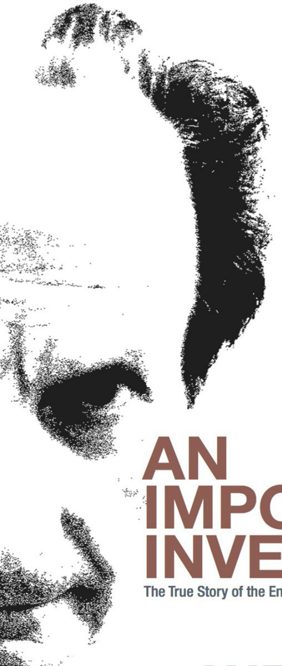
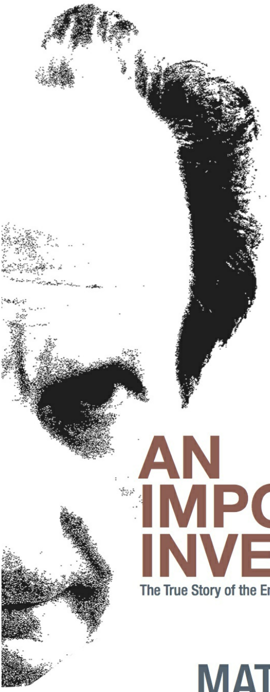


AN IMPOSSIBLE INVENTION

The True Story of the Energy Source that Could Change the World

MATS LEWAN



AN IMPOSSIBLE INVENTION

The True Story of the Energy Source that Could Change the World

MATS LEWAN

An Impossible Invention

Mats Lewan

An Impossible Invention
Published by Mats Lewan, First Edition, Stockholm 2014.
Original title: En omöjlig uppfinning: Den sanna historien om energikällan som kan förändra världen.

Translation by Mats Lewan

US Editor: John Joss
Book cover by Marco Renieri
www.animpossibleinvention.com
Produced by Vulkan.se
ISBN: 978-91-981649-4-7 (Print)
ISBN: 978-91-981649-5-4 (Epub)

An Impossible Invention

The true story of the energy source that could change the world.

Mats Lewan

For Olivia and Joel

In memory of Martin Fleischmann (1927 – 2012), Sergio Focardi (1932 – 2013), Sven Kullander (1936 – 2014), and of several other prominent scientists who were never recognized for their fundamental contributions to the field of cold fusion.

Preface

You might want to look through the book's concluding appendix—*E-Cat theory, or how to become a nuclear physicist in half an hour*—before you start reading this story. But it is not necessary.

The crazy open the roads that the wise then travel on.[1]

Carlo Dossi, Italian writer.

1. I pazzi aprono le vie che poi percorrono i savi. Note azzurre, 1870/1907 (postumo 1912/64).

CHAPTER 1

The start of an unlikely journey

I had tried for weeks to create a mental picture of the man, this strange Italian who seemed to have invented, or perhaps one should say discovered, an unparalleled source of energy with the potential to change the world. Literally the whole world. I had not met him, only heard his energetic voice on the phone a few times and seen a couple of short video clips from a presentation of his invention in Bologna on January 14, 2011—the presentation that led me to this remarkable story. Without deep thought I had imagined him as a typical clichéd inventor. You recall the movie 'Back to the Future?' Something of that sort, aside from Christopher Lloyd's bushy white hair: a little manic and on edge, with an intense but somewhat distracted look in his eyes. Obviously this had little or nothing to do with the man standing before me on that cold and snowy afternoon, February 3, 2011. We stood at the entrance to the editorial offices of the newspaper *Ny Teknik* in central Stockholm, where I had worked as a journalist for more than ten years. No evasive look. On the contrary, facing me was a relaxed man in his 60s with lively eyes and a friendly smile, dressed in a gray jacket and a dark overcoat.

"Buongiorno!" Andrea Rossi said, extending a friendly right hand, easy and relaxed. In his left hand he held a copy of *Ny Teknik* in which we had published, the day before, a major feature interview of him and his scientific advisor Professor Sergio Focardi, with a photo of both men. Almost a comical pair: Rossi's slightly lanky but vigorous frame and steady gaze, his arm around Focardi, a head shorter and a bit chubby. Focardi's wondering eyes looked out from behind dark brown, horn-rimmed glasses with classic '50s cut and thick lenses. Rossi seemed delighted

by the article. His gratitude was easy to understand. I knew that his invention—the ‘energy catalyzer’ or E-Cat—touched an area that had been stigmatized in the scientific community and the media for over 20 years: cold fusion. After the presentation in Bologna a couple of Italian newspapers had covered the event with brief reports. Otherwise the silence was almost total worldwide, both in the media and in the scientific community. So it would remain for a couple of years.

Thorough reporting in a serious, established technology newspaper such as *Ny Teknik*, with its 300,000 readers, represented an important confirmation of Rossi, something for him to celebrate. But Rossi’s unreserved delight worried me and made me suspicious. What had I missed? Was Rossi’s positive reaction a sigh of relief, satisfaction that I had failed to detect something about his work that I should have noticed? Had I helped support something questionable?

Indeed, when it came to Rossi I had been warned, on reasonable grounds. Within the physics community the concept of cold fusion was questioned strongly. There was no broad scientific acceptance that it was even possible. The delicate question of Rossi's proprietary intellectual property made the situation even more complex: he did not explain in detail how the device was constructed, referring to 'industrial secrets,' intellectual property he had to protect. Moreover, he had a couple of failed but quite famous inventions in his past. One was to produce oil from organic waste, another to create energy from the difference between cold and heat via a thermocouple—a small metal structure normally adequate for measuring temperatures or at most for supplying power to electronics. But Rossi had claimed that he could make it produce significantly more energy. On top of that, the demonstration in Bologna created suspicion. It was performed for invited scientists and media representatives, like a news conference—usually a bad sign when it comes to scientific breakthroughs. It often leaves a disturbing aftertaste, the suggestion that the whole picture was not disclosed. Scientific news usually comes in professional, peer-reviewed papers in which all the details are included so that other researchers can replicate any experiment and confirm that the new work is indeed valid. The goal is to share knowledge, rarely the case when scientific news is presented at a news conference, often held to attract investment.

Here it was not a question of presenting a scientific novelty, even if it was revolutionary and epoch-making—if Rossi's device could be shown to work. The presentation in Bologna was more about showcasing an upcoming commercial apparatus. Rossi did not mince words. He promised a pilot installation for a customer in Greece in October 2011, an installation that would produce one megawatt of thermal power. A megawatt is a lot—a well-chosen and moderately impressive power output. It's negligible compared to, say, a nuclear power plant, perhaps a thousandth of such a plant's power output. But it is significant, comparable to a thousand electric radiators at full power, simultaneously, or equivalent to the average consumption of about 300 Western households, including electricity, space heating, water heating and air conditioning. Reference to industrial secrets and IP was therefore justifiable. Rossi's focus was not to convince the world about a new physical process. His plan was to show the world that he had created a new energy source that worked and could be commercialized. He had to convince customers and potential funders. Thus there was no reason to reveal exactly how the device was designed. The important thing was to show that it worked. That the presentation a few weeks earlier in Bologna had been made at all was, according to Rossi, because Sergio Focardi had asked him to demonstrate the technology. Rossi explained that he had wanted to wait for a public announcement until October, when he had something more substantial to show, but that Focardi had been impatient.

"I would have preferred to do it earlier. You see, when you achieve results, it is satisfying to spread them. Besides, I'm 78 years old and cannot wait that long," Focardi explained when I called him.

Rossi didn't seem immediately to be fishing for money. On the contrary, he stated clearly that no one would owe him anything before the plant in Greece was completed, up and running. He said that he was paying for all development himself, out of his own pocket, with money from his previous activities. So the old business and earlier inventions had to be considered. But even before I reviewed his background he had explained the situation to me and told me his own version of why his company—Petroldragon, with its invention of oil from waste—closed abruptly and led to his being arrested for environmental crimes and tax fraud, charges of which he was subsequently acquitted in most respects. His explanation, if not self-evident and easy to confirm, was at least plausible, I thought, though Rossi had paid a stiff personal price. In brief, he explained, you do not go unpunished when moving into an area where you fight two powerful interests simultaneously: the oil industry, selling oil, and organized crime, seeking to control waste management in many countries. I perceived acceptable explanations for all the warning bells that the skeptics observed—the failed inventions, the trade secrets, the news conference and the problems with his old business.

The crucial issue was the device itself. It may not have increased Rossi's credibility that it looked like a sloppily built home-distilling apparatus wrapped in aluminum foil. The biggest problem was different: most physicists and scientists agreed that it absolutely could not function the way Rossi and Focardi claimed. Yet it seemed to sit there and simmer and produce much more heat than was supplied through electricity, and not small amounts, either. The device was boiling water to steam with a net power of ten kilowatts, roughly comparable to an electric stove with four burners at maximum heat. The scientist who testified that the device actually produced that much heat was Giuseppe Levi, an experimental physicist and researcher at the University of Bologna, widely considered to be the world's oldest such institution. Levi had been a colleague of Professor Focardi for many years and had been engaged to monitor the demonstration in Bologna from a scientific point of view, with an eye on the instruments and on how the measurements were made. He stressed that the results were preliminary, but obviously the apparatus had made a strong impression on him.

"I saw this object for the first time in December 2010 and I am very impressed by the high power output," he said, when I talked to him on the phone. "What impressed me and what sets this work apart from everything I've ever seen is that we have 10 kW of measured power output and this output is completely repeatable," he continued.

It's not particularly difficult to measure heat energy, especially such large amounts. You simply let the energy source heat water and then use straightforward formulas to calculate how much energy is required to heat that water from a certain temperature to another. If the water boils into steam, there is a simple formula for that, too. For physicists, either process is usually a breeze. But in this case the result was so controversial that everyone involved looked anxiously for all potential sources of error. What could possibly have been missed?

As for me, I stood there at my offices, that day in February, wondering if the man with the lively eyes, gentle smile and friendly handshake was perhaps an accomplished con artist. I realized that it would be difficult to uncover such a fraudster but I imagined that I could at least apply my journalistic experience and engineering education. My questions lined up one after the other, spanning a broad spectrum. What data were presented? How reliable were the sources? How credible were the theories according to which the apparatus could not work? How much of the scientific skepticism was pure sociology—resistance to the new? Who were the people involved? What were their scientific backgrounds and credentials? How did they behave? What were their motives? What risks did they take? How would a scam be implemented? How many people had to be involved in a possible scam? And who was Andrea Rossi?

"Rossi is behaving as a serious scientist. Anyone who tries to execute forgery behaves differently and does not go into a physics department, does not accept that you put up measuring instruments and does not confront scientists," Levi had told me. I had never met Levi but I had no reason to doubt his judgment. On the other hand, the whole story was so controversial that I felt that basically I should not trust anyone. All these thoughts had passed through my mind as I stood there before Rossi. I took his outstretched hand and greeted him—his was a firm handshake, without hesitation.

He immediately held up the newspaper article. “This is lovely, *bellissimo*—many thanks!” he said. I mumbled that there was nothing to thank me for. We chatted, while I continued to think about who he really was, then asked if he’d like a cup of coffee. We went around the corner to my little watering hole, an Italian coffee bar that I used to sneak down to every morning for a *seconda collazione* or second breakfast: *capuccino* and *cornetto*, plus a chat in Italian and time for reflection. Behind the bar the coffee machine gleamed, managed by Alessandro and Vincenzo, two young Italians from Puglia who ran the place. Their establishment was one of the few sources of really good quality Italian coffee I knew in Stockholm.

§

I had acquired a bad habit with *la seconda collazione* when living for a couple of years in Italy, obviously influential in this story. My wife is Italian and I learned to speak the language with relative ease. Added to my physics knowledge as an engineer, this seemed to have been crucial in contacting Rossi. After his previous experiences he was reserved towards journalists. Indeed, my Italian language skill had made me aware of Rossi's device. A few days after his semi-public presentation in Bologna one of our readers had tipped the newsroom with a link to a blog in Italian. Looking at it, an informal report on Rossi's work, I had realized quickly that the results were unique, if they were genuine. I thought also that with my skills in Italian I could perhaps examine the sources properly. I was skeptical, however, and in no great hurry.

Only the day after, I wrote a summary of the news, published on the newspaper's website, entitled *"Cold Fusion: now supposedly ready for production."* Then I thought no more about it. After a few hours I had to change my mind. The response was tremendous. Readers pounced on the news. From experience we knew that our readers —mostly engineers—were keenly interested in the topic of energy. While the general public was concerned about how energy consumption and carbon emissions affected the environment, most engineers' approach was ravenous interest in every possible technical solution to the problem. Solving the energy issue had recently become many technicians' ultimate dream—the Holy Grail—and the primary goal of many entrepreneurs, large and small, particularly those with a history of success in other areas who now had money to invest in new projects. A new energy source that promised cheap, clean and virtually limitless energy was an irresistible morsel for readers, especially if they could discuss whether it worked or not. The article exceeded all other stories on our website in number of readings and soon surpassed 100,000, well beyond any prior story. In absolute terms, this was also a high figure for a technical article in Swedish—Sweden is a small country with a population of nine million. Readers entered immediately into a lively discussion about the technology, based on their engineering expertise in various areas. Comments rapidly reached several hundred and soon the same polarization crystallized, as it had earlier with other observers: on one hand it couldn't work based on established physics; on the other hand it seemed to be working. Then the readers' questions arose: who was Rossi and what did he really want? They wanted to know more.

First I contacted Hanno Essén, a Swedish theoretical physicist at the Royal Institute of Technology in Stockholm. His profession as a physicist was in itself significant but he was also president of The Swedish Skeptics Society[2]—with its sister organizations around the world it persistently debunked pseudoscience, i.e. things presented as science but that according to the association were folklore or outright lies dressed up to instill scientific confidence. I asked him to review Rossi's work and its documentation, including a somewhat scientific paper that Rossi and Focardi had published a year earlier, in February 2010. The paper carried little weight. It had not been accepted by established scientific media—a small world of specialist publications containing articles based on peer review, in which submitted papers are reviewed and critiqued by independent experts and researchers in the same discipline before being approved for publication. Rossi's and Focardi's paper could not be accepted in that world, partly because there was no scientifically acceptable explanation for the process within the unit, but above all because its design was not described in detail—Rossi's famous 'industrial secrets' were precisely that, secret—and other researchers thus could not repeat the process based on the paper. Instead it was published on a website that Rossi started and named *The Journal of Nuclear Physics,* immediately evoking scientific journals, though it was Rossi's own website.

Hanno Essén reviewed the material. To my surprise his first comment was: "This looks interesting." I was immediately curious and asked him to explain. Like Levi, Essén noted that it revealed a hefty amount of energy and experimental data. “The fact that it’s reproducible, that they actually built a stable unit, that’s new,” he noted. A lengthy discussion ensued.

“But the objections regarding physics?” His response was that much of our knowledge of nuclear physics had been established for many years but areas remained where our understanding was poor. “There is no need to be dogmatic,” he said. He mentioned a paper of his own that he, like Rossi and Focardi, had posted on an open website without peer review. It could possibly concern the physics in Rossi’s device but had been met with silence when he published it. The paper described a phenomenon that occurred when you heated metals. Among other things, electrons were generated that orbited at speeds approaching the speed of light, creating a state of so-called plasma that was one area where scientific knowledge was still limited.

I recalled history’s great scientists and explorers, visionaries with subversive ideas such as Nicolaus Copernicus, Giordano Bruno, Galileo Galilei and Charles Darwin. Some clashed with contemporaries when presenting ideas contrary to established views and threatening a prevailing worldview. Others risked death or were—as with Bruno—even executed. Galilei, often cited as the father of science, focused his binoculars—the invention he had himself refined—towards Jupiter. He discovered four moons circling the planet and realized that he not only had good reason to agree with Copernicus that the earth could not be the center of the Universe, with heavenly bodies attached to large globes of glass rotating inside each other, but that he, Galilei, had evidence. That he later observed the phases of the planet Venus through his binoculars was icing on his astronomical cake. He could not with impunity question a view that had existed for millennia. The earth as the center of the Universe was a concept fundamental to the beliefs of the Roman Catholic Church. If one could not trust the Church in that, how much more could one not question? What might people start to believe, or disbelieve? The Vatican had realized those dangers from the start. Galilei had ended up in front of the Inquisition, forced to renounce his ideas and placed under house arrest for the rest of his life. But he continued to write in secret anyway.

New knowledge could indeed be that frightening, both to those representing the current knowledge and to those with powerful interests based on the current world order. Though our scientific methods may seem modern, a similar situation could occur even today. It was not hard to understand, though in this case it was about knowledge—nuclear physics—that was only about 100 years old, not 2,000 years. It was also obvious that enormous power interests were at stake, if a cheap, clean and virtually inexhaustible energy source emerged, but I had difficulty believing that this would be significant already in assessing the physics of the device. Instead, it was a threat waiting just around the corner, if the apparatus worked.

I thanked Hanno Essén for his comments, hung up and gathered my thoughts. A device that should not work but seemed to work anyway. A skeptical physicist who thought it 'interesting.' An overwhelming response from readers. This was an intriguing combination. I had to talk to Rossi, I thought, and sent an email in Italian to him and Focardi, formulated with the usual Italian courtesy phrases, noting that interest in Sweden was huge. Could I interview him? I apparently intrigued him and received a reply the same day. *"Great, I'll call you at 1400 tomorrow,"* Rossi wrote.

The interview with Rossi and Focardi was the feature we published on *Ny Teknik's* cover—the one Rossi had seen, stepping through our office door in Stockholm that day in February when we first met. As is our custom, we also published it on our website in Swedish in slightly different form. Since I began to understand that there was significant international interest and that no major media had picked up the news, I did a self-translation into English that we published on the website simultaneously. Later, it seemed that the English version had not only acquired a large international audience, it also seemed to influence events in this story.

On our website, the article was headlined: *"Cold fusion may provide one megawatt in Athens."* In the newspaper, it said instead, on the front page: *"We deserve the Nobel Prize."* It was not Rossi but Focardi who, politely cautious, expressed his views on the technology and the possibilities of the Nobel Prize when I interviewed him.

"You know, rewards are something I usually give to myself," he first said, modestly. Then he added: "I believe—forgive me if I say it—that this is the greatest discovery in human history. So let's say that if they were to award us the Nobel Prize, I think it would be well deserved."

When I later saw the headline on the front page, mentioning the Nobel Prize, I thought that if it all turned out to be a well-executed hoax or misunderstanding, or if the apparatus simply did not work, the critics would take every opportunity to mock us for that title even if we had been quoting something Focardi had said. If it worked, it would be almost an obvious Nobel candidate, though it was not clear to whom it would be awarded. The front page of the print version would then be easier to defend, I said to myself, and thought of my editor Jan Huss who had made the decision to publish it as big news despite his skepticism.

§

Rossi got a couple of copies of the newspaper and we went down to the coffee bar for an espresso and a follow-up interview. I had a battery of questions. My own speculations, readers' different views, ideas on how the device could be made to produce heat with hidden methods, oddities surrounding the Greek client, Professor Focardi's role and a number of other matters that needed answers. Above all, I wanted to try to understand who Rossi was and what drove him. To all my questions he had direct answers. And I believed that I had understood two things. The first was that Rossi seemed to be a very intuitive person who often took quick and important decisions based on gut instinct. The second was that based on his intuition he already seemed to have decided to trust me. I realized that this could serve his purposes. Having an interested journalist as a friend in the Nobel Prize nation, with a large, curious and knowledgeable readership, was valuable to him even if he could not control what I wrote. Though he could not know what I would publish, he told me details that could harm him if they became public, including his early collaboration with a large American corporation that probably did not want to advertise a link to the suspicious cold-fusion area.

I ended up in a classic journalistic quandary. I had received information that I could not publish freely because I would risk losing the connection with Rossi, my main source. On the other hand, I could not reject the information he was giving me. It helped me to build up an over-all picture that formed the basis of relevant reporting. Moreover, I realized that the technology itself, with its huge potential, was so fascinating that those involved could become virtually spellbound and lose their perspective. I had to count on Rossi, the concerned scientists and my own judgment. I could console myself only because I understood the risks. I realized all too well that I had just begun a journey that could end up... anywhere. I knew that as far as possible I should keep in touch with people holding different views on Rossi and his invention, and enter into discussions with them, in person and with an open mind. Then it was just a matter of getting on the train.

2. F÷reningen Vetenskap och Folktro

CHAPTER 2

What is cold fusion?

1. When a distinguished but elderly scientist states that something is possible, he is almost certainly right. When he states that something is impossible, he is very probably wrong.

2. The only way of discovering the limits of the possible is to venture a little way past them into the impossible.

3. Any sufficiently advanced technology is indistinguishable from magic.

Arthur C. Clarke's Three Laws [3]

Cold fusion. To many people it may sound more like a dessert than a physical phenomenon. It is a concept that has become controversial in science since 1989 when two scientists at the University of Utah, Martin Fleischmann and Stanley Pons, astounded the world with a fantastic new energy source that according to them was based on what they called ‘cold fusion.’ It is called cold because it is not nearly as hot as plasma fusion or ‘hot’ fusion—the process that lets the sun and stars live for billions of years and produce huge amounts of energy. Cold fusion would mean keeping a similar process running on a desktop, at a temperature of several hundred degrees, and extract energy, based on a process within nuclei—hence, nuclear. Colder than the sun but still so hot that it would burn if touched.

In many ways cold fusion seems to be a great energy source, almost too good to be true:

- It is inexpensive and virtually inexhaustible—just like hot fusion it uses hydrogen or heavy hydrogen, part of water and among the most abundant elements on Earth and in the universe; and it would use only about a gram of hydrogen to run an automobile for a year;

- It is clean—the fuel is harmless and leaves no hazardous waste or emissions;

- It is easy to use—it requires no high temperatures and produces practically no radiation while running, so it can be placed basically anywhere without needing security or protection;

- It’s peaceful—unlike the ‘weapon’ connation so often associated in the public mind with the word ‘nuclear,’ it has no immediate purpose as a means of harming anyone or anything.

Some of these properties make cold fusion fundamentally different from hot fusion. Hot fusion generates for example intense radiation, so much that anyone who gets close to a plasma fusion reactor, without several meters of radiation protection, dies instantly. There are no operational plasma-fusion reactors, however. For decades researchers have been trying to tame the solar and stellar nuclear reaction to produce what many believe would be the ultimate source of energy, fueled with heavy hydrogen from ordinary seawater. But despite huge investments in gigantic projects, fusion technology is still in the experimental stage. The powerful radiation is one of the challenges. Another one is that hot fusion reactors must operate at hundreds of millions of degrees, even hotter than the sun and stars.

The fact that cold fusion does not generate any significant radiation nor requires such high temperatures, are things that prevent most physicists from believing that it's a feasible process (read more about this in the appendix). And to avoid the term 'fusion' a new, broader concept—Low Energy Nuclear Reactions (LENR)—has emerged. It is still a kind of nuclear reaction, like fusion. By 'low energy' we mean that the reactions occur at moderate temperatures and are less violent. But omitting the word fusion, the term LENR leaves open the question of how these reactions work.

Whether you call it cold fusion or LENR, it is in other words an energy source that would be as clean and inexhaustible as hot fusion, but far cheaper and without the intense radiation. And again, cooler, which makes it easier to work with and more practical. Moreover, it could be contained within a convenient form factor that would fit in a standard home or perhaps in vehicles of many kinds. In other words, LENR is a dream come true for those trying to figure out how the world could enjoy cheap, clean energy and end its reliance on costly, dirty, hydrocarbon energy sources such as oil and coal; and costly, potentially dangerous ones, such as conventional nuclear power plants. The memories of Three Mile Island and, more recently, Fukushima Daiichi, are always in the public mind.

No wonder there was such a stir when electrochemists Martin Fleischmann and Stanley Pons presented, at that news conference at the University of Utah on March 23, 1989, startling results they said might be caused by cold fusion. In front of journalists, the scientists assured the world that it was a clean and inexhaustible energy source that used heavy hydrogen, present in sea water, as fuel. The researchers' results immediately became global news. 'Cold fusion' was on everyone's lips. The description had been used a few times before—as far back as 1927 the Swedish physicist John Tandberg applied for a patent on a process at room temperature, which produced energy and was similar to Fleischmann's and Pons' method. But it was in 1989 that the idea of cold fusion got its breakthrough and it is still intimately connected with Fleischmann and Pons.

That the fuel was found in ordinary sea water sounded too good to be true. In fact it was just water they started with to produce the 'nuclear reaction' they thought they had discovered. Because the point they made was that it must have been a nuclear reaction. They had been experimenting for several years with a setup that suddenly began to produce an anomalous amount of heat. Not much heat—water in a beaker suddenly reached 80 degrees Celsius, though it otherwise remained around 60 degrees. But there was enough heat to exclude chemical reactions as an explanation. There was not enough material in the experiment to function as chemical fuel and create the measured energy, by a wide margin. The heat energy released was hundreds or thousands of times greater than what could come from any kind of chemical reactions in the experiment, such as combustion.

Fleischmann and Pons therefore assumed that some sort of unknown nuclear reaction was occurring. The reason: nuclear reactions produce about a million times more energy than chemical reactions from a given amount of fuel. A nuclear reaction seemed to be the only possible explanation. Their message immediately became top news in newspapers and TV channels worldwide. The scientific community initially seemed to react with optimism, surprised not only at the results but also at the very idea, which was both bold and innovative. The problem was that the experiment seemed difficult to replicate, and repeatability is crucial for scientific research to be considered acceptable. It makes independent replication of a claim possible, a core value of the scientific method. Moreover, it was not entirely clear what one was trying to replicate because no one knew exactly what cold fusion was. Only one thing was clear—it was not ordinary fusion because it would have produced such strong radiation that the experiment itself would have killed the researchers.

During the weeks after the announcement, researchers worldwide tried to repeat the experiment, with mixed results. Some found a few of the signs of a nuclear reaction that Fleischmann and Pons claimed; others found nothing. Then something unusual happened. Some physicists were skeptical from the start, saying that the described process conflicted with established knowledge about fusion and nuclear physics. Others seemed, during the first weeks after the news conference, to be sincerely curious about the exciting new idea and seemed to have faith in Fleischmann and Pons and in their methods. Among them were those who tried to repeat the experiment but failed, and believed that they might have missed something important in the experimental setup, as often happens with new scientific experiments. They let the lack of verified conclusions be a temporary advantage for Fleischmann and Pons—in other words they gave the two men the benefit of the doubt. In his book *Undead Science: Science Studies and the Afterlife of Cold Fusion*, sociologist Bart Simon used the term '*interpretive charitability'* to describe the phenomenon.

Researchers who failed were generously prepared to doubt themselves rather than Fleischmann and Pons. A reasonable motive could be that Fleischmann and Pons had worked for several years with the experiment while researchers trying to repeat it had tried only for a few weeks. This is the normal process in science. An experiment lacking a specific outcome is never evidence that the outcome is *impossible* to obtain. It is simply an experiment in which the described results could not be verified. Consider, as a historical example, the scientific certainty for many years that noble-gas compounds could not be created, until Howard Claasen and Neil Bartlett in 1962 independently created xenon compounds. The ‘impossible’ was soon verified.

But in May 1989, a few months after the Fleischmann and Pons news conference, public opinion in the scientific community had swung. The American Physical Society held a seminar on cold fusion in Baltimore. Around 1,800 people were on site when one negative report after another was presented about the attempts to replicate the experiment. Fleischmann and Pons, who were not present, were severely criticized and accused both of incompetence and of engaging in *pathological science*, i.e. when researchers, through self-deception and wishful thinking, find non-existent results. Participants at the workshop applauded.[4]

Bart Simon notes that many who tried to replicate the experiment and failed, who had previously doubted themselves, now decided to doubt Fleischmann and Pons—without having their own new results to support their decision.

The ball was rolling. In the following months, several critical papers were published in a number of scientific journals. Failed attempts to replicate the experiment at the California Institute of Technology, Caltech [5], and at the MIT Plasma Fusion Center, PFC [6], had a particular influence. The management of PFC had said in a newspaper interview that Fleischmann's and Pons' research was 'scientific schlock' and 'possible fraud'—a suspicion related to a grant of $125 million that the Bush administration, together with the industry, had started to discuss with Utah University.[7]

And when the U.S. Department of Energy (DoE) in November 1989 published an acclaimed report by a panel that had examined cold-fusion theories and experiments, MIT's paper was placed first among the references. The DoE report killed cold fusion as defective research. It recommended that no special funding be offered to investigate cold fusion and that no special programs or research centers be established. It concluded that the results were poor, ending with the statement: *"Nuclear fusion at room temperature, of the type discussed in this report, would be contrary to all understanding gained of nuclear reactions in the last half century; it would require the invention of an entirely new nuclear process."* [8]

The fact that Caltech's experimental results later turned out to probably have been positive, but that the researchers had misinterpreted them, changed nothing (the journal *Nature*, where Caltech's paper had been published, categorically refused to provide space for such criticism[9]), neither did the disclosure that the measurements in the experiments at the MIT Plasma Fusion Center had been altered before publication have any significance, nor that scientists had also made a joke of cold fusion and celebrated its death with a wake even before the results were ready. Until the measurements from PFC had been altered, they had shown small signs that the experiment had worked, but somebody had apparently found reasons to hide those signs.[10] Could it have been because the funds to PFC, which conducted research on hot fusion, were threatened if cold fusion proved to be a working process?

Nothing seemed to shake the scientific community's rapid judgment against cold fusion. Icing on the cake was perhaps when Professor Ronald Ballinger at PFC outlined his views on cold fusion in *The Gordon Institute News:*

"It would not matter to me if a thousand other investigations were to subsequently perform experiments that see excess heat. These results may all be correct, but it would be an insult to these investigators to connect them with Pons and Fleischmann. (...) Putting the 'Cold Fusion' issue on the same page with Wien, Rayleigh-Jeans, Davison Germer, Einstein, and Planck is analogous to comparing a Dick Tracy comic

book story with the Bible." [11]

Not until 15 years later, in 2004, did the DoE undertake a new evaluation, this time on the initiative of a handful of researchers who since 1989 had sacrificed promising careers for to work in the still-resented field of cold fusion. Finally, after over a year of discussions with the DoE, a meeting was quietly organized at the hotel Holiday Inn in Rockville, Maryland on August 23, 2004. One by one, the six researchers described their results, hoping at least to be able to argue for further research in the field. The panel reviewing the presentations and the state of the research into cold fusion consisted of 18 anonymous experts from various fields, half of whom were present at the meeting. When the day was over, the mood among the presenting scientists was positive. They later said that it was liberating just to be taken seriously by the panel.

But the report, released on December 1, 2004, dashed their hopes. The conclusion was more or less the same as that presented in the DoE report in 1989.[12] The report was criticized by people who knew the state of the research well. Their analysis made it likely that the panel had not studied the conditions of the experiments particularly well and that it had dismissed the research results on weak grounds. The panel did not explicitly disapprove further research in the field. But when Professor Melvin Miles, an experienced electrochemist and researcher in cold fusion, later filed for a new research grant and got the cold shoulder without a detailed examination of his application, doubt faded—cold fusion was still, in practice, not acceptable in the scientific community. [13]

Yet the situation was strange. While cold fusion was condemned by most scientists, many peer-reviewed articles published in scientific journals reported on successful observation of excess heat in experimental setups similar to Fleischmann's and Pons'. In April 2009, at least 153 such articles had been published, most of them from 1989 and the following years.[14] The articles were written primarily by about 60 scientists from 50 institutions, including John O'Mara Bockris, Edmund Storms, Tadahiko Mizuno, Yoshiaki Arata and Michael McKubre are often mentioned. Despite criticism from other countries they had stubbornly continued their research, often with limited resources, yet confident of being able to contribute importantly to humanity.

One might imagine that the field had attracted dozens of incompetent or mad scientists who had become enamored of the idea of cold fusion and had tricked themselves into finding results where there were none—more or less what Fleischmann and Pons were accused of at the American Physical Society seminar in May 1989. But most of these researchers were serious and competent, not least Martin Fleischmann himself. Up until the 1989 news conference, he was considered one of the world's leading electrochemists. It seemed more reasonable, then, that all results showing the generation of excess heat indicated that an unknown nuclear process was hidden in the middle of it all (i.e. precisely what the DoE so perceptively had stated was required to complete the picture) but that such a process was so unlikely to work in the experimental setups being used so far that results became uneven, highly unpredictable and hard to repeat. Yet even the DoE's initial report did not register total disapproval. It concluded: *"It is not possible at this time to state categorically that all the claims for cold fusion have been convincingly either proved or disproved"* [15] But this precarious situation seemed still to have troubled the research community. Debating after the news conference, when a stance for or against was required, the majority chose to turn their backs on cold fusion. In terms of Bart Simons' analysis, they chose to reduce their *interpretive charitability*.

The scientific community's judgment against cold fusion thus seemed to have been based on sociological rather than on scientific grounds. The fact that the cold-fusion phenomenon also threatened research funding into hot fusion hardly helped. Traditional fusion research was based on conventional nuclear physics, in which cold fusion seemed to have no place. To be forced to compromise on that model and reduce research was not pleasant for those involved, especially since it involved billions of dollars (and other global currencies) in funding.

The most startling aspect is perhaps that the negative attitude towards cold fusion has persisted, despite the more than 150 observations of the phenomenon mentioned before, with experimental results published in scientific journals since 1989. Even when the DoE made its second evaluation in 2004 there was, according to most of the scientists involved in the research, no further doubt that excess heat was occasionally produced in experiments of the type that Fleischmann and Pons made. Those observed increases far exceeded any explainable via chemical reactions. It was also clear that elements that could only occur through nuclear reactions were occasionally produced. Furthermore, by 2004 one of the most experienced cold-fusion researchers, Michael McKubre, who was also at the DoE's evaluation in Rockville that year, had identified a number of conditions required to reproduce the effect—a series of specific requirements that explained why many had had such difficulty replicating Fleischmann's and Pons' experiment.[16] Similar conclusions were drawn by chemistry and physics professor Dennis Cravens in 2008, when he identified common criteria for those who had successfully replicated Fleischmann's and Pons' experiment.[17]

These specific requirements probably lay behind the elusive and almost mocking nature of the phenomenon. Among the few researchers who had become entrenched in the area, many had achieved clear and obvious results occasionally, only to see no measurable results after that. Some testified that it was precisely because they had observed clear and positive results in the early stages that they continued their research. Otherwise they would probably have abandoned it, given how difficult it seemed to capture and repeat the elusive phenomenon, though they had used exactly the same experimental setup repeatedly.

But did they really use the *identical* experimental setup? Perhaps, when the experiment worked, the researchers had fulfilled conditions of which they themselves were unaware and thus could not control. It could concern subtle characteristic in a metal that varied from one sample to another, though the chemical composition and purity, according to the specifications, were identical in all the samples. In 1996 radio chemist Edmund Storms wrote the paper *How to Produce the Pons-Fleischmann Effect* [18], in which he revealed that an important aspect was how to choose functional pieces of the metal palladium that was central to Fleischmann's and Pons' experiment. Storms had tried out samples comprising 90 pieces of what were, at least in principle, identical palladium, one at a time, and after a year of experimentation he found that only four of these worked [19].

This is also why cold fusion is thought to need collaboration between researchers in many fields—nuclear physics, material science, chemistry, astrophysics, electrochemistry, thermodynamics and more, to understand as many parameters as possible. For that reason, it is a problem that the field has attracted so few researchers. This is because it has had such a bad reputation that no young researchers could engage in it without risking their careers. The small, active group over the years has consisted of a few older truth-seeking scientists with less to lose. And if the original experiments have been difficult to replicate, the work has not been improved by the fact that so few have even tried to do the experiments.

When repeatable results are not produced, experimenters have not even arrived at the first step in the traditional scientific method—comparing experiments and theory by performing the experiment again and again, gradually changing the parameters to see how the results are affected, then drawing conclusions. This is why so few scientists have taken seriously the hundreds of reports of clear, well-documented results in cold fusion. But from the perspective of the documented results and reasonable explanations for why repeatability is so difficult to achieve, it becomes obvious that cold fusion has received undeservedly bad treatment, especially given the technology's enormous potential. Some have compared the situation to the physicist Wolfgang Pauli's comment, writing to his colleague Rudolf Peierls in 1931: *"One shouldn't work on semiconductors, that is a filthy mess; who knows whether any semiconductors exist".*[20] Researchers had for decades sought an acceptable explanation for the semiconductor phenomenon, which later turned out to be perhaps the greatest discovery in the 1900s on which the world's whole modern information-technology industry has, in practice, been built.

Just as with semiconductors, much of the constant controversy surrounding cold fusion started when no acceptable way was found to explain the phenomenon theoretically with known physics. Just as the negative view of semiconductors was unfair in the 1930s, the treatment of cold fusion seemed similarly unfair. It was obviously, also, an unacceptable waste of human resources that the eminent scientists Fleischmann and Pons and more with them, such as Nobel laureate Julian Schwinger, suffered serious allegations and effectively were frozen out of the scientific community for their attempt to observe or understand anything related to cold fusion. Yet a small group of scientists continued to work, stubbornly. The most visible aspect of their research has been the calibrated measurement of excess heat generated, along with constant attempts to achieve repeatability. Because if excess heat could be detected beyond doubt, and if the results could be repeated, theoretical protests would be moot. It was also what the DoE recommended that further research should focus on.

Now the crux of the matter emerges. Andrea Rossi's E-Cat received so much attention, so quickly, from established researchers and significantly shook the current chilly reaction to cold fusion and LENR, because it produced so much excess heat and seemed to start without hustle every time it was switched on. It was the first time the phenomenon seemed both repeatable and strong enough to be used in a commercial product. Also, this time, suggestions on possible theories led mostly to long discussions based on locked positions. The crucial question, on the other hand: had excess heat been measured correctly or not? This matter also provoked lively discussion. The measurements on Rossi's device had not been particularly accurate—not at all in line with many previous experiments in cold fusion. Yet the developed thermal energy was so large that it was not particularly difficult to measure and difficult to deny. Because the scientific community's resistance to cold fusion and LENR had become so entrenched, the difficulty of questioning the excess heat generated in Rossi's device led instead to a feverish search for sources of error and the possibility of fraud—that is, how measured values could be manipulated or external energy inserted. On the other hand, if Rossi's device really worked, large parts of this chapter—the entire monumental skepticism over cold fusion, plus all past research on hot fusion as an energy source—would be turned instantly into the timeless history of science.

3. http://en.wikipedia.org/wiki/ClarkeÆs_t

4. http://partners.nytimes.com/library/nat cold-fusion.html

5. Lewis, N.S., et al., Searches for low-temperature nuclear fusion of deuterium in palladium. Nature (London), 1989. 340(6234): p. 525.

6. Albagli, D., et al., Measurement and analysis of neutron and gamma-ray emission rates,other fusion products, and power in electrochemical cells

having Pd cathodes. J. Fusion Energy, 1990. 9: p. 133.
7. http://www.infinite-energy.com/images/pdfs/mitcfreport.pdf
8. http://files.ncas.org/erab/sec5.htm
9. http://lenr-canr.org/acrobat/RothwellJhownaturer.pd
10. http://www.infinite-energy.com/images/pdfs/mitcfreport.pdf
11. http://www.infinite-energy.com/images/pdfs/mitcfreport.pdf
12. http://lenr-canr.org/acrobat/DOEreportofth.pdf
13. http://lenr-canr.org/acrobat/LENRCANRthedoelies.pdf
14. http://lenr-canr.org/acrobat/RothwellJtallyofcol.pd
15. http://files.ncas.org/erab/sec5.htm
16. http://www.youtube.com/watch?v=5_XN52jX178
17. http://lenr-canr.org/acrobat/CravensDtheenablin.pdf
18. http://www.lenr-canr.org/acrobat/StormsEhowtoprodu.pdf
19. http://lenr-canr.org/acrobat/RothwellJlessonsfro.pd

(p8)
20. Hoddeson, L., Braun, E., Teichmann, J. and Weart, S. (1992). Out of the Crystal Maze, Oxford University Press, 121.

CHAPTER 3

Rossi

Andrea Rossi was born on June 3, 1950 in Milan, at the start of perhaps the most prosperous time in Italy's modern history, a time that gave great scope for development when World War II was over and the Fascist regime gone. His father Luigi ran his own company—*Metallotecnica Rossi*—which fabricated steel structures for the construction industry; his mother Ada helped in the company. They became the parents of Andrea Rossi and his sister, four years younger, during an intense period in Italian society that was rich both culturally and industrially. An important event was when Italian state television, RAI, started broadcasting in 1954.

Paradoxically, it seems that television united Italians linguistically more than schools and teaching could. Hundreds of years of division into regions and small kingdoms with strong local traditions meant that there were—still are—many local dialects and even a series of regular languages, in addition to the Italian language. Only in the '50s, with the breakthrough of television, was today's Italian language becoming the common national language. Television had a strong role in shaping Italian daily life then.

Another trend was that Italians began to move around the country and discover new opportunities, helped by legendary industrial products such as the Vespa scooter and the tiny FIAT 500 car, which was rapidly replacing the motorized bicycles and small motorcycles immediately after WWII. In film and television footage of that era one can see how the queues at toll stations during vacations consisted almost entirely of Fiat 500s. Even Rossi's parents had one, a model popularly called the *Topolino* or Little Mouse, which FIAT had produced in the mid and late 1930s in an earlier design. "I still remember when I was five and my father bought two small pastries at the bakery and I put them on the armrest of the Topolino," Rossi told me, when I once asked him about his background and upbringing.

But what many may associate most with Italy in the '50s and '60s was *La Dolce Vita*—the relaxed, dissolute lifestyle that attracted movie stars and the jet set from around the world—a lifestyle named after Federico Fellini's classic movie from 1960 with Marcello Mastroianni and the Swedish actress Anita Ekberg in the lead roles. Andrea Rossi was too young to see the movie when first released but as a child he watched RAI's success show *Carosello*, which premiered when he was seven. "It consisted of four or five short movies lasting two or three minutes each, well made and fun. Kids habitually watched *Carosello* and then went to bed. This was also true for me." Carosello was not a children's show but, for those days, a cunning format with advertisements for various products. The short pieces—usually cartoons or jokes—were created for companies. All ended with a promotional message addressed to the parents.

Best known of the characters was perhaps the little black chicken *Calimero*, with half an eggshell on his head, involved in various adventures, who complained that no one wanted to play with him because he was black. Each episode ended with the mother in the house saying, "But *Calimero,* you're not black, you're just dirty!" Then she washed him clean and bright in a large wooden tub with water and a detergent named Ava. "*Ava come lava*" ("Ava washes so well!"), *Calimero* then exclaimed.

Another character Rossi remembered was the Indian *Unca Dunca* who in some unclear way made advertisements for boilers. "It was a boon for the industry—the audience was huge, with only one TV channel. And since little advertising was shown, a company immediately became famous if it participated in the *Carosello*. In fact there was a waiting list. Not everyone could make it to the

Carosello."

Another TV program Rossi followed was the American series about the historic German Shepherd dog *Rin Tin Tin*, which became successful in Italy in the late '50s. But what seems to have characterized Rossi's upbringing most was something else entirely.

"I was born with a severe form of asthma. The doctors said they did not know if I would survive. For years I suffered from allergic asthma. I was allergic to all sorts of things—eggs, fish, citrus fruits, chocolate and all kinds of herbs and plants. They caused both allergic reactions and asthma attacks and for my first ten years I lived as in a glass house. I had to be kept virtually vacuum packed and of course I was never well. When I was playing with other children I was always fragile and I suffered from a complex about all this.

"But at age twelve I said that this was too much. I was fed up! I had had enough. I went to a boxing club on *Via Zuccoli*, near where I lived. The club was run by Nazzareno Giannelli, who had been a European flyweight champion in the fifties, and like all flyweights he was very technical. He was fond of American music—Frank Sinatra, Dean Martin, Ella Fitzgerald—which he always played in the training room, with a tape recorder of the brand *Geloso*.

"So I started boxing. Curiously, when I decided not to live in a glass house anymore I recovered from my asthma. I became good at boxing too. Since I was a lightweight I could just rely on technique. The others couldn't hit me. I learned to dodge and I always won." So though many people associate Italy during *La Dolce Vita* with pleasures and dreams, and with one movie after the other recorded in *Cinecittà* in Rome, this was not what set the tone of Rossi's life. His parents did not go to the movies and he himself had little time for entertainment. "I devoted my life from ten to twenty mainly to studies and sports. I had no time for other things. In a way it was good because

I became used to working a lot. The schools I attended were intense and the teachers loaded us with homework. I studied a lot; I have always been one who worked much in school. Of course my favorite subjects were the scientific ones.

"And I always did sports in a serious way too, at a competition level. It takes a lot of time and it forces you to adopt a certain lifestyle. If you're into competitions you want to win, otherwise it's pointless to compete. The time remaining for doing other things is short."

At 18 Rossi finished with boxing and turned to long-distance running—a sport that gave room for his dedication and his urge to do things on his own. At 19 Rossi performed a athletic achievement that in some ways would symbolize his future life. The challenge: run as far as possible on a track for 24 hours nonstop. Between April 23 and 24, 1970 Rossi concluded the race at the *Calvesi* stadium in Brescia. In 24 hours, he ran 175 kilometers and 144 meters[21], beating the former Italian record set in 1891 by the legendary Luigi Vittorio Bertarelli.[22] An enthusiastic piece in the newspaper *Giornale di Brescia* next day describes how a small group of supporters had cheered Rossi on during the long night hours and that a large crowd, giving him all its support, had gathered in the evening of April 24 when the race ended.

"... a flash of sympathy, which as Andrea said immediately after the conclusion of the successful attempt was a valuable, or even necessary complement to his human resources." Pictured are the young Rossi with his mother Ada, who proudly gets a big hug from her son after the race. Most notable is perhaps that the article describes Rossi's performance in a way that almost uncannily touches everything in which he would later engage: "A personality from another time? We prefer to say that Andrea Rossi is a beautiful young man of our time, one of many who despite public enthusiasm for much more convenient and acclaimed sports still believe in the beauty of lonely and exhausting challenges, bordering on the unbelievable, like the one he just achieved."

Just a few months later, his sporting instincts led to his first visit to Sweden. "With the national team in long-distance running—there were of us four with the coach, Bruno Bonomelli—we trained throughout June at the sports center on Lidingö outside Stockholm. I have a spectacular memory of it."

Just returned from Stockholm, Rossi set his personal best in a marathon—two hours and 28 minutes—at a race in Putignano, in the Puglia region that forms the heel of the Italian boot. Shortly thereafter, just as many other young Italians participated in student revolts and when unrest shook Italy during the years after 1968, Rossi began working. This is not really true; he had really started to work at age seven.

"Both my parents were hard workers. They taught me since I was born that to achieve something you have to work. I still have my mother and my father as role models. They worked from six in the morning until evening."

His father was his teacher and role model when it came to entrepreneurship while his mother, who had a degree in ancient literature, taught him how to study properly. During school holidays, if the family was not on vacation in the mountains, which his father preferred to the beach, he worked on the shop floor in his father's business until he was sixteen. After that, he started working in the office, where he learned to plan and to lead the work of design and testing.

"When I was 20 I could build a plant with my own hands—design it, install it, assemble it and test it. It was a very tough school but tremendously effective." So when Rossi "began working" at age 20, that was when he started his own business. "I opened a factory producing energy from waste. Today it is called 'biomass'." Thus he was immediately on the track that he has stuck to since then: energy. Producing energy from waste would be his central pursuit for the next 25 years. He first worked with British companies, especially Lucas, most likely Lucas Furnace Developments Ltd, a company that pioneered in waste-recycling technology with incinerators designed to recover energy from combustion. Rossi initially imported these products to Italy. He had to further develop the technology as it gave problems with polluting emissions. He then started working on patent applications related to flue-gas cleaning. He received his first patent when he was 22 years old.

"The first system that I designed under my own name I made in 1972. In 1970 I stopped sports and enrolled at the university. I worked during the day and studied at night, so even then there was no time for anything else. I went to the university to follow the indispensable lectures, for the rest I could not attend. Yet I took my exams and in the end it all went well.

"I graduated in philosophy as I preferred to deal with problems from a theoretical point of view, because I was more interested in theoretical, in-depth studies. And I chose the most difficult approach—theoretical philosophy, namely the study of human thought in relation to scientific development—relativity and the philosophy of science, including mathematics, physics, chemistry and logic. And there were also exams in history and psychology.

“I gave a dissertation on theoretical philosophy, based on the phenomenological interpretation of the theory of relativity. Phenomenology involves analyzing the distinction between subjective and objective aspects of theory. It is quite complex. First, you must study the theory carefully. Then you must criticize aspects of it both from objective and subjective perspectives, that is, what in your opinion is essential to criticize and what is possible to criticize in the given situations. Remember, for a philosopher, anything cannot be considered valid—what’s required is that it can be demonstrated that it is wrong in at least one situation.”

At 25 he graduated with the title *Dottore Magistrale*—a master's degree—in philosophy. Rossi thus gained no formal science degree. Also none in engineering. He got his engineering degree a few years later from the University of Kensington in California—a fake university that claimed to hold courses via correspondence, closed by court order in 2003. "They sent me a degree *honoris causa* based on my patent. But I have not heard of the university since then," Rossi explained later when accused of faking his degree.

But even if he was not trained as an engineer, he had nevertheless, at graduation, apparently picked up a lot of equivalent knowledge through his own work and study. The focus on energy in general, especially in recovering energy from waste, seemed to have been based on personal urges. "In principle, I wanted to do something that others did not, and this is a character trait of mine—if I am to start in any area I must do something that others do not. I always have been like that".

In waste management and combustion, there was much that few had begun to ponder. “In the ‘70s ecology was a word that appeared in academic circles but had not reached the public. The idea that waste was something you could recycle didn’t exist. Waste was something you threw in a pit or burned. Moreover, belching chimneys were not a negative symbol in the ‘60s and ‘70s. They were positive symbols, meaning industry and industrialization.

“If you look at the paintings of Umberto Boccioni from Milan, you see that belching chimneys appear as symbols of energy, as a release of energy, labor and development. No one thought that the smoke was a bad thing that polluted, or that waste was a bad thing that contaminated and that you needed to control such things. In my opinion, however, this industry would develop, inevitably. Just as I was disturbed by the view of emissions and waste in those days, the first academic papers started to pop up. I read them at the University, which helped me in that approach to the problems.

"I decided to start working in this area for two reasons—I liked it, and it was a pioneering area where little or nothing had been done. The most advanced countries were the United Kingdom and Sweden. I learned an enormous amount from the Swedish company *Svenska Fläktfabriken*. It was a fantastic company that made electrostatic precipitators—a nice product that *Fläkt* had invented. Basically you let the smoke pass an electrode where the particles were charged electrically and then they got stuck on another electrode of opposite charge. Unfortunately, they were expensive and had limited scope. But I found a way to make them very cheap so they could be used anywhere and they became a big success. They were called *Cabine Filtranti di Rossi*, and this was around 1974.

"Sweden was at the forefront in ecology. It was the first country to start talking about respect for the environment. But in Italy, when you went around saying that you had to invest to not emit smoke, people looked at you as if you were stupid. So in the beginning, when I went around to sell my plants, I first had to explain to people why they needed my technology. Because if you said you sold equipment that could be used to burn waste without polluting the air or the water, people wondered what it would be good for.

"You must consider that Italy's first air-pollution law, the famous Act 615, went into force in 1977. Until then anyone who polluted the air could get complaints, but it was not punishable. So in the early '70s you had to find other motivations for selling equipment. For example, not only would I make sure that you didn't produce smoke emissions so that you could avoid becoming a health hazard, but I also saved you money by recovering heat content from the smoke. In that way I could sell.

"It was a kind of philosophical approach, if you will. I reasoned in the same way with waste. And that's also why I focused so much on the idea of extracting value from waste." Rossi was referring to his later efforts at extracting oil from solid waste. Until then, he had focused on waste incineration with flue-gas cleaning. Had he started 35 years later he would have been in the line of entrepreneurs working in the hot field of clean tech. Now he was a pioneer, and so early that his potential customers had relatively little understanding of what he wanted to sell. During the first years as an entrepreneur his business was basically a department of his father's company *La Metallotecnica*, a department that Rossi had given the name Dragon. "Because incinerators look like dragons that emit fire. Pure imagination," Rossi explained.

Later he incorporated *Petroldragon*—a name that would be associated with revolutionary technology, dreams, fantasies, scams and environmental scandals. The company would promote and further develop the technology Rossi patented in 1978—to produce biofuel from organic waste. Today, such methods are well proven, though you rarely start from mixed waste but rather with discarded animal fat or different types of crops. Since this was something completely new and since the word ‘biofuel’ didn’t exist, Rossi talked merely about oil. It did not make the technology less relevant, because the public had on its mind the oil crisis of 1973, triggered by the October War between Egypt, Syria and Israel.

“When the patent was granted, the American Embassy was immediately interested and President Jimmy Carter had me invited to the U.S. They even offered me a permanent visa and suggested I move production to the United States. I chose to stay in Italy, which I think was a mistake, because of what happened later.”

21. Approx 109 miles

22. ôAndrea Rossi ha battuto il primato delle 24 oreö, p 12, Giornale di Brescia, April 25, 1970.

CHAPTER 4

Petroldragon

"It all started at 7.35 on September 6, 1977. The industrialist, then twenty-seven, went down the stairs, just as he had every morning, in the scarlet building in Milan where he lived, in Viale Beatrice d'Este, halfway between Porta Romana and Porta Ludovica."

The journalist Luigi Bacialli wrote the above in his book *Petrolio dai Rifiuti*—Oil From Waste—describing how Rossi invented his new technology and about his success and failure in the first year. The challenges Rossi encountered during that year were certainly not close to what he would face in the coming years but the picture still shows how it all started. Bacialli described the young Rossi, with the "*skull larger than average, very wide forehead, the dark eyes rather close to each* *other, small and magnetic, robust jaw, smooth slightly aquiline nose, wide mouth.”*

Of course he had the habit of going both up and down stairs running—we meet a very energetic Andrea Rossi in Bacialli’s book, not far from the Rossi I met more than 33 years later. Some of his character traits had possibly smoothed out with time and, judging from the pictures of the young man in casual ‘70s clothes, he then had a dense, dark head of hair that 33 years later had thinned a little. In a few decades he had also become slightly leaner but hardly less vigorous and his eyes still had their distinctive depth. He already seemed to have been intuitive, with a vibrant temperament. Hard work was the mantra that he never gave up, day and night if need be.

In Bacialli’s story Rossi felt a need to develop his activities in his father’s business, though the incinerators and the equipment for flue-gas cleaning sold well despite difficult economic times. On that September day in 1977, when the book starts, Rossi had been sitting and thinking in his office at *Metallotecnica* with a sketch of the Earth in cross section on the table in front of him. Below the crust he had drawn a volume of organic material that by geological processes over time had been converted to mineral oil, a widely understood phenomenon that drives the world petroleum industry. Suddenly Rossi got his idea—he planned to mimic nature. In the drawing, reproduced in the book, we see Rossi's compact, somewhat sprawling handwriting: *"Organic wastes, exposed to changes in pressure and temperature, have been transformed into oil; perhaps, imitating this process, you can get oil from waste."* [23]

He started a vigorous development project in a way that seemed characteristic of Rossi. He first studied intensively the relevant chemical processes—chemistry was his favorite subject, so it should have come naturally. He made numerous calculations—no one knows how relevant they were but they seem to have helped Rossi create a picture of the necessary process. He soon built a prototype of the machine intended to perform the process of transforming organic waste into oil. In an industrial barracks on the company site, he worked tirelessly on the unit with his assistant Luciano Romanato—partly in the daytime but especially during long hours at night. When the calculations did not seem to give the expected results and the device ejected only small amounts of hydrocarbons, Rossi engaged in trial and error, built new sets and tested different combinations of pressure, temperature and chemical additives.

After months of fruitless effort he fell asleep at the machine one night in late January 1978. When he awoke next morning he discovered to his horror that it was still running and approached cautiously, fearing that it would explode under the violent strain of many hours of high pressure and high temperature. Something in the system suddenly burst with a muted bang and the machine seemed to stand lifeless. Spontaneously, Rossi lifted the small container where the oil was supposed to be collected and was surprised when a spray of dark liquid soaked him head to toe. Bacialli describes how Rossi carefully smelled and felt the liquid—it had the unmistakable smell and feel of oil—and how he screamed with delight, rushed out and rolled in the snow at the company's yard while the employees arriving for work watched him, amazed. Rossi had the oil analyzed at a laboratory belonging to the Italian oil company *Agip*. The energy content supposedly amounted to 10,165 kilocalories per liter, slightly more than regular crude oil that has a corresponding value of about 9,200 kilocalories per liter.

Rossi immediately applied for a patent on the process, a variation on a method that today is called thermal depolymerization. He subsequently built a full-scale pilot plant—a giant at 30 tons with a 39-foot cooling tower. On the side was an inscription in Latin: "*Pro Christo Omnia in Deo*" or "All for Christ in God." The fact that Rossi believed strongly in science did not prevent him from also being religious. For example, he believed that evolution is insufficient to explain the origins of life. “I am deeply religious. Evolution remains valid to a certain extent but it’s not enough. In a way it’s like if you say that a truck can serve as an airplane: the truck is not useless, indeed, is very useful, but it cannot fly,” he explained.

Rossi claimed that the pilot plant could process ten tons of organic waste and in 24 hours extract about two tons of oil, two to three tons of gas and the rest as coal. Furthermore, the process was self-sufficient—the energy needed to power the waste conversion was extracted during operation. And, of course, the machine was equipped with an effective flue-gas cleaning system with active carbon and electrostatic precipitators. Appropriate waste came to 70 percent from households—paper, wood, food scraps and various kinds of plant-based waste, and 30 percent from industry—rubber, plastics, synthetic materials and residues from chemical industries. The potential seemed enormous. Rossi estimated that every Italian produced an average of about one kilogram of useful garbage a day, which with 50 million inhabitants in Italy in the '70s meant 50,000 tons of appropriate waste and the production of 10,000 tons of oil (70,000 barrels) a day, or more than three million tons (20 million barrels) a year. It was nowhere near the 108 million tons (750 million barrels) of oil Italy imported in 1978 but still represented significant economic value—at current oil prices around $100 US a barrel, it would mean nearly seven million dollars a day, or $2.5 billion a year. Furthermore, you could avoid processing a lot of garbage for additional economic benefit.

Suspicions arose. Many called Rossi's technology a fantasy and he had difficulty finding financing to expand the business, especially in Italy, where reactions were particularly cautious, whereas international interest rose gradually. Neighboring Switzerland was one country that showed interest and one day a Swiss finance company appeared suddenly and unexpectedly, willing to invest 15 billion Italian lire, or about $10 million US. Around the same time, Rossi decided to make his patent public domain, without requiring licensing fees. He felt that this was the only way to spread the technology worldwide. An offer from an American entity to acquire the patent for $3.5 million influenced his decision. Rossi suspected that it was just an attempt to bury his technology, because he got the cold shoulder when he asked that two hundred plants be built in the space of two months. Whether this level of production might have been feasible is moot. But another reason for his suspicion that someone could try to stop an invention of this kind was his belief that his technology was not new. *"My process is so simple that I'm sure I was not the first to discover it,"* he is quoted as saying in Bacialli's book.

He concluded that somebody, perhaps many years earlier, could have conceived the same idea but had been unable to disseminate the technology, either because someone bought the patent or simply eliminated the inventor. He cited the diesel-engine's inventor, the German Rudolf Diesel, who on September 29, 1913, just before the First World War, disappeared mysteriously from the ship SS Dresden on its way from Belgium across the Channel to Britain, where he had intended to sell a license on his technology to Consolidated Diesel Manufacturing Company in London.

"I confess that I do not want to end up like Diesel," Rossi said, according to Bacialli. The parallel to Diesel was not taken out of thin air. Diesel's engine was originally designed to run on vegetable oils and in 1912 he predicted the now common use of biofuels in large parts of the world when he said: *"The use of vegetable oils for engine fuels may seem insignificant today. But such oils may in the course of time become as important as petroleum and the coal tar products of present time."* Facing the possibility that someone would want to kill him, however, Rossi had a simple strategy—he'd rather walk around unarmed and trust in God, he explained, than need

a bodyguard of ten people, which could lead to unnecessary bloodshed. A potential enemy would have to show up with a force of twenty.

With the Swiss investment in the bank, Rossi started building what he had dreamed of—a plant with ten towers, each corresponding to the prototype, with a total capacity of 100 tons of waste, to produce about 20 tons (150 barrels) of oil a day. During construction he received a fresh setback—the Swiss financiers had received a negative report about Rossi and his technology and instantly froze all investments. Rossi continued with his own money, small loans and assiduous attempts to convince customers that had delayed payments for his old plants, but he was soon forced to slow the project. Somewhat later, it turned out that the report to the Swiss had been manipulated by Rossi's detractors. They had accused him of pouring mineral oil into the tanks at night and selling it as his own genuine process byproduct during the day. But Rossi was cleared of those accusations. Funding continued and the plant was inaugurated on August 5, 1979.

At this time the United States began to show interest in the process, now called Refluopetrolio. The offer presented on behalf of President Jimmy Carter was that Rossi would move R&D and production to the U.S. At the same time, he was offered a permanent-resident visa. Rossi received the invitation, traveled to Washington for a few weeks, but declined eventually, still convinced that he could develop and deploy the technology from Italy. Later he would regret the decision, not least when the real challenges started. Once back home, everything still proceeded slowly. The technology never gained traction in Italy, nor anywhere else either. Rossi certainly got considerable media attention and was soon called "*lo sceicco della Brianza*"—the sheik of Brianza, the area north of Milan where Metallotecnica and Petroldragon were based, on Via della Chimica in the small industrial town Caponago. No further expansion occurred. The large plant with ten towers financed with Swiss funding was both the first and the last.

Rossi's own explanation, in retrospect, was that it was impossible to venture into an area where there were not one but two powerful enemies with major economic interests—the oil companies who wanted to sell traditional mineral oil and the Mafia who gradually became interested in waste management. Moreover, there was strong interest from local authorities to control waste handling. Indeed, Rossi never got a permit to dispose of household waste but had to use only industrial waste. His business continued this way until 1987, when his real misfortunes began. According to him, they derived from hostile interests, including the Mafia's growing interest in industrial waste. What happened was that due to a new law all kinds of residues from industrial production generally became regarded as 'special waste' that required special handling permits. Under the law, even Rossi's end products—the oil, coal and gas he produced—were automatically defined as special waste requiring those special permits. Since Rossi lacked such permits his activity became illegal essentially overnight. The customers were also affected—suddenly they had purchased products without the required permits. The large plant in Caponago was seized by the authorities, though via appeals Rossi managed to keep some kind of business running briefly.

A few years later, in 1990, he nevertheless bought a refinery named Omar for about $7 million US in the city of Lacchiarella south of Milan, to refine crude oil produced by Petroldragon's plant into various solvents, and eventually a biodiesel fuel he tried in modified engines. First, he used the fuel in two Fiat 131s that circulated on the industrial site, but in 1993 Rossi supposedly formed Team Petroldragon with an Alfa Romeo that participated with success in Formula Three. But Omar only had permits for refining oil, not for handling special waste, and as the oil from Petroldragon was now defined as 'special waste' the authorities struck against Omar in 1994. Rossi continued to appeal and managed to keep the business running but the following year, on March 23, 1995, Rossi was arrested early one morning, together with a Swiss businessman.

This time money laundering was alleged. In a company called St. Andrè-Oreficeria Italiana in the small southern Italian village of Ariano Irpino, Rossi had produced several kilos of silver and gold, then exported these precious metals to Switzerland for jewelry making. Essentially the company recovered the precious metals from waste such as discarded photographic film and electronics, which today is a mainstream business. According to Rossi, it later turned out that almost all the documentation and transactions were in order but when he was arrested the allegations of money laundering were enough to land him in jail. With Rossi in jail, Petroldragon and Omar finally stopped operating, leading to further problems—the crude oil produced at Petroldragon's large facility was stored in tanks, some at the Omar site. When operations ceased, the authorities inevitably regarded them as illegal depots of special waste, comprising roughly 60,000 tons. Rossi claimed to have orders that more than covered product in the storage depots but instead of being sold they were now left unattended and began to leak. The money-laundering allegations went away rapidly but other accusations were launched, both in connection with the bankruptcies of Rossi's company and for various environmental crimes. According to Rossi, the Petroldragon business led to a total of 56 criminal processes, starting in 1987, when the first was launched, and they occupied him for 17 years.

Exactly what led to what, before and during the legal tangle, is difficult to discover afterwards, especially in an opaque country like Italy, where things are rarely what they seem. Among the ways of reviewing the events, the environmental perspective is one. Despite Rossi's high environmental ambitions, his process was not without problems. Starting from industrial waste meant potentially harmful chemical residues, toxins and heavy metals of different kinds in the material to be transformed into oil. Preventing them from contaminating the oil required waste pre-selection before processing. "The pre-selection of waste was supposed to be done at an earlier stage, before it was delivered to us. Indeed, it was not easy," Rossi admitted when I asked him about the problem.

On the other hand, as Rossi pointed out in his defense, all petroleum products are generally harmful to the environment, with a high content of hazardous substances. The oil stored in the depots was no more dangerous than any other, he argued. Not more dangerous than the raw materials stored at any oil refinery that would be regarded as an environmental bomb, should the refinery suddenly be closed and confiscated. Indeed, when the Lombardy region, with Milan as its capital, seized the depots they were treated as an environmental bomb. Cleanup and disposal were costly—at least $50 million US[24], which Lombardy taxpayers eventually had to pay. The price was determined by a procurement Lombardy conducted shortly after the seizure.

Rossi wondered why the price per kilo[25] ended up at almost twice the market price of about 30 US cents[26]—the price he claimed he had paid to let authorized companies handle unusable remnants left over in his own business. Someone likely gained on this transaction, just as someone gained when Rossi could no longer compete for industrial-waste sources. Possibly it was the Mafia, which Rossi suggested. Today we know that organized crime for a long time sent toxic industrial waste from northern Italy to big, secret pits in the south. There it poisoned the ground water and was absorbed by vegetation that cattle ate. This left residues of harmful substances in products such as the classic southern-Italian delicacy of buffalo mozzarella, a heavenly, tender, rich creation that must be tasted by anyone who has tried only the pre-packaged mozzarellas sold in small plastic bags in most grocery stores worldwide. There is no comparison.

Basically, however, there was nothing really strange about the law that according to Rossi was introduced without warning and made his activities illegal. The law, called 915, was introduced in 1982 but for various reasons did not become fully effective until 1987. It had, in turn, a natural basis in a couple of European directives for harmonizing the waste concept across Europe. Rossi's problem: what earlier had been seen merely as the residue of industrial production was, under the new law, defined as 'special waste' and not only required special permits but also meant that everything derived from such residue was itself considered special waste and hence required permits. Many others had this problem—the law covered anyone who wanted to recycle waste materials in industrial production. Because recycling was in fashion, under a new 1988 law the concept of 'secondary raw materials' was defined for recyclable residues. It did not, however, help Rossi, since the regulations made an exception for substances that could be burned to produce energy. He was in a legal trap from which there was eventually no escape. Ironically, it was thus the apparently completely legal activity—recycling silver and gold—that led to Rossi's being arrested, in turn preventing him from defending his businesses. "In addition, I no longer had enough money to pay my lawyers," Rossi explained to me.

Whether his business of extracting oil from waste could otherwise have had a future is hard to say. It was a matter of his word against others' regarding product quality and retroactive chemical analysis is not possible. Rossi had collaborated in an R&D project with the Department of Industrial Chemistry at the University of Technology, the Politecnico, of Milan, and at one of the trials concerning Petroldragon in 1996 Professor Paolo Centola testified that Rossi certainly recovered 30% of a kind of crude oil from industrial waste. He also pointed out that this did not necessarily mean that it was a commercially viable product[27]. Rossi was clearly a biofuels pioneer and could have developed his technology. Engineering for biofuels generally has evolved since then and even Rossi himself would return to the area in other ways a few years later. But in 1995 his business at that time was buried.

For Rossi, personally, the consequences were significantly worse. When his legal problems began, the earlier positive attention from newspapers and television reversed. He was quickly dumped into the category of scam artists and environmental villains and was accused, among other things, of simply accepting industrial waste and storing it in large, uncontrolled depots without plans to handle it. The news was not always well researched, often based on incomplete facts. As with all media reporting against individuals, the reporting on Rossi hit him hard, personally, at a time when he was already under pressure from fighting with the judiciary. Rossi has his own view of the experience and of the influences behind the media attacks.

“It was devastating. My business with waste had received much attention and was seen as a great success even among the public, because it was remarkable in the late '70s and the '80s that you could make combustible oil from waste. But when politicians with connections to interests more or less linked to the Mafia decided that waste management was a business that should be run in a certain way, it became necessary to destroy not only my business but also me, personally. Because it was necessary to justify that waste should end up in landfills or incinerators and not in plants like mine, they had to argue that the plants were actually a scam and a charade. So the attack on me was also personal. At that time there was no Internet, so when the two or three most important newspapers in the country attacked a person, that person was destroyed and could not defend himself. Today it's different—the Internet is stronger than the newspapers. The main Italian TV channels reported the same thing and it all went on for months. Can you understand? So the devastation was total and led to serious trouble [for me].”

Whatever the real causes of the media reporting, the consequences were dramatic for Rossi. Even his closest friends saw reason to doubt him. Not even his family seems to have believed in him. “Absolutely not. Because you know, when you come to a situation where everyone says you are in a certain way, if everyone says it, it means that it is that way. It was devastating.”

His marriage broke up and he also seemed to have lost contact with his three children, and so it would remain for a long time. In Shakespeare’s words: *“When sorrows come, they come not single spies, but in battalions.”*

“It is very difficult. Very difficult. Very difficult,” Rossi said resignedly to me one day in April 2011. “I do not remember which Indian philosopher said that when something bad happens, who is to say it is bad, and when something good happens, who is it to say that it is good. In the end, everything happening now comes from what happened earlier.”

23. ôI rifiuti organici, sottoposti a variazioni di pressione e di temperatura, si sono trasformati in petrolio; forse, imitando questo processo, si pu≥ ottenere petrolio dai rifiutiö. p59, Petrolio dai rifiuti, Luigi Bacialli, SugarCo Edizioni, November 1979.
24. http://archiviostorico.corriere.it/2004
25. http://archiviostorico.corriere.it/1998
26. 450 Italian lire
27. http://archiviostorico.corriere.it/1996

CHAPTER 5

Thermoelectric Generators and the U.S.A.

Rossi remained in detention for six months. When he was released in the fall of 1995 he was virtually penniless and estranged from his family. The legal processes over his businesses were still continuing but they didn't require him to stay in Italy. Neither did he have friendships to hold him back. I asked him if he still had friends from the past. He said no and I asked how that could be. "A good question," he replied.

"First of all, I am not a very social person. I am a hermit. I'm not that easy to get along with. Second, I have always been extremely involved in the things I've done and I have had very little time to cultivate friendships. So, frankly, I cannot say I've had any friends. It's my own fault, though, because

I have not been sociable.

"I'm not a nice person; I've never been a nice person. Also because, among other things, I have always been extremely focused on what I do, so I tend to be quite irritable. Just to be with me is not easy because it is not easy to put up with me. Of course I'm sorry. Look, I'm certainly sorry because it is not pleasant. But it is my nature."

I perceived that he was harder on himself than people around him would be. But at this time little kept him in Italy and he still thought that his activities would have enjoyed much better conditions in the United States. His decision to leave Italy and travel across the Atlantic was therefore easy. He intended to remain and settle in the U.S. if possible. He settled initially in Boston and among the first things he did was to pick up the trail of extracting oil from waste, resulting in contact with people who would mean a lot for his ongoing work in the energy sector.

According to the model of collaboration with the

Technical University of Milan, he wanted to start local, collaborative research in the U.S. and contacted Tufts University in Boston. The university directed him to the responsible manager in the Department of Sustainable Development, Tom Kelly, and they agreed to meet. Kelly, in turn, contacted Craig Cassarino, a friend who for many years had worked on developing renewable-energy technologies. "We made a successful presentation at Tufts University," Rossi recalled. Regardless of how successful the demonstration, the meeting also seemed to have led to good contacts, especially with Craig Cassarino, who had driven an hour down to Boston from his Bedford, New Hampshire home.

"I went down and met Andrea, who was cutting up inner tubes from tires and producing oil and gas from them and demonstrating the process he had developed in Italy. Maybe it was because my name ends in a vowel, but we connected. I invited him to New Hampshire. I was working in business development for a company in Bedford. He came up and loved New Hampshire, and we developed a relationship," Craig Cassarino told me about their first meeting. Rossi began working as technical director of Bio Development Corporation in Bedford, where Craig Cassarino was vice president.

Somewhat later, in December 1996, Rossi founded his own company in Bedford—Leonardo Corporation—where he intended to further develop his own technology. Instead of starting with waste, this time he wanted to use oil extracted from plants and animal fats. The idea was then to sell generators driven by motors run on biodiesel —'gensets'—and also to deliver the fuel. Initially, however, he pursued the work with biodiesel at Bio Development. In his own business, he developed instead a different energy technology: thermoelectric generators.

A thermoelectric generator is a simple but clever design based on the Seebeck effect, discovered by the German physicist Thomas Johann Seebeck in

1821. The effect occurs in conductive materials as a voltage generated between a point kept cool and another that is heated, i.e. electricity is produced from the difference between hot and cold. For this to work, two pieces of two different materials with a Seebeck effect of different strength must be joined at one point. If the point where they meet is heated and the extremities kept cold, a small electrical voltage is generated between the outer ends of the materials. If connected, an electrical current flows.

Normally only minute electrical power is produced, which is why the phenomenon has been applied mainly in thermocouples used in electronic thermometers—the small electrical voltage is enough to create a signal sent to a gauge calibrated in degrees, displaying temperature. By experimenting with different materials, the effect can be increased sufficiently to light lamps, power electronics or recharge batteries, becoming, in effect, a thermoelectric generator. Trials are underway worldwide with thermoelectric generators driven by the hot exhaust gases from automobile engines, to use the heat otherwise released to the atmosphere—even in today's most efficient car engines about 60% of fuel energy is lost as heat, through the exhaust pipe and the radiator. By producing electricity from part of the heat, the hope is to reduce fuel consumption by up to five percent.

Rossi was early in developing thermoelectric generators and had been granted a patent on a relatively complicated structure that he claimed would provide very high efficiency—about 20 percent, while the best value otherwise accomplished had been about four percent. He soon told Craig Cassarino and Tom Kelly of his thermoelectric generators. They became interested partly because they knew that the U.S. Department of Energy was investigating the possibility of producing energy with this technology in various areas—in cars, aircraft and spacecraft, and from excess heat, in applications such as fuel cells. Craig Cassarino contacted his childhood friend

Charles Norwood and a person with whom he had just started working, Robert Gentile, highly placed in the DoE as Assistant Secretary of Energy of Fossils. Along with Rossi, Cassarino and Gentile now formed Leonardo Technologies Inc, LTI (not to be confused with Rossi's Leonardo Corporation), to explore for the DoE the possibility of thermoelectric generators.

"Andrea had come up with some new concepts. We tested them at the University of New Hampshire, where my friend Tom Kelly, a former Tufts department head, had become the new Operations Director for Sustainability," Craig Cassarino told me. "We had fairly good results."

The results of the experiments were amazing. A report by the U.S. Army Corps of Engineers indicates that the test, carried out in early 2000, lasted seven days, with measurement of voltage and current every half hour. Power from the test thermoelectric generator reached about 100 watts—enough to power a standard 100-watt light bulb

—an impressive value at the time.[28] The DoE allocated funds to finance further development. It was time to try to produce a series of large thermoelectric generators that could supply up to up to 1,000 watts—enough to heat a kettle. But this time Rossi was unsuccessful. First the house where he lived in Manchester, New Hampshire was hit by a fire. "The apartment building burned down. He lost everything, notes, everything," Craig Cassarino remembered.

Rossi returned to Italy, hoping to produce the thermoelectric generators less expensively than in the U.S. But his chosen subcontractor apparently wasn't successful—according to the U.S. report, 19 of the 27 delivered thermoelectric generators didn't work, for various reasons. The remaining eight produced less than a watt—not even close to the 800-1,000-watt goal, or the 100 watts achieved during the tests at the University of New Hampshire.

"To make a thermoelectric generator with 100 watts of power that worked well, I spent three months in the lab, working 10 hours a day. It was a masterpiece, working with alloys and doping unthinkable in industrial production. A 100-watt generator made this way would cost €20,000 —a completely unreasonable price," Rossi explained to me.

"When I then tried to industrialize the manufacture of alloys, I encountered huge problems. You must know that to achieve the Seebeck effect with high efficiency, the position of even a dozen atoms is important—if they are improperly placed they become electrical resistance. That's why I later switched to thermoelectric generators with low efficiency that were more robust and easier to manufacture." He later used those thermoelectric generators, with an efficiency of only about two per cent, but very high temperature resistance, in his diesel-powered generators.

The main reason that he failed to deliver efficient thermoelectric generators at this time, however, was quite different. In late May 2000, on a trip to Italy, Rossi was suddenly stopped by police on the bus on the way home from the airport and was again jailed, pending the outcome of ongoing trials regarding Petroldragon and Omar. This time he was detained for more than a year, until June 6, 2001. He was sentenced ultimately to four years in prison for accounting fraud in connection with the bankruptcies. Of the 56 processes, five led to a conviction, according to Rossi, while in the other 51, including those related to environmental crimes, he was finally acquitted or the case was time-barred. Time already served was deducted from the prison sentence. The rest he had to serve either under house arrest or on probation. He was released in June 2001. The year and more in jail ended the development of his thermoelectric generators, but proved crucially important for Rossi's next invention—the Energy Catalyzer or E-Cat.

28. Application of Thermoelectric Devices to Fuel Cell Power Generation,

Demonstration and Evaluation. John Huston, Chris Wyatt, Chris Nichols,, Michael J. Binder, and Franklin H. Holcomb. US Army Corps of Engineers, September 2004.

CHAPTER 6

In jail

When I lived in Milan for two years in the late 1990s, I often passed the San Vittore prison at the corner of *Viale Papiniano* and *Via degli Olivetani*. Its bare, whitewashed concrete wall, decorated with thin longitudinal red brick lines, stood high on the corner and continued along the sidewalk on both streets. It contrasted sharply with the residential buildings and trees in the avenue at *Viale Papiniano*, where on Saturday mornings people throng to a busy market with long rows of stalls displaying clothes and delicacies in open trucks extending several blocks, filling an alley in the middle of the broad street, just steps from the trendy area along the canals, with model agencies and advertising agencies—*I Navigli*—where intellectuals and artists thrive.

Sometime I thought about who sat in the San Vittore and how a prison could be located so centrally in rich Milan, where property prices soared constantly. Little did I understand that Andrea Rossi—at the time I did not even know who he was—would end up there just a few years later, ironically a stone's throw from Italy's national museum of technology and science, named after the polymath-genius *Leonardo da Vinci*, whose name Rossi had lent by then to two companies—Leonardo Corporation and Leonardo Technologies Inc. His share in LTI he had to sell, though, when he was arrested and jailed.

"We used LTI strictly as the consulting company for DoE. As a foreigner, he just couldn't do it," explained Craig Cassarino. It probably didn't help that Rossi had been detained in Italy.

"Italian prisons are like those in the Third World. Let me only say this—in a cell twelve feet long and five feet wide, we were six prisoners and there were two three-story beds positioned one after the other. So the beds took about two feet of the entire width of the cell," Rossi told me. "So the situation was catastrophic. As soon as you entered you got short of breath.

"My companions changed in rotation. They were all sorts of characters. But I was always well-respected, in the sense that they always left me in absolute peace. After all, I was a little strange because I was always studying."

Rossi was studying cold fusion. The phenomenon had caught his interest when Fleischmann and Pons held their news conference in spring 1989.

"As soon as the news came, I threw myself on it because I was extremely interested. The first thing I did was to try to repeat Fleischmann and Pons' experiment, but I did not succeed. Then I began to think about it but I never had time to devote myself to it properly—I only thought about it in my spare time and, as you understand, I didn't have much spare time.

"When you have a business with customers who do not pay, plants that do not work and a number of other serious problems, part of the brain is engaged continuously in other things, so you cannot make the critical effort that really takes you over the hurdles.

"But when I ended up in jail, paradoxically I also ended up with an advantage—that they had taken away everything from me, so I suddenly had nothing to worry about. From a certain point of view it was a wonderful time because the phone never rang, no one would annoy me and I had nothing to do. So I said to myself, Andrea, the negative side of this is that you are in prison, the positive is that you have 24 hours a day at your disposal and you have nothing to do. And at that point, you can do all the things you would not otherwise have time for.

"The focus on the problem [with cold fusion] I had during that time, I wouldn't ever have had in my life. I studied like crazy. From that standpoint it was providential, a golden age, for I made tremendous progress there. Because I had nothing to do. In practice, I shut myself up in my own universe. At that point you don't have any problems with space anymore because space is something you create in your own head. Space is ultimately still a relative thing, and time, too.

"When evening came, I told myself that, damn it, I didn't manage to do all the things I had to do. I organized the day. In the morning I got up and during the break I ran, so I did sports. When the break was over, I started studying—I could order all the books I wanted, so I did. Thus, a schedule of sports from a certain hour to another, then studies, read the newspaper, think about the theme of cold fusion, and finally came the evening and, misery, I said to myself, that I had not managed to do all the things I should do. So the time flew away. From this point of view it was one of the most wonderful times of my life. It may seem paradoxical, but it was.

"Starting from scratch is not a disadvantage, it is an advantage. With the desperation of having to do something at all costs. And the fact that you do not want your life to be in vain also plays a role. It’s like a spring loaded to the limit.

“I made really big progress when I was in a kind of meditative concentration. When I came out I had written thousands of pages—thousands of pages full of numbers and calculations. So much that one of my cellmates must have said to himself, ‘I do not understand any of that stuff, but if he works so much the stuff he writes must be worth a lot of money.’

“And they stole the papers. One day I came back after the break and I could not find them. I was desperate. So I told the prison guards, listen, while the cell was open, for during the break the cells were open, someone must have accidentally taken my papers. I was desperate. But the guards said not to worry, they’d find them. After an hour, they came back with them.

“On the other hand, ‘in heaven with the saints, at the tavern with the drunken,' it is written."

Those who helped Rossi to find meaning in prison were, in other words, Fleischmann and Pons, with their cold-fusion concept, even if they hadn't been able to move it ahead and had their research careers ruined. One reason they got stuck, as did others who followed in their footsteps, said Rossi, was because of their experimental setup. It was based on electrolysis—a reaction initiated by passing a current through a liquid, usually water. Electrolysis of water—precisely what Fleischmann and Pons used—is a classic desktop experiment performed daily in schools worldwide. When you connect power, bubbles of hydrogen and oxygen—the elements that comprise water—immediately begin to form.

"I do not know if someone will eventually manage to achieve something with electrolysis, but in any case Fleischmann and Pons definitely did something significant. They gave us a dream. They said that this is possible. How it was possible they didn't say, for the path they showed has not yielded concrete results, at least up to now. But the road ... if they had not pointed out that road in 1989, I would probably never have started. I started because they held that news conference, I threw myself on it. Then it did not work. But by then I was already convinced that it could work. I would have to change the system, but it could work.

"I am convinced of Fleischmann and Pons' good faith. The problem? They failed to provide a way to repeat the experiment reliably. And in fact I abandoned the approach of electrolysis after a while because the energy developed by electrolysis is too low."

The decision to abandon electrolysis is just one of many examples of Rossi's intuitive way of working—intuition, combined with his persistent studies to acquire more knowledge. His reasoning on electrolysis was simple, focused on a useful result—to turn cold fusion into something useful, you had to extract lots of energy. Rossi believed that Fleischmann and Pons' electrolysis was too weak to initiate a powerful, useful reaction. Interested scientists who later became involved with the E-Cat would notice and comment on Rossi's strong intuition, while they questioned aspects of the theories that he had generated, at least initially, regarding the E-Cat's physics—at that time still a scientific question mark.

In the years after Fleischmann and Pons' news conference, long before Rossi ended up in prison, he had experimented on and off with various similar setups. When he abandoned electrolysis he began, for example, to use heat instead to try to start the reaction, using an electric heater cartridge that he would later keep as a method. He also sought alternative routes by trying different materials. Fleischmann and Pons used water, which may seem unimaginably simple. More specifically, they used heavy water—oxygen and a variation of hydrogen called 'heavy hydrogen' or deuterium. They assumed that their experiment involved fusion of the nuclei of heavy hydrogen—a reaction that normally occurs in the sun at tens of millions of degrees. Rossi tried instead a broad range of materials—heavy hydrogen and ordinary hydrogen, oxygen, palladium, platinum, nickel, heavy water, copper and iron. He also started to use catalysts—substances that are unaffected by the reaction but help it, additives that constituted the secret components of the E-Cat when presented publicly in January 2011.

Despite all the variations he tried, for several years he saw no results. Yet he could not let go. Only in 1997 did he see the first sign of heat from something that might be a nuclear reaction. In New Hampshire he happened to touch a sample he was working with and suddenly burned his finger. The nickel he used in the sample had melted at a small location—at 1,455 °C. As a whole, he saw up to 100 watts output a few times, about as much as an ordinary immersion heater for a small pot. His nagging thought that the phenomenon somehow should work then grew, but he also realized that he could not get far with the limited time he could dedicate to the work. That he did not fully engage in the experiments was, on the other hand, easy to understand—this was the period when he was fighting the judiciary over Petroldragon and the Omar refinery, ended up in jail for six months in 1995, was stripped of everything he owned, traveled to the U.S. and started his business there, developed his thermoelectric-generator technology, went home to Italy and ended up in jail in the San Vittore prison in Milan and there, finally, was left in peace for just over a year, with time to think and calculate. Locked up, literally and in his own world, he found several key ideas that would guide him throughout the E-Cat development. The one he considered most important originated in an article in the American journal *Physics Today* that he had brought to the prison almost by accident.

The article was about making small holes in ice, a hard material. It requires high pressure, but if a small hole suffices it's easy—high pressure in a small spot is easily achieved with limited effort. If you apply a pressure on a surface using a certain force, then reduce the surface to one-tenth, the pressure becomes ten times higher on the smaller spot—though the applied force is unchanged. Thus you can create high pressure with little force, if you make the surface sufficiently small. This was important for Rossi. Because to achieve fusion the nuclei must be pressed against each other so tightly that they merge—or fuse—at which point they produce a lot of energy. It's difficult: all nuclei repel each other, having the same positive electrical charge—much like magnets turned with the same pole towards each other. Indeed, nuclei repel each other so forcibly that it is almost impossible to get them together. The only way that science knows today is to accelerate them, achieved only one way—by raising the temperature to tens of millions of degrees, as in the sun and the stars. This is why fusion can happen in the sun but should not work at a few hundred degrees, as in Rossi's E-Cat, or at room temperature, as in the Fleischmann and Pons experiment.

Fleischmann and Pons' trick was to force the heavy-hydrogen nuclei into 'vacant spaces' in a rod of palladium, a metal that easily absorbs hydrogen. Inside the metal rod, the nuclei would be packed so closely that the proximity would make it easier for them to fuse. Through the article about ice, Rossi got the idea of working with extremely high pressure to force the nuclei together. Several researchers, with whom he later shared this idea, said that it was strange, because pressure is normally something discussed in the macroscopic world we can see and experience—air pressure in car tires, water pressure at great depths or squeezing things to be glued—but not in individual atoms. But the idea seems to have led Rossi forward.

Another picture he used was a hammer and an anvil. Instead of merging two tiny nuclei of heavy hydrogen, which Fleishmann and Pons had tried and the sun also does, Rossi conceived of combining a small nucleus with a large one. The small was the hammer, the large was the anvil. As a hammer he chose the nucleus of ordinary hydrogen, the smallest in the universe, consisting of only one particle, a proton. In addition, it occurs in vast numbers in the sea—every water molecule has two hydrogen atoms, as in H_2O. As the anvil he had to choose an element that liked hydrogen. Fleischmann and Pons had wisely chosen palladium but Rossi noted that it cost $30-40 US per gram. If he tried to make a useful device of the whole thing, that would be too expensive. He looked in the periodic table—a table containing all the known elements in the universe, about 100, cleverly arranged so that elements in the same column have similar properties.[29] Below palladium in the periodic table is platinum, which is even costlier, but in the spot above palladium is nickel—one of the most abundant elements on earth, costing about $100 a kilo. And since nickel, like palladium, likes hydrogen, the choice was easy—nickel became the anvil. Rossi himself said he didn't think the idea was unique.

"Keep in mind that the choice of nickel and hydrogen is archeology," he said, meaning that many before him had reached the same conclusion on the periodic table vs. cost.

Indeed, a small group of researchers who persisted in cold fusion used nickel and hydrogen, including Randell Mills and James A. Patterson, as well as the Italian Francesco Piantelli and the Greek Christos Stremmenos, who would both turn up later in Rossi's story. Rossi says firmly that he never received inspiration or ideas from any of them but he was obviously not alone in his choice of nickel and hydrogen. But he was possibly the first to use nickel in the form of fine-grained powder, thus increasing the surface area where the hydrogen gas could contact the nickel.

With these ideas as a base and various other details written on his thousands of pages of notes, he decided where he would begin once free—he would put a few grams of fine nickel powder and some catalysts into a small reactor chamber, load the hydrogen gas under pressure, then initiate the reaction with heat from an electric heater cartridge. On June 6, 2001, he was released.

29. The first truly useful periodic table was created by the Russian chemist Dmitri Mendeleev, in 1869.

CHAPTER 7

The E-Cat takes shape

"The first thing I had to do when I was released from prison was to make money, because whatever you're doing you need money. Because I was good at producing energy from organic material, I attacked it again. Without modesty I can say that I was one of the best in the world in this field. I had a tremendous experience, gigantic—I was a pioneer in the '70s, when people looked at you as if you were crazy if you went around and introduced such technology."

So in 2002 Rossi founded the Italian company, Eon, in the small town of Bondeno in northern Italy, unaware that a German energy giant had almost the same name. He chose Eon because it means millions of years, the time required for fossil fuels to form from organic residues, a time that Rossi said was no longer necessary, given the technology he used to produce biodiesel from plant waste. He didn't know of the German company E.on—not yet present in Italy—and the two companies continued to carry almost the same name. He started from the development work he had initiated at Leonardo Corporation and began producing gensets run with biodiesel produced from plant and animal waste.

"We started to produce machines that could compete immediately. They sold well and we earned a bit of money. Electricity is expensive in Italy, so the margins were good. The technology was based on my previous technology that had caused the hassle. But since then it had become widely known, not as it had been in 1978, when I said that you could make oil from organic waste and everyone screamed that it was a fraud, impossible, buffoonery, a joke."

Meanwhile, Rossi's contacts with Craig Cassarino and LTI in the U.S. continued, and they helped him to develop a parallel business through Leonardo Corporation.

"We were going back and forth, working with him during that period. Then, as the business started to evolve for LTI, we also decided to look at other developing projects. We looked at helping him develop the market for his Eon and the vegetable generators in the U.S. We visited, brought engineers from LTI and made an agreement to help him market that technology."

With the business up and running, Rossi could pick up the ideas he had developed in prison and began to devote more time to experiments with the E-Cat, or his 'toy' as he started calling it.

"I started to build reactors in Eon's Bondeno laboratory. I had a machine shop there which was well equipped and a staff that was talented. I started getting several hundred watts of power."

During this period he experienced several explosions, some quite significant. While Rossi worked alone in the evenings, sometimes the reaction generated a strong peak with extreme heat. Later he would learn how to handle such peaks by designing the reactor in a particular way, and by knowing how high the peaks reached and what was required to control them. But at that time he did not have that experience and hadn't developed the necessary reactor technologies. So the peaks increased until the reactor exploded from heat and pressure. The component that failed first was a valve for filling hydrogen, which loosened and careened like a projectile through the lab. Rossi escaped unscathed, but beyond flying reactor parts that could have been dangerous the process also developed radiation via the unknown nuclear reaction and he did not know its magnitude at the instant of the explosion. He reassured himself that it should be short-lived because he did not use radioactive materials—substances such as uranium and plutonium, used in nuclear power plants, that are naturally radioactive even before the reaction starts. Nickel and hydrogen in Rossi's reactor were not radioactive but the reaction probably produced traces of radioactive materials. But radioactive materials become less radioactive over time, since they are gradually transformed into other substances by radiation. Rossi was dealing with substances that radiated weakly and lost their radioactivity in a few hours. Next day there was thus no radiation, but the experiments were still dangerous.

In the early 2000s Rossi based his research on practical experiments, to learn from his mistakes. He considered the exploding reactor a mistake from which he could gain experience. So he experimented alone—he shut himself up in the evening and worked with the reactor as often as he could. Gradually the results improved and eventually the measured energy output exceeded the input. This was fundamental in all cold-fusion experiments. Since Fleischmann and Pons' famous work, many such experimental setups were started and sustained by feeding electrical or heat energy into the reaction. To be useful, energy output must exceed energy input, or the net result is negative.

When Rossi observed positive net energy he realized that he had to go further and deeper, and he began to devote two or three hours to his experiments, daily, instead of one hour each evening. He still believed that he had probably made calculation errors. What he was seeing was too good to be true, he decided, disbelieving his results until he met Professor Focardi—the University of Bologna physicist to whom Rossi turned to understand what he was actually doing. He had reached a point where he had to decide whether to invest wholeheartedly in developing the E-Cat or abandon it.

"It became essential to build a proper lab with proper safety features, to begin work in earnest. The dilemma was this: either I followed the track of all the others so far—laboratory experiments that gave more or less valid results, for a second, for a minute, then wait for Godot—wait for a white knight to lavish money on you because you are a genius and have made the Great Invention or I could do what I did with the gensets that produced electricity from plant waste: build functioning plants.

"I thought that if I stuck with the first option I'd never get anywhere, because the white knight never comes and even if he does the ensuing difficulties are immense. In other words, you cannot climb Mount Everest in your spare time in tennis shoes as a hobby. If you want to climb Mount Everest you should climb Mount Everest properly. In that case you need the right equipment, the necessary time, proper exercise and training, then you climb Mount Everest."

This reasoning led Rossi to meet with Sergio Focardi, a meeting that would prove crucial.

"I had read a paper by Professor Antonio Bertin at the University of Bologna. He had been trying for years to replicate Fleischmann and Pons' experiment. Since I was in Bondeno, not far from Bologna, it was natural to turn to Bologna. It was the nearest faculty, so I called Bertin.

"I explained that I needed to consult him, but not in a positive sense. I needed his advice in a negative sense. I wanted to explain what I was doing so that he could convince me that the whole thing could not work, so I could say ‘period,’ put an end to my work and not think about it anymore.

“On one hand, I was convinced that I was right. On the other hand, I realized that I could not possibly be right. Not to be trapped in midstream, I had to decide whether or not to devote my life to this thing. It had made my time in prison fly by and it had been good in that way. Now I had come to the point where I either had to invest big money and valuable time, or nothing at all, because I was about to hurt myself to no avail.

“Bertin said that he did not want to deal with this kind of problem anymore because he had already spent years with it and he didn’t want to work with it, no matter what. But, he said, you could turn to Professor Focardi.”

Sergio Focardi, retired for two years, had done research on cold fusion at the end of his career.

But when Fleischmann and Pons presented their results he didn't believe them.

"It was not possible. And besides, they presented their results at a news conference and not in a scientific journal," said Focardi.

A year or so later, however, he met two friends at a physics conference in Trento, Italy—Francesco Piantelli from the University of Siena and Roberto Habel from the University of Cagliari, on the island of Sardinia. Piantelli had got into the cold-fusion area more or less by accident and had achieved results. Unlike most others he worked, like Rossi, with nickel and hydrogen. The three friends had decided to collaborate and eventually published their results. When Focardi retired he had abandoned his cold-fusion research. When Rossi phoned him at the end of June 2007 it was summertime and Focardi, pushing 75, was relaxing in the coastal village of Lido di Spina on the Adriatic Sea, on Italy's eastern coast. Rossi explained what he had told Bertin and Focardi invited him to Lido di Spina. A little later Rossi stepped into his car and went down to the sea from Bondeno, past the town of Ferrara to Lido di Spina. A horrible resort with terrible water, he thought, and pondered that since the polluted Po flows into the sea nearby it was easy to understand why the water was so bad. But it's nice for kids, if they don't go into the water. The beach is beautiful. Moreover, the Ferrara residents are pleasant, he thought.

Lido di Spina sits on a spit of land with a small lagoon on one side and the Adriatic beach on the other, where the *bagni*—bathing establishments—with their sun loungers and parasols stand in neat rows, though on a slightly smaller scale than in the major tourist towns of Rimini and Riccione a bit further south. The two men met in a bar. The tourist season had not yet started and it was relatively quiet on the streets and beaches, though a mild and pleasant summer heat prevailed, which most Europeans would consider perfect holiday weather. Rossi had brought his papers, repeating that he had reached a point where he had to decide whether to move forward or abandon the project.

“I’ll pay you as a consultant for you to explain to me why I need to stop working on this—surely you understand more of this than I do. Just tell me where I’m wrong,” he said.

Focardi, a thoughtful man, sat quietly and listened intently while Rossi talked. He smiled occasionally and took his time before asking Rossi if he could study the material and come back later. Rossi handed over his materials and returned to Bondeno.

§

After a few days Focardi called and said that he was sorry, but he had bad news.

“Look, it’s not bad because I was expecting this perfectly, just explain to me why it does not work,” said Rossi. Focardi then stated his surprise.

“No, you see, the bad news is that I cannot do what you ask of me. On the contrary, I believe that it is worthwhile to continue working on this."

Rossi hesitated as Focardi's words sunk in. Then he rallied and understood. The conviction that he was on the right track had overpowered its mental opponent—the belief that he could not be right—and stood as the clear winner. He decided then to devote all his energy to developing the technology. Focardi, though retired, gladly offered to contribute with his knowledge.

The first thing Focardi taught Rossi was how to protect against radiation. During an early experiment with Piantelli, Focardi had detected neutron radiation—particularly unpleasant because it is difficult to guard against. The neutron is a neutral nuclear particle that cuts through anything in its path, including thick protective barriers. It's also the most difficult radiation to control in traditional nuclear plants and in experimental fusion power plants. Gamma radiation, which Focardi had also observed in his experiments—a small and intense variant of ordinary light, used in ordinary X-rays—is easier to protect against.

“With lead you can protect against gamma radiation, but not against neutron radiation. Neutrons are terrible. They are the most dangerous,” Focardi explained to Rossi.

He arranged that each of them always wore a neutron-radiation detector while experimenting—a little box containing liquid in which small bubbles form when neutrons hit it. Should it occur, they could take action and move to safety. They need not have worried. They saw no trace of neutrons in their joint experiments. In addition to the neutron detectors, Focardi taught Rossi how to protect against other types of radiation. Eventually they were working in earnest. Rossi built a wide range of reactors that worked more or less well. In total he built and destroyed a thousand reactors and tested thousands of combinations of different materials, or at least that was his recollection when I asked. Could it have been that many? I was never sure. Could it merely have been minor, ongoing modifications that he was counting? Who could say? Among his tests were different types of the all-important catalysts, different processing of the nickel powder and different reactor-chamber designs. Tiny details could make a big difference, he discovered, and he had no proven theories to rely on. His work was almost entirely empirical. He also needed to integrate his theories on how the reactors really behaved.

"It was like crossing the Amazonia and as a theory having a compass and the knowledge that the Atlantic Ocean is to the east and the Pacific Ocean to the west, instead of having a detailed map. This work had not been done before—integrating the theories that you build with what really happens—because it requires tremendous effort and a lot of money, and instead everyone is waiting for the white knight."

The fact that it cost a lot of money was partly because it took a lot of time and needed mechanics to assemble the experiments. “Mechanics cost,” Rossi used to say. “You realize that when you take the car to the garage for repairs.”

Though the workshop in this case was his own, it cost a lot. But Rossi convinced himself that he must dare to spend. To get enough, he decided to sell his company Eon—the one that sold gensets fueled with biodiesel. He was helped by a good friend who believed in the new invention—the business consultant Giuliano Guandalini, who became a partner in the company when Rossi sold it for around €1 million, or $1.3 million US. A million euros was all he had and it had to be enough for him to create a usable E-Cat prototype. Because, from that moment on, he didn’t work on anything else. Focardi proved invaluable in enhancing the credibility of the remarkable invention. Still Rossi had to be careful. He realized that a university professor like Focardi was used to sharing his findings and results. So Rossi did not reveal the reactor design and catalysts to Focardi and let him instead do external measurements of heat production, input energy and possible radiation. Focardi had no problem with this but was pleased to participate in the trials with a device that produced much more interesting results than those he had achieved earlier with Piantelli.

On October 16, 2007, a few months after the Lido di Spina meeting, they conducted the first experiment at the lab in Bondeno. Focardi had estimated the expected radiation, based on his experiments with Piantelli in Siena, provided that the phenomenon derived from a similar reaction, and found that they should be able to perform the experiments with Rossi's device without radiation protection. The Bondeno lab site was more a raw industrial hangar with about 20-foot ceilings and lots of space. The walls held miscellaneous equipment, cartons, plastic tanks with chemicals, shelves, gray sheet-metal drawers and a huge fan set. The floor was concrete, gray as the walls. They set up the experiment on the floor, in the center. On a wooden table were various gauges and a plotter. Beside the table stood a six-foot hydrogen tank and next to it, on a blue and white metal barrel, a red plastic tub in which the reactor was submerged in water, connected by cables and hoses for measuring instruments, power and hydrogen.

Focardi was excited and the experiment gave the first seemingly interesting results with a heat that was difficult to explain, except that the reaction worked. Later he noted that they had committed a few significant mistakes and that more trials were needed before he could draw firm conclusions. As an experienced experimental physicist, he had designed experimental setups based on different principles to detect mistakes that crept in due to overlooked systemic errors. When they performed initial experiments a few months later, the results became more reliable. Focardi felt excited initially to witness something he knew was historic but calmed down as the work progressed and continued systematic measurements with different methods. When he came occasionally to the

Physics Department at the University of Bologna, where as a professor emeritus he still had an office, he could not resist the temptation to tell what he'd been through working alongside Rossi.

"Come here, I'll tell you something extremely secret," he told a couple of his research colleagues at the department, Giuseppe Levi and Enrico Campari.

Levi and Campari received regular reports from Focardi but kept them carefully to themselves. Over time, more and more people at the department got to know what Focardi had been doing, since he occasionally mentioned a few things about his experiences. That the secret still didn't escape the institution was easily explained: few took it seriously. The same thing had occurred back in the 1990s when Focardi had experimented with cold fusion in parallel with other research. When he had mentioned his research his colleagues had listened attentively and agreed but when he told them that the measurements and results had to do with cold fusion they rejected it and registered distrust. Yet in both cases he had reported nothing but measurements and observations, carried out by the same person—the same process, in other words. Many of his colleagues reacted similarly when Focardi mentioned experiments with Rossi that yielded far more impressive results. Focardi was simply not taken seriously.

One person who noticed this and asked himself why measurements from one area would be less reliable than from another was the physicist Giuseppe Levi, who had done other research with Focardi. Levi had tried previously to persuade Focardi to resume his cold-fusion experiments but Focardi had declined, thinking that they would never lead to useful amounts of energy. With Rossi's device the matter was entirely new: it produced such large amounts of energy that it apparently could be useful. So Levi followed Focardi's reports closely. He believed that those who didn't take Focardi seriously had made two mistakes in their reasoning.

The first error was to claim that if one believed that the device worked one had to know how it worked. This 'logic' was defective, Levi thought. For example, even a primitive knew that the sun heats without understanding the reactions that produce the heat. The second mistake was that one could not keep secrets, as Rossi had. Rossi's device, Levi realized, was not the result of research at a public university but his own project, himself the only risk-taker. It made sense to protect it with a patent and to keep the design secret. Later Levi got to see, feel and measure the E-Cat. Meantime, he was careful not to form ideas about how it worked. He knew from experience that a theory about a new, unknown phenomenon, created too early, could lock the inventor into that theory and make it hard to interpret measurement results with an open mind.

Rossi was still relatively unaware of all this but, as usual, his intuition guided him correctly when it came to understanding how Focardi could best help him. Beyond helping with the experiments, Focardi could help formulate the science around the device, though no one yet knew in detail how it worked from a physics standpoint. Rossi now needed this kind of description because he had become aware that he must somehow try to protect his invention with one or more patents, not an easy process. One problem was that the patent authorities, particularly in the U.S., were skeptical about cold fusion. For many years no applications based on the phenomenon had been accepted in the United States.

Another problem was how much to disclose. To get a patent, you must normally describe the invention such that someone else can use it. It is the point of the patent: you get protection in exchange for sharing technology and users must pay a license fee. To describe a working device, the inventor must disclose the secret design details. Without these details, the technology would work just as badly as when Rossi began his experiments. The problem was classic—if the patent were not granted, his secrets would be disclosed, since patent applications become public after a certain time. So what might seem a boring task—writing patent applications—is an art form, balancing what must be said and what cannot be said, and in precisely formulating the claims describing what is to be protected.

Rossi turned as before to his patent attorney—Professor Franco Cicogna in Milan—but also got important assistance from Focardi in formulating the scientific elements of the application, filed in Italy on April 9, 2008 and internationally on August 4 the same year.[30] Still this first patent application would later be viewed as essentially without merit. It was approved in Italy, via an older standard under which patents were granted more formally.[31] Nevertheless, most reviewers considered it so poor that an international patent could never be granted. In February 2008 Rossi also founded a new company to license the technology, EFA—*Energia da Fonti Alternative* (Energy from Alternative Sources). The majority shareholder was his then wife, whom he had met during the years after Petroldragon and Omar had been terminated, and the patent application was also in her name. "That way there will be no problem if I die," he reasoned, but probably it also reflected claims that could descend on Rossi from the old Petroldragon business.

Minority EFA shareholders were Giuliano Guandalini and Luca Aldrovandi, who with Guandalini participated in the Eon acquisition. Aldrovandi was also president of EFA from 2008 until 2011. The idea was that the EFA would control the Italian and international patent rights, except in the U.S., where a separate patent application was filed.[32]

Patents give no absolute protection. On the contrary, patents may provide a false sense of security, especially for lonely inventors and small businesses. Large companies commonly violate patents in their path. If they are notified of infringement, they have the resources to pursue litigation for years with an army of lawyers who can skillfully and persistently argue their case. Small patent holders with limited resources has no defense and usually see themselves destroyed, uncompensated, or facing an expensive venture with court costs and lawyers' fees. However, with both an Italian and an international patent application filed, Rossi in 2008 felt ready to contact his friends in the United States.

"He said he had something interesting to discuss. He came over and we sat in Bob's living room, and he started to describe his E-Cat device. This was intriguing but, as you can imagine, not being a technical guy, it was a bit mysterious to me," Craig Cassarino remembered.

Rossi invited Bob Gentile and an LTI researcher, Richard Noceti—like Gentile, with a DoE background—to Eon's Bondeno lab. He had replaced the burner in the premises' boiler with an

E-Cat and said he had heated the building with it for months—an alternative way to estimate the heat-energy output, since you could compare output with the gas burner used before. After visiting the University of Bologna and having met Focardi, Gentile and Noceti traveled back to the U.S. and described what they had seen.

"As you can imagine, when we came back and started talking about this there was lots of skepticism. Oh boy, you know, we've heard this before," Craig Cassarino told me.

Because Cassarino and Gentile had known Rossi for 15 years, they knew what he could do. In addition, an LTI researcher had worked for almost 20 years with what, instead of cold fusion, was now being described with a new term: LENR—Low Energy Nuclear Reactions. He thought that the phenomenon worked and when he got a detailed description of the device in Italy he believed that Rossi was onto something. They decided to start helping Rossi, among other things in obtaining a visa so that he could come to the U.S. and start building a business around his remarkable technology there. Rossi later told me that the U.S. immigration authorities, in connection with the visa application, wanted to look at the files concerning the lawsuits against him. He remembered that when the visa was ready the officer who had read the documents said: 'Your life has been a Calvary, Dr. Rossi. Come and get your visa.'

Rossi went back to the U.S., where his Leonardo Corporation in Bedford, New Hampshire, had hibernated while he was in jail. He let Leonardo Corporation become the basis for developing the E-Cat and later also discreetly erected a small factory in Miami, Florida, with another trivial blue-collar business as a cover. Eventually it was time to demonstrate the E-Cat for his friends at LTI. They had begun to recognize the invention's huge potential, if it worked. Fearful of being observed, they had rented a garage in secret, where the first demonstration was performed. LTI had brought in researchers who knew the measurements and observations to be made and could help Rossi set up appropriate measurement arrangements. The result was convincing, with substantial excess energy produced. Though Rossi didn’t reveal the nature of his secret catalysts and could not, or would not, explain in detail how the device worked, his LTI friends decided that he had a revolutionary invention in process and would follow him in the venture.

Craig Cassarino, Bob Gentile and their colleague Richard Noceti at LTI. who met Rossi in Bondeno, founded the company Ampenergo with Cassarino’s childhood friend, real-estate agent Charles Norwood, who had met Rossi when he had worked with the thermoelectric generators. Reasonably, they could use their good relations with both the DoE, where Gentile and Noceti had worked, and with the Department of Defense (DoD). When later, in November 2009, they made two additional tests of the E-Cat with Rossi at LTI’s office in New Hampshire, secret representatives of both Departments were present, according to information contained in a paper that Rossi and Focardi later published together.

The contacts must have been sensitive, given that cold fusion had been so stigmatized since Fleischmann's and Pons' controversial experiments, and also because the DoE had played an important role in the negative perception of the phenomenon through their 1989 and 2004 reports. Yet they must have been valuable for Rossi if he wanted to continue to establish his business in the U.S. Even after the painful experience of Petroldragon, he had decided not to keep his home country, Italy, as a base for developing new technologies. He realized that he had made mistakes at that time and that the technology he was working with was not ideal, but he was also convinced that the resistance he had encountered had been disproportionate, likely engineered by powerful interests he had somehow threatened.

My own image of Italy in terms of innovation was that old and deeply rooted structures in the Italian society, with power positions that people were prepared to defend at all costs, represented effective obstacles to new ideas and technologies. This does not mean that there were no new ideas. On the contrary—many Italians I met were creative, committed and problem-solving but they seemed to face a constant uphill battle. An Italian journalist whom I had met, Roberto Bonzio, had been running a project he called *Italiani di Frontiera*—translatable as 'Italians without Borders'—where he documented Italian innovators and entrepreneurs and their work worldwide. He described experiences matching my own views: that many Italians faced a seemingly hopeless struggle to push new ideas in their home country, only to discover that they could achieve greatly once they developed their potential in countries with more open cultures. While working with Focardi in Bondeno, Rossi would again experience the impression that he did not get the support he wanted in Italy.

In summer 2009 he contacted Italy's major utility Enel—the second-largest in Europe—through his friend Giuliano Guandalini. Guandalini had a rich network of contacts among powerful people in Italy. Among others, he was closely acquainted with Enel Chairman Piero Gnudi and discussed with him whether Enel would be interested in evaluating Rossi's technology. As a result, Enel had two of their engineers visit Bondeno to measure the E-Cat accurately. In early July 2009 they filed a positive technical report. Enel made an offer to Rossi but Rossi soon realized that he could not accept the terms. Guandalini explained why.

"Enel had drafted a proposal for collaboration with Rossi and suggested that the company would finance the entire development cost. But Enel refused to recognize or pay for the work Rossi had already performed. The remuneration Rossi requested was modest. For years of study and for costs and investments, he specified an amount that Enel would not recognize and this was why contact between Enel and Rossi ceased.

“I later called Dr. Gnudi again and said that I was sorry that Italy would miss such an important opportunity. Gnudi said that he could not do anything. He explained that at the operational level the CEO of Enel was more important than the chairman.

“I never talked with the CEO, Dr. Fulvio Conti, only with an engineer, Livio Vido, Conti’s spokesman. Rossi heard directly from Vido, who manages development of new technologies and innovative energy sources. I was present. But obviously the announcement from Vido came directly from Dr. Conti, as CEO. In other words Dr. Conti took the unfortunate decision to terminate relations with Rossi, though the chairman tried to continue the project.”

I contacted Enel to get a comment on this incident but I never got any response.

Could Enel’s reluctance have reflected strong interest in reintroducing nuclear power in Italy at that time—an effort that would be threatened by a revolutionary new energy source? A few years later the situation might have been different—this was before the Fukushima nuclear disaster in March 2011, which contributed to an Italian decision to shelve its nuclear plans. A year after the accident, in fall 2012, another major European utility—Swedish *Vattenfall*—expressed its views on nuclear power vs. Rossi's technology. Anders Åberg, a physicist and research engineer at Vattenfall, said on Swedish state television, SVT: "We have a problem. Eventually we will have to replace nuclear power with something." Whatever was behind Enel's actions in 2009, Rossi noted that Italy had to wait its turn.

Instead, it would unexpectedly become Greece that, together with the United States, took the opportunity to be part of the first commercial phase of the E-Cat. Again, the contact with Focardi turned out to be crucial. Before that happened, however, Focardi and Rossi had another ambition. They wanted to stick their necks out and dust off the specter of cold fusion in a scientific paper to see if they could get recognition for their experiments in the scientific community.

30. http://www.google.com/patents/EP2259998

31. http://www.uibm.gov.it/uibm/dati/Avanza load=info_list_uno&id=1610895&table=Inv

32. http://www.google.com/patents/US2011000

CHAPTER 8

Paper, Greeks and public demonstration

On February 28, 2010 Rossi and Focardi published their paper[33] and the international patent application on a blog Rossi had started: *The Journal of Nuclear Physics*. The name invoked classic scientific journals, the traditional channel for publishing research papers for several hundred years. These journals feature 'peer review' through which all submitted articles are reviewed by independent experts before publication. The concept—still respected, though questioned in some quarters—ensured that published results were relevant and scientifically rigorous.

Rossi and Focardi knew that publication in such a journal was not even worth hoping for. Cold fusion had been discredited among the journals in the field for 20 years as ‘pathological science’—a term usually applied to research where scientists somehow were fooling themselves to find results that were not true, ignoring systemic errors or inaccurate observations. It would probably still have been unlikely to get the paper published because it did not explain in detail the experimental setup, meaning the design of the apparatus, the reactor and the substances used, but simply referred to the international patent application where details were still secret. It was even rejected by Arxiv.org—a website whose existence since the early 1990s had contributed to a new trend with far greater transparency in the publication of scientific results.

On Arxiv, researchers could freely publish drafts or pre-prints of papers they intended to submit to an established journal. The trend, ‘open access,’ became so strong that some scientists simply thought that it was enough to publish there. Over time, a loose system with a formal examination of pre-prints had evolved at Arxiv. Though this assessment was far less rigorous than traditional peer review, Rossi's and Focardi's findings were so controversial and the description of their experiment so incomplete that their paper did not get through. Most provocative was perhaps the last line of the conclusions: '... *this is an endless energy source for the planet, without emissions into the atmosphere.*'

What was particularly controversial was the scientific content—a theory that the device produced energy via the fusion of hydrogen and nickel nuclei. The result of such a nuclear reaction would be copper, of which Focardi and Rossi had found traces in the fuel powder after use. Since the reaction occurred at only a few hundred degrees, it would be a kind of cold fusion—the phenomenon that the scientific community rejected as impossible according to known physics. It hardly helped that the paper did not describe the experimental setup. In other respects, however, it was traditional, with a systematic description of

Focardi's measurements, using three independent methods, in a satisfactory scientific spirit. In the paper the two trials at LTI in the U.S, with DoE and DoD representatives present, were also mentioned, also that experiments had been performed in Bondeno in the presence of observers from the Italian energy giant Enel.

On Rossi's blog the paper got a lot of attention, certainly more than Rossi could have hoped for but for Focardi's participation. Focardi was now probably more important to Rossi than ever: an established researcher who had collaborated in the experiments and put his name on the paper.

"His support was crucial when disseminating the results. Had I presented this alone they would only have laughed at me. If not for Focardi's name, the paper might have been read by me ... and by my wife," Rossi said.

Now a few hundred visitors a day read it, full of curiosity. Other scientists commented and some published on Rossi's blogsite their own papers related to the phenomenon. Rossi thus not only got attention but also a dialogue with others knowledgeable in the field. This became for him a source of new ideas about his technology. One scientist who commented was the Greek Christos Stremmenos, a retired professor of physical chemistry at the University of Bologna, who also knew Focardi.

The contact with Stremmenos would have a decisive impact on how the story developed. I met Stremmenos much later, in April 2011—a tall, jovial gentleman, approaching his 80 years in good shape. His dense gray forelock was combed back, his chin adorned with a proper goatee with accompanying mustache. Behind his glasses, with thin metal frame, he had a calm look with one eye slightly more open than the other. He had a habit of slurring a bit as he spoke but when he wrote he seemed articulate and clear about the ideals he revered—ethics, scientific truth as well as cultural, democratic and human values. As with Focardi and a couple of other researchers at

Bologna University, Stremmenos had engaged in research on cold fusion in the '90s, partly using nickel and hydrogen like Rossi and Focardi, and also nickel powder, like Rossi. Stremmenos had then just returned to the University after having been the Greek Ambassador in Italy for five years in the '80s.

"Besides me, it was Professor Focardi, Professor Premuda and Professor Cammarota. We exchanged opinions, materials, tools, optimism and confidence ... in short, an atypical true collaboration, in parallel, that lasted until 2003, the year I retired, convinced by our experimental results about the existence of the cold-fusion phenomenon," he told me.

Stremmenos also had contacts high up in Greek politics. He was a friend of the aspiring Greek Prime Minister George Papandreou, whom he had met during the resistance against the Greek military junta in the '70s, when Stremmenos had run a secret Greek radio station in Bologna. Along with a working group on energy at a congress of the Greek socialist party PASOK in 2004, Stremmenos handed to Papandreou a report on his research on cold fusion and explained its potential, not only in energy but also in environmental policy and economics. The two agreed to keep each other informed of their progress—according to Stremmenos, Papandreou also said that such technology could have an enormous impact. In spring 2009, Focardi contacted Stremmenos and told him about his work with Rossi, whom Stremmenos had not yet met. Focardi explained that Rossi had made a leap from the low output levels of a few watts, common in cold fusion, to kilowatts—i.e. thousands of watts.

"Dear Stremmenos, we made it!" Focardi exclaimed. The announcement left Stremmenos profoundly moved.

"It filled me with joy. Clearly we were way beyond the experimental phase, in which we had achieved power outputs of four or five watts through persistence and long periods of work, without resources or moral incentives. It was not just a victory for all of us but, as I thought and still think, a victory for humanity," Stremmenos told me.

When Stremmenos later got to know Rossi in Focardi's office, they discussed different options and agreed on Stremmenos idea: launch Rossi's technology in Greece as the first country in Europe, from cultural and economic motives, with exclusivity for Greece and the Balkans. Backed by a gentleman's agreement, Stremmenos went to Athens in spring 2010 to tell Papandreou about the technology and its possibilities for Greece. He brought a friend from the resistance, Antonis Karras, a veteran politician who had followed Stremmenos' research on cold fusion in the '90s. Papandreou, by now Prime Minister, called a meeting to discuss the issue. Attendees included Professor Achilleas Mitsos, secretary general of research and development in the government, Dr. Apostolos Baratsis, vice president of the state energy company, DEH, as well as members of the prime minister's staff. After a thorough disclosure of information about the situation and a discussion, the meeting ended, according to Stremmenos, with the decision that the government wanted to move forward to test the feasibility of Rossi's and Focardi's technology, even at the industrial level.

Greece was at this time in severe economic crisis, with no energy resources of its own. Furthermore, the country was sitting on 83 percent of Europe's nickel deposits, and nickel was one of the components needed for the reaction in the device. The possibility that a revolutionary energy source could provide a historic turnaround—both for the world's energy problems and for the Greek economy—was naturally attractive, politically and financially. The controversial technology created much debate between skeptics and cautious optimists, even among the Greeks, but after a few months a group was formed, comprising members willing to go further at an industrial level and also to find funding. The main character was a friend of

Karras, Alexandros Xanthoulis, who had studied economics in Canada and worked in the finance industry.

"Karras is the most fascinating person you'll ever meet, a socialist legend. I've known him since 1972 when I was 16 years old. I'm a total admirer. He wanted to do something for Greece and this was one of the things he wanted to do. So he tried, through Stremmenos and me. But for me and my life, Karras will always be a very important person," Xanthoulis told me much later.

Soon the group contacted Rossi. To verify that the technology worked, a test of the E-Cat was performed in Bologna in October 2010. Xanthoulis had brought two old friends, mathematician and programmer John Hadjichristos and engineer and banker George Sortikos, who together performed all the measurements. In addition to Rossi, Focardi and Stremmenos, Karras participated, along with a physician at the University of Bologna with a focus on physics, David Bianchini, who later worked closely with Rossi. The test was successful and a month later, on November 17, 2010, Rossi and the Greeks met in Athens to sign an agreement giving the Greeks exclusive rights to produce and distribute products based on the E-Cat in Greece and the Balkans, and an option to distribute worldwide, except in the United States and for military purposes. The Greek company formed for this purpose was Defkalion, named after Deukalion who, according to Greek mythology, was the Greek patriarch. Deukalion had saved himself from a deluge in a basket he built after he had been advised by his father, the Titan Prometheus. He is, in other words, a kind of parallel to Noah in biblical mythology.

Xanthoulis, Stremmenos, Hadjichristos and Sortikos were members of Defkalion's board—Xanthoulis as representative of Praxen, a Cypriot holding company through which the investors would control Defkalion. The agreement was signed formally between Praxen and EFA, which controlled the E-Cat licensing rights, and was signed on behalf of EFA by CEO Luca Aldrovandi. A first phase called for €15 million to be paid into an escrow account by February 24, 2011. The amount would then be available for EFA nine days after an approved test controlled by a group of scientists appointed by Defkalion and Greek authorities. In a second phase, Defkalion would start research and development to design products based on the E-Cat. Moreover, Rossi would build a pilot plant producing one megawatt of thermal power—a big plant seemingly based on the idea that Rossi had while working with Petroldragon, when with such a plant he would convince the world that producing oil from waste worked.

One megawatt is not much compared with the power of a modern nuclear plant—less than one-thousandth—but it's still a lot of heat, as much as one hundred and electric stoves at full power, simultaneously, or equivalent to the consumption of about 300 Western households, including electricity, space heating, water heating and air conditioning. This is so much that in practice it would be impossible to produce that much heat through a hidden scam. Thus it would no longer be possible to deny that the technology worked—though it should not work, scientifically speaking.

The plant was to be delivered to Greece and when it was up and running Defkalion would pay an additional €100 million to EFA. In total, Defkalion's own costs included, an investment of nearly €200 million would be needed. Given the amount and realizing that it concerned a technology that the scientific community did not want to touch with a disinfected barge pole, it would be a tough challenge, but obviously Xanthoulis had a plan to find interested investors. If the E-Cat delivered what it promised, the agreement implied on the other hand a huge commercial opportunity in which energy giants and venture capitalists would have teamed just for a small share. Yet everything continued without much attention and among the few who were interested many were largely skeptical.

Opening the megawatt plant was planned for October 2011. To handle the task, Rossi established his small factory in Miami. According to Rossi it was around ten thousand square feet and had a handful of employees who manufactured key elements of the device. The plant would comprise 100 coupled E-Cats, to deliver one megawatt. Rossi later changed this to 300 of a smaller model, then changed again to 100 of a new and more powerful variant. Manufacture was secret. To attract minimal attention, the factory had, said Rossi, another everyday activity as a cover and an official address in an office building in another location. Since no outsiders had seen the factory, many doubted its existence. I myself never received proof that it ever existed.

Rossi continued to experiment with his reactors in Bondeno, among other things to test the reactor's limits. One way was to push it harder, to where it was self-sustaining, without assistance from the electric heating cartridges. He knew it was dangerous because the reaction could become unstable. He later described an incident one night in June 2010, when he was, as usual, working alone in the laboratory and the temperature inside the reactor began to rise uncontrollably.

In the balmy summer night Rossi followed the temperature development in the device that was set up in the spartan hangar with its gray concrete floor and gray walls. None of his measures to suppress the reaction helped yet he stayed stubbornly to see what he could learn. It exploded finally and loudly while a couple of parts flew across the hangar. This time Rossi was scared. Unlike earlier explosions, this time he was wearing the radiation detectors Focardi had taught him to use and they were full of bubbles—a sure sign of dangerous neutron radiation. How strong the radiation dose was he did not know but it probably decayed quickly. He knew that the reactor materials were not radioactive and had now learned that the weak radioactivity during the reaction should subside within 20 minutes after the reactor was stopped. No harm done, he noted, but he also thought that he must establish greater safety margins and keep the reaction running with support from the electric heaters in the future. In just one year it was time for the inauguration of the big megawatt plant and by then he must have safety under total control.

One person who found it difficult to wait a whole year and would have liked to see the invention getting more, earlier attention was Focardi, now 78 years old. His health was failing and while he felt that Rossi’s invention was perhaps one of the most important in history he worried that he might not live to see its recognition. So he went to Rossi and asked if they could carry out a public demonstration, where independent scientists could make measurements and confirm that the device really worked.

After his previous experience Rossi wanted to wait with publicity until he could show off the plant delivering a megawatt and put an end to public skepticism. On the other hand he fully understood Focardi's situation and knew that his invention might never have seen the light of day unless Focardi had convinced him to go forward, on that June day in Lido di Spina, three years earlier. So Rossi and Focardi began planning a demonstration in collaboration with the University of Bologna. Once again, Focardi's involvement was invaluable for Rossi. "The university would never have done the test unless Focardi had been involved. They would have told me they had other things to do and not to disturb them," Rossi commented.

The independent researcher Focardi had in mind was Giuseppe Levi, his younger colleague, who had already received regular reports from Focardi about the trials in Bondeno. When I met Levi a few months later I was struck by a notable feature in his appearance he shared with both Focardi and Rossi—the high forehead, reminiscent of individuals with well-developed brain power. Coincidence, or something that united them? Hard to say. Like Rossi, Levi had close-set eyes and wide mouth but his short-cut forelock was denser than Rossi's. He was not as slim but slightly plump, like his older colleague Focardi. Like Focardi, he had a certain thoughtfulness, often followed by a big smile.

Since Rossi and Focardi wanted his help as an independent assessor, he would now, in mid-December 2010, a month after the test with the Greeks, participate for the first time in a test of the device about which he had heard so much. Levi had met Rossi about a year earlier and since then they had discussed the technology. Rossi built up his trust in Levi when he realized that he was among those who did not pre-judge the process as physically impossible, nor was Levi suspicious of Rossi for keeping construction details secret.

When Levi came to Bondeno, on a chilly day in mid-December 2010, he was relatively well prepared. Still, it was an unforgettable experience for him to get his hands on the device that was possibly based on a hitherto unknown physical process. When Rossi was ready to start the E-Cat, Levi began to make a series of routine checks. The device as a whole was then little more than a kettle in the form of a horizontal copper tube as thick as an arm, with a chimney, also copper, sticking straight up. Inside the copper tube the reactor itself was made of steel, about the size of a potato. Inside the reactor were a few grams of nickel powder, the secret catalysts and pressurized hydrogen. Around the reactor, through the copper tube, water flowed slowly via a small external pump. The entire construction was wrapped in insulation to prevent heat from being conducted away. With two electrical-resistance heating cartridges, the reaction was started and it quickly got hot inside the reactor—hundreds of degrees Celsius, sometimes over a thousand degrees. Thus the whole setup became a kettle—water pumped through the copper tube quickly began to boil around the hot reactor and the steam was led away by a hose high up on the side of the chimney (see graphics chapter 10).

Levi's routine checks were simple. He measured how much electrical power was fed into the device, how much water the pump was pumping, the temperature of the water pumped and the temperature of the steam. He verified that there were no hidden wires or connections that could provide the apparatus with energy secretly. He put his hand on it and felt the boiling, put his ear to it and heard that it was boiling and felt that the emerging steam still burned after flowing through the two-meter hose.

As an experimental physicist, both measurements and sensory impressions were important to Levi. The possibility of a scam decreased. The observations could be used to draw conclusions. The conclusion was finally simple, albeit surprising: the device worked. As Fleischmann and Pons had observed, Levi saw the fundamentals—the reaction did not appear to be chemical, since there was no room inside for a chemical reaction that could develop so much heat for nearly an hour. So it seemed to him to be some sort of nuclear reaction. And a new physical phenomenon that he could not explain.

“Excellent, interesting. This means that there is work to be done,” Levi thought. Still he regarded his conclusions as preliminary, and expected to need a series of experiments to be sure. He looked forward to this work.

After the test he even searched for the most powerful battery on the market, to see if there might be space in the experimental setup to hide a battery sufficient to boil that much water. What he found was a military traction battery that could keep the kettle boiling for about an hour. But the battery was three feet long, two feet wide, eight inches thick and weighed 300 pounds. To make room for such a thing in the copper pipe was impossible. Levi had lifted the blue control box with electronics next to the E-Cat. It weighed just a few pounds. So Rossi would have had to have invented a new kind of very powerful and compact battery.

“If Rossi had made a battery with those characteristics he would have solved the problem of the automotive industry and would receive the Nobel Prize in chemistry!” Levi said to me later.

Rossi, Focardi and Levi began to plan the public demonstration on premises belonging to Rossi’s company Eon, in an industrial area outside Bologna, on January 14, 2011. Three days before the event the physics department sent out an invitation both to colleagues in the department and to Italian media. The test would be led by a Physics Department researcher, the first time independent researchers could try the device.

At three o’clock in the afternoon the guests began to arrive in the dense winter fog at Via dell’Elettricista 6/D—professors and researchers, Italian newspaper reporters and a film crew from the Italian state television RAI. In addition, Professor Christos Stremmenos was there, with representatives of Defkalion, making no fuss since the company’s involvement was still secret. The test site, in an industrial area east of Bologna, was a large whitewashed hall with high ceilings and gray concrete floor. In the center were rows of chairs and in front were a couple of tables and a television screen where participants could follow the experiment conducted in a small room adjacent to the main hall. Participants had to register and sign a declaration that they had been 'informed and were aware that they would attend an experiment with energy production through a new type of reaction between hydrogen and nickel, and of the possible risks it entailed for animals, objects and people,' that they participated at their own risk and waived all claims of responsibility on the part of those carrying out the experiment.

About 50 were present when Focardi, with his taciturn and thoughtful voice, explained how the experiment had been prepared. Rossi said he would soon start the reactor that was in the next room, then Levi took the floor and described what measurements he would perform and why. Initially those present could follow what was going on in the small room with the E-Cat shown only on the TV screen but eventually they were admitted into the room, six at a time.

Unsurprisingly, the media's way of relating to the experiment differed from the researchers'. After an hour the journalists started to become impatient. They needed to prepare material in time for tomorrow's newspapers—the TV team could broadcast that same evening. One journalist was in such hurry that even before the experiment was under way he went to Levi and asked what the results would be. The contrast between the journalists' working methods (speed, with limited opportunities for deeper investigation) and the researchers' (patient, focused precisely on deep investigation), is plausibly one reason why the scientific community views news conferences suspiciously. Even if the event were not about presenting research but rather to show off an invention claimed to be ready for commercialization, the journalists' impatience meant that the experiment had to be stopped earlier than Levi, Rossi and Focardi wished.

Levi had wanted to run the reactor for at least two hours, to make clear that a chemical reaction was excluded. But after about 40 minutes Rossi shut down the reactor and took questions. The journalists were told that the unit worked with one gram of nickel and a little hydrogen, that it had produced significantly more energy than the input during the experiment, that no elevated radiation was detected outside the apparatus and that the design itself was an industrial secret. They were also told that no one yet knew exactly what physical process could explain the energy development but that a European company was nevertheless ready to start mass production. Some Italian newspapers wrote about the demonstration and recalled the controversial history of Fleischmann and Pons 20 years earlier. Internationally, a few specialized websites picked up the event in Bologna, but otherwise the media were largely silent and would remain so.

33.

http://www.nyteknik.se/incoming/article
Focardi_paper.pdf

Contact with Sweden

Five days after the Bologna demonstration, a reader tipped me about the news. Next day, I wrote the website piece that attracted explosive attention: well over 100,000 visits, though it was only in Swedish. I realized that energy was the issue that engaged our readers most, by far. It was clear that new ways to provide clean energy for the world had become technology entrepreneurs' and engineers' ultimate dream—their Holy Grail. I also received the surprising comment "it looks interesting" from Hanno Essén—assistant professor and theoretical physicist at the Royal Institute of Technology in Stockholm and president of The Swedish Skeptics Society[34]. In science, 'interesting' is always a key indicator. As recounted earlier, I interviewed Rossi, Focardi and Levi, which led to my *Ny Teknik* website piece 'Cold Fusion will provide one megawatt in Athens.' In the print edition we titled it 'We deserve the Nobel Prize' on the front page, since Focardi, a little shyly, had said: 'If they give us the Nobel Prize, I think it is well deserved.'

Shortly after that I shook hands with Rossi in the newsroom and sensed that he seemed to trust me, perhaps because it served his purposes. I had by then understood the potential of the technology. Having researched a little nuclear physics, I also saw what militated against it—mainly that fusion should occur only at tens of millions of degrees, and that if, against all odds, it occurred at room temperature it should nevertheless generate strong, thus dangerous, radiation. Or as Levi, laughing, had told me: "I said to my colleagues, somewhat in jest and somewhat in earnest, that the fact that I was still alive meant that it couldn't be 'real' fusion. Because then we would have had huge radiation that could hardly be shielded and everyone around would have fallen down, dead as a doornails."

I sat there in the newsroom with the snow and winter darkness outside, thinking. After the first interviews with the people involved, I had a hard time believing that it was a fraud—it was not easy to understand even how the experiment could have been faked. Rossi seemed, in some sense, credible, and he could account reasonably both for his troublesome background and for the secrecy around the construction. Focardi emerged as an distinguished physicist with a good reputation and deep-rooted scientific mind. Why would he engage in fraud in his old age? Did Rossi deceive him? Difficult, considering Focardi's long experience as an experimental physicist. Levi would have everything to lose and little to gain from participating in a large-scale conspiracy. He could be accused generally of not being independent, because he worked with Focardi, but it seemed far-fetched. It would be more likely that he, too, was deceived by Rossi.

I could be sure of none of this. But it was hard to see the reason for a possible fraud among those involved—especially as Rossi insisted on delivering first, then getting paid. No one could explain credibly how the experiment could be executed by cheating, especially if only Rossi knew and everyone else had to be fooled repeatedly. Yet skepticism was substantial. Readers split into two camps—many were curious and thanked us for covering the technology; others were critical, even to me, and some thought it was time to unsubscribe from *Ny Teknik*.

Many of my editorial colleagues were spontaneously skeptical, but they had much less information than I did on which to base their understanding. Even my editor, Jan Huss, was skeptical, while agreeing that we should publish the story as big news, then continue to monitor the issue. In that assessment Huss was basically alone. In Sweden, a few papers wrote short reports after the enormous attention our articles received and a Swedish TV channel broadcast a few short news reports. Then, silence—for a few years, it would turn out.

I continued to search for information and soon came to a question mark when I tried to verify the existence of the Greek company Defkalion Energy. Initially nothing made sense but eventually I reached a Defkalion spokesman, Symeon Tsalikoglou, who explained that the name was already taken and that the company had to change its name to Defkalion Green Technologies. He also told me about the agreement with Rossi and about Defkalion's exclusive rights to produce and distribute the technology, but he would not identify the investors.

A few days later Defkalion representatives appeared in a newscast on Greece's NET TV channel. Someone pointed out later that getting several minutes in prime time with a brand new company, based on such an uncertain and controversial technology, implied good contacts high in Greek society. It was possible, I thought, not knowing that the contacts indeed extended to the Prime Minister. I gathered that the company at least existed and a few days later we published a piece about Defkalion. I explained the collaboration with Rossi and Tsalikoglou's answers, including his answer to the question of how Defkalion thought the technology would evolve:

"This technology will not change world energy usage overnight. Essentially we are introducing a new and impressive energy source that offers cheap, clean and renewable power. We are pursuing socially responsible pricing and market penetration. We are also considering global energy trends and meshing with expected gradual energy transition."

Especially when Defkalion appeared on Greek TV, I thought media attention would accelerate. It was, after all, a technology that, if it worked, could potentially change the world. Furthermore, Rossi had told me a week earlier that he was in New

York to meet with a Swedish journalist, Peter Svensson, who worked for the U.S. news agency AP, the Associated Press—a world news giant. Svensson had found Rossi and the E-Cat through *Ny Teknik,* which he read regularly. Like me, he usually focused on IT and telecoms but when he learned about Rossi's invention he had apparently decided, as I had, that he had to follow it. In his meeting with Svensson, Rossi decided to give AP exclusive print and television rights to report the opening of the one-megawatt plant in Greece in October. But because Svensson had contacted Rossi through my reports in *Ny Teknik,* Rossi thought that I, too, should be at the plant inauguration. "The two of you will be on site. No one else," Rossi told me. Meanwhile, I was told that "one of the biggest American newspapers"—I didn't know which one—had obtained exclusive rights to follow the Defkalion story and that it would be published "in due course."

Over all, I expected that it would all soon be big news worldwide and believed that other Swedish media would soon present their view. So I asked Rossi if he had been contacted by other Swedish journalists. He had not, and he took the opportunity to offer me the exclusive rights in Scandinavia to all news concerning him and the technology. I declined, for several reasons. I was convinced that the reporting would be much better if as many journalists as possible did their own research and reported independently—as usual. My own credibility would be damaged if I had an exclusive with Rossi—I would appear to be his spokesman, not an independent journalist, and would eventually be accused of this. In practice, moreover, I could just as well have had exclusivity. Widespread reporting never got started. Not even limited reporting by major media. Peter Svensson at AP told me that he had to wait before he could publish something.

The situation was strange. I felt as if I were running like crazy in a stadium full of spectators watching me, carefully, in silence—a waking nightmare. In that nightmare I ran and ran. My heart pounded. The sweat ran down my forehead and down my back. I heard my rapid breathing and my footsteps pounding the track, echoing into the stands. Apart from that, nothing. A crazy silence.

In their comments to the articles on our website, readers asked why *Ny Teknik* was the only newspaper following the news about Rossi. Wasn't that a bad sign, some readers wondered? Almost the same thing had happened when in 1905 the Wright brothers claimed to have flown 24 miles in 38 minutes. Since the local papers did not believe in them, few media reports appeared for a whole year. Because the reports were so rare, skepticism among major U.S. and European newspapers eventually turned to allegations of fraud and even ridicule. *"It is difficult to fly. It's easy to say, 'We have flown',"* the New York Herald wrote in its Paris Edition in 1906. Yet the Wright brothers had tried for a long time, unlike Rossi, to sell their invention without even trying to demonstrate that it worked. Rossi had gone public.

At that point my editors and I decided that the next step should be to have experts discuss the news and question it as much as possible. Again I contacted Hanno Essén, who agreed to take part in a discussion. Since Essén had already commented positively, I tried to find a physicist with a more skeptical attitude. I contacted a physicist rated most critical by our readers but he declined to participate and recommended others. I was introduced finally to Professor Sven Kullander. He seemed a good choice: a nuclear physicist with extensive experience who was also chairman of the energy committee of the Swedish Royal Academy of Sciences—the organization that, among other things, awarded the Nobel Prizes in physics and chemistry. Kullander agreed to participate. We decided that he, Essén and I would meet in our newsroom in mid-February 2011. To give them both a better chance to assess Rossi and his device, I asked them to write the questions to which they wanted answers, to pass on to Rossi. Rossi did not seem to mind, which I took as a good sign.

I considered what I had learned about interviewing technique—to find consensus and confidence before addressing sensitive and difficult issues. The answers are often surprising and interviewees rarely reject them, even if the information is inconvenient. A nuanced, accurate picture is perhaps a relief to most people, even for fraudsters. Or consider that those who know best how to ask questions are not journalists but psychologists and police officers. Their goal is, on the other hand, not to disclose the answers publicly.

Rossi had never hesitated to answer my questions. I got the impression that if he lied he did it so well that he believed himself. A series of awkward questions from Kullander and Essén should be a good challenge, I thought.

Meanwhile, Levi and Rossi were preparing to make a much longer test of the E-Cat, mainly because Levi wanted to understand better how it behaved, to create guidelines for accurate measurements. Rossi intended to enter into a partnership with the University of Bologna and pay €500,000 for two years of commissioned research on the E-Cat—much as he had already collaborated with universities on biodiesel and thermoelectric generators. He said that the money was the last of the €1 million he had received when he sold his company Eon—€500,000 had been spent to develop the E-Cat, along with what he estimated at 35,000 man-hours of work (equal to over 15 years full-time work—maybe on the high side but undoubtedly including the work of his associates and subcontractors). Levi also wanted further tests to safely exclude chemical reactions. If the reactor was up and running for about a day, he could state confidently that a chemical reaction was unthinkable. He also wanted to avoid boiling the water. After the January demonstration a lively discussion on the vapor produced had emerged.

Physicists normally use a simple formula to calculate the energy needed to boil water to steam.

Since the result was now controversial, a search for all possible and impossible sources of error began, and one was the steam. Was the steam really ‘dry’, i.e. without water vapor? If vapor were present, how much was there and how did it influence the calculations? Could the problem lie there? One of Levi’s colleagues had measured the dryness of the steam and certified that it contained only a small percentage of water, but the measurement method was questioned and the debate continued for months.

To avoid this problem, Levi preferred just to heat the water. But to stop it from boiling, he had to pump much more water past the hot reactor: about one liter per second, or five full buckets a minute —more than typical fuel pumps in gas stations. Levi didn’t have such a large pump so he had to connect the inlet hose directly to a tap. Its flow was not completely stable, but it had to do. He measured it with a flowmeter and recorded the reading with a camera. By measuring the temperature of the water flowing into the device and of the water coming out, he could calculate the energy consumed to heat it. No steam would be produced.

Early on February 10, Levi and Rossi were ready. Rossi had loaded the E-Cat with nickel powder and catalysts, and they connected the hydrogen tube to the reactor. This time they disconnected the gas hose after filling the reactor with hydrogen—less than half a gram—so the reactor had to function with the initial fuel load. Rossi turned on the electric heaters that would start the reaction. They soon saw the temperature curve rise sharply, in fact too sharply. The water inflow was almost freezing—about seven degrees Celsius—and despite the high flow rate from the tap it reached 40 degrees in the short time it took to reach the outlet. Levi made a quick calculation and found that the power needed to heat the water so fast was over 130 kilowatts—about ten times more than at the January test. Rossi was worried, Levi told me later.

“This could be dangerous,” he said to Levi, who felt the tension rise. “We must slow it down.” He managed to control the reaction and power output stabilized around an estimated 15-20 kilowatts, still more than in January. Once stabilized, the E-Cat continued tirelessly to heat water, hour after hour, showing no signs of reducing its power output. Since Levi wanted to see how it worked without electric heating, Rossi minimized the electrical input for 10 hours—a kind of idling, with power applied only to the control unit. He knew from experience that this was dangerous because the reactor became less stable, but he had to show Levi that it was possible.

Late that night Rossi slept for a few hours, then left the E-Cat to Levi and his colleague David Bianchini, a physician specializing in radiation protection, and to a friend of Levi’s, blogger Daniele Passerini, who was also present. Early next morning Rossi awoke and after a while they decided to stop the experiment. The E-Cat had been running for 18 hours nonstop, with smooth and powerful energy production. For Levi it was interesting and impressive. He could rule out a chemical reaction as a heat source. For Rossi it was probably not so strange—he claimed to have already had the E-Cat operational for months in Bondeno, more or less uninterrupted, albeit at lower heat levels. But he knew he had to convince Levi.

Around the time Rossi and Levi started the 18-hour experiment, Kullander and Essén emailed their concerns. Each had written dozens of questions—the theory behind the device, the conflict with established physics, how Rossi had created and developed the idea, the design sensitivity, certain measurements, experiments with other materials, fuel analysis after reaction and more. I sent the questions to Rossi and after a few hours received an apologetic response. He had just returned to Rome after the long test in Bologna. I had known that the test was underway—Rossi had sent email reports—but did not yet know the details. After the night in Bologna Rossi drove two hours north to

Milan, in the opposite direction to Rome, where he lived. I had asked for a copy of his degree from the University of Milan and he had to apply for a copy in person at the University.

My interest was due partly to the scandal surrounding the businessman Refaat El-Sayed, who had had great success with a biotech company in Sweden in the ‘80s. El-Sayed claimed a Ph.D. in biochemistry, a lie. When the falsehood was revealed the company collapsed and El-Sayed ended up in prison for accounting fraud. Rossi had claimed a Ph.D. or doctorate that I wanted to check out, not least for his own sake. I had already learned that the engineering title he used occasionally had been sent to him by the fraudulent Kensington University in California.

Rossi’s Ph.D. degree depended instead on a translation problem, which I had suspected. In Italy everyone is called *dottore* after undergraduate studies at the University. Undergraduate education is a few years longer than in most other countries and includes a relatively extensive final dissertation. But it doesn't require post-graduate research, as a Ph.D. degree usually does. When I got the copy of the degree it said, as I expected, that Rossi's title was *dottore magistrale*—roughly equivalent to a Master's degree. This was also when I understood that Rossi had studied philosophy, not physics or chemistry as I had imagined. Nor was he an engineer. I was surprised, and though his philosophy studies had focused on science I began to understand better Rossi's way of working—a philosophical basis combined with an intense personal quest for knowledge.

After his detour to Milan, Rossi drove the 360 miles to Rome and wondered if he could answer the Swedish physicists' questions the next day, after resting a bit, and that was no problem. The answers were detailed. Rossi seemed to have decided to trust the Swedish scientists and revealed in his answers more than he claimed to have told Focardi, Levi or any other third party.

Among other things, he detailed the theory that had led him forward during the E-Cat development and how he thought its energy was produced. He stopped short, however, at describing the catalysts, information he still kept to himself.

The answers increased Kullander's and Essén's interest in Rossi and his apparatus, even if they were skeptical about his theory. An email dialog continued for several rounds with follow-up questions to which Rossi responded just as thoroughly. Rossi asked us to consider the information private. He could not ask anything of me but it did not seem in the public interest to publish it. Moreover, I could publish later, depending on how events unfolded. I realized that I could be considered an 'embedded journalist,' like the journalists accompanying U.S. troops at war in Iraq and Afghanistan. A *Ny Teknik* reader subsequently called me just that. I considered the risks and opportunities it entailed.

I also thought of Rossi's potential enemies, the interests his invention threatened and the risk that someone would want to kill him to stop it. What did he think about his personal safety? His replied that his safety was in God’s hands. He also discussed a plan under which, if something ‘irreversible’ happened to him, a full description of the technology would be sent to selected people. If this technology works it cannot be stopped, I thought.

Before I met Kullander and Essén for the discussion we had planned, I contacted Levi, who talked about the long E-Cat test. He was obviously impressed. It was the third time he had seen the device operating. It had started on command each time, demonstrating repeatability, Levi observed, something that had been so difficult to achieve in cold fusion. Moreover, the first critical power peak—the one that had worried Rossi—had impressed him, and that the reaction had lasted 18 hours, without additional hydrogen beyond the initial load. He had also checked out details, e.g. that the blue control box next to the E-Cat was basically empty, except for electronics needed to regulate the electric heating cartridges. I told him that many readers felt that he was not independent because he had worked earlier with Focardi. Levi sighed. “Let’s say this: if I were an old professor ending my career I would have nothing to risk. But deception on my part would be a terrible career move. What could I hope for? To have a title for ten days, then be thrown from my own department? If this is a scam it will sooner or later be revealed, because cheating always spills out. So if I ... look, honestly, I would be really stupid!” he exclaimed.

His answer seemed to come from the heart. That an acclaimed physicist like Levi would also be full-fledged fraudster who could play his role as a professional actor seemed absurd. So again I concluded that if there were something fishy about the E-Cat, Levi had also been deceived.

On the afternoon of February 14, Essén, a tall man in his 60s dressed casually in a gray sweater, and Kullander, about ten years older, slightly shorter and dressed in shirt, tie and a dark wool vest, came to the newsroom. I knew, roughly, Essén's opinions. From Kullander I expected a critical attitude. So I was taken aback when Kullander said, before we even sat down to talk: "You have to embrace this."

We stood in the middle of the newsroom, on its slightly worn parquet, and discussed the technology's potential, if it worked. Kullander, who had the issue of future energy constantly on his table as president of the Academy of Sciences Energy Committee, noted that it could be valuable to be aware early, if it turned out to be a promising new technology. When he had first heard of Rossi and his demonstration in Bologna on January 14, he explained, he had been doubtful. "I figured that since there are heat pumps in which you feed in electricity and get out four to five times more energy, Rossi's technology must surpass it considerably if there were to be any point in it," Kullander said later.

A heat pump is a kind of reverse refrigerator that runs on electricity. In effect, it takes heat from the environment, which becomes colder, and moves the heat into a house, which becomes warmer. Thus it consumes much less power than a common electrical radiator, which only heats by electric current. The difference was that Rossi's device, long term, should be developed into consuming no power, if the reaction could be self-sustaining, without external electricity. But Kullander had been skeptical from the start. "I did not believe that it could be something of interest," he told me. Yet now he seemed curious and seemed unable to stop thinking that perhaps it could work.

We sat down in a small room with a few low red armchairs and a round table in the middle, with a colleague of mine, Anders Wallerius, and set to work. While the discussion focused on nuclear physics, perhaps the most important question was what impression they had had of Rossi, since this would determine how much they could rely on information from him—for example, that he had

had the E-Cat running in Bondeno for months. Both stated that their impression had been reinforced by talking with him. They thought he was interesting to talk to and noted his systematic approach in developing the E-Cat.

"I actually find it hard to imagine that he is an impostor," Kullander said. They also said that most of their colleagues, especially theoretical physicists, were skeptical and assumed that it was some sort of scam.

"For the skeptics virtually all imaginable warning bells are ringing: plenty of claims, but little detailed descriptions and verifiable data. Details withheld by reference to underlying patents and industrial secrets (...). The whole proceeding unfortunately smells scam," wrote Göran Ericsson, Associate Professor of Applied Nuclear Physics at Uppsala University, in a blog post.[35] Admittedly he was doing research in 'hot' fusion, research potentially threatened if some form of cold fusion was shown to work, but his

criticisms were shared by others. Gradually I realized that Kullander and Essén, two renowned physicists, were about to stick their necks out, just by having a cautiously positive attitude to Rossi and his invention. Yet their reasoning was not very remarkable. Essén had looked at Focardi's and Piantelli's previous research, had noted Levi's arguments and observations and had made theoretical observations. In response to an email from one of the physicists who criticized his position, Essén reflected on this and summed up: *"After my studies of relevant reports and original texts, I am confused and interested."*

Kullander had quickly figured out that Rossi's and Focardi's proposed nuclear reaction, if it happened, would release energy. The apparatus was thus in some sense theoretically possible. Still it should be impossible—just like his colleagues, Kullander spontaneously thought that in principle the reaction should be impossible at a few hundred degrees. "But you don't have to rule that out in advance," he thought, too, as he later told me.

Kullander was an experimental physicist, like Levi. Like Levi, he felt that the first priority must be to study the measurements, “not speculate about what might happen in theory,” as he put it. This assumed that Focardi and Levi could be trusted, which Essén and Kullander seemed to do. They also trusted Rossi—both for letting Focardi and Levi apply careful measurements on the device and for their dialog with him. They acknowledged the theoretical problems but, like Levi, believed that those problems justified further experiments.

We debated the question for an hour. When we were finished, I realized that the two physicists’ conclusions were amazing. While the scientific community was skeptical of Rossi’s device and our readers waged a debate between critics and optimists, I had accidentally contacted two established physicists who were curiously interested and cautiously optimistic. Only afterwards did I realize that even Kullander had been involved in research on cold fusion. It had been a project led by Hidetsugu Ikegami, professor emeritus at Osaka University in Japan, with results presented in a report to the Swedish Energy Agency in 2006[36], which later gave Rossi valuable inspiration.

"The link to Ikegami came to my mind later. Those were measurements made over many years. I was not involved in the experiments but helped initiate them, supported the project and noted the results. Also these were difficult to explain and energy was produced, but not in useful amounts. It was some million times more power than should be possible in theory, but still only microwatts," Kullander explained later. The discussion with Kullander and Essén, which *Ny Teknik* published verbatim, became a strong support for Rossi, also internationally. Not only that—Kullander and Essén wanted to continue contact with him. Just ten days later Rossi visited Sweden for a first meeting with Kullander, Essén and a couple of their colleagues. Their impression of Rossi was mixed.

"What we did not understand was his explanation.

He had a table with various experiments that had lasted for months but the theoretical explanation seemed far-fetched and unlikely," Kullander remembered.

This was typical for cold fusion. Though hundreds of well-documented experiments demonstrated an effect of unexplained excess heat, albeit difficult to replicate, the small group of researchers who worked in the field constantly fumbled for a theoretical explanation that could fit. Many proposals had been put forward but none had won general acceptance. The problem was due not least to the difficulty of building theories when the experiments could not be repeated, and to observe what was happening when conditions were changed gradually. Rossi's theory thus did not impress Kullander: "He never gave the impression of understanding physics at the expected depth. But I saw him as a talented engineer and inventor, an ingenious person. His strength is to be a Gyro Gearloose, or what I should call him," Kullander said.

During his Uppsala sojourn Rossi left two small bottles of the fuel powder used in the E-Cat—one with unused fuel and the other with powder that Rossi said had run in the device for months. Later Kullander had measurements made on the powder, indicating that Rossi's theory was wrong. But Rossi was impressed by Kullander and by Ikegami, whom he later met, and he adapted his theory partly according to their views. The February meeting created increased curiosity and contacts with Rossi continued. On March 29, 2011, Kullander and Essén flew to Italy to go to the industrial premises near Bologna where the first public E-Cat test had been performed on January 14. That afternoon, they participated as observers in a similar test. At that time I had no idea of the conclusions in the report they would soon write, nor its impact.

34. F÷reningen Vetenskap och Folktro
35. http://www.vof.se/blogg/kall-fusion-i-italien/
36. Ultradense Nuclear Fusion In

Metallic Lithium Liquid, ER 2006:42, ISSN 1403-1892

CHAPTER 10

"It's a nuclear reaction"

"Any chemical process for producing 25 kWh from any fuel in a 50-cubic-centimeter container can be ruled out. The only alternative explanation is that some kind of a nuclear process gives rise to the measured energy production."

That's what Kullander and Essén wrote in their report, which we published on *Ny Teknik's* website one week after their Bologna test. In short: this is a nuclear reaction! This conclusion hit more or less like a bomb in many circles. Focardi had already argued along these lines with Rossi. Levi had reached the same conclusion, excluding a chemical reaction just as Kullander and Essén had. But skeptics could always suspect a connection between Levi, Focardi and Rossi. Instead, two

Swedish physicists unconnected with Rossi—one, President of the Swedish Skeptics Society[37], the other, president of the Royal Academy of Sciences' Energy Committee—had written a weighty report after observing the E-Cat test in Bologna. When I talked with Kullander and Essén the day after their visit they were still positive. They came to the newsroom; we sat in a meeting room and discussed their experience at the test.

"My belief has probably been strengthened considerably when I saw and measured how it all works, that there is an energy release far beyond what one might expect," Kullander told me.

Essén agreed. "Everything we have learned thus far fits. Nothing seems strange. Everyone [involved] seems to be honest and competent," he said.

They had checked all the measurements and equipment carefully and pointed out that Rossi sometimes left them briefly. They had been free to walk around, examine the equipment and touch the setup. Rossi had also removed the thick insulation from the E-Cat so that they could see the construction, naked, even photograph it, photos we later published.

"It looked nice," Kullander commented cheerfully. He and Essén still felt that the focus should remain on making more measurements and downplayed the theoretical problems.

"Somehow, new physics is taking place. It's enigmatic but probably represents no new laws of nature. We believe that it is possible to explain with known laws of nature," said Essén.

Kullander said he would compile their observations into a report and a few days later he sent me a draft. Only then did I realize how far they had gone in their wording. With no major reservations, they retained their basic conclusion—the energy generated by the device could be explained only by some kind of nuclear reaction. When we published the report along with an interview a few days later, our readers pounced on it, both in Sweden and abroad, with over 100,000 website hits. Below the Swedish article, in the website 'comments' section, the debate between skeptics and optimists gained momentum—soon our readers had made over 1,300 comments. The hunger for information and the need to discuss the project seemed to have no limits—it persisted when we invited Rossi to our newsroom to participate in a live chat with readers. Some questions focused on theory and nuclear physics while many were general, such as these:

Reader: What is your main goal with this project? Is it to become extremely rich or do you want to help ordinary people?

Rossi: This technology has been made to be useful to mankind, like every good technology.

Reader: When people understand the magnitude of this it will be an extreme situation, considering that wars are fought over oil today. Are you prepared for this? Best regards and congratulations to the greatest technology invention in man's history.

Rossi: I have fought many battles in my life. This is not the first and will not be the last. Anyway, I've taken precautions and I'm ready to fight.

Rossi could respond only to a few of the questions that poured in, so we followed up with his answers to several dozen additional questions—each time with tens of thousands of readings and hundreds of comments on everything we published. The news article was also commented upon elsewhere and many physicists expressed their views on Kullander's and Essén's report, mostly critical. *"Essén's and Kullander's travel report contains little news compared to what was found during the demonstration in January 2011. (...) It is clear that if the energy-balance calculation is correct, it must be a nuclear energy source. The problem, in my view, is that there has been fiddling with extra power input or cheating with cooling water,"* wrote Peter Ekström, lecturer at the Department of Nuclear Physics at Lund University.[38]

Ekström also worried about safety. Had it been 'normal' fusion with a similar energy level as in Rossi's device, it would have produced a directly lethal dose of radiation. Walls several feet thick would have been required for protection. If it was not cheating, it must instead be about a new, unknown type of nuclear reaction that under particular conditions did not generate deadly radiation. *"What if these particular conditions suddenly disappear? For an E-Cat with ten kilowatts of power we would suddenly have a source with an activity of the order of 10^{16} Becquerel. Everyone around would get a lethal dose in seconds!"* Ekström wrote.

Rossi explained to me that the report had a huge impact and was of great importance to him in his contacts with individuals and businesses in the United States. "Everyone I meet in the U.S. has read the article. Just everyone." Again I thought that media attention would then increase but, as before, the silence continued. An editor at the journal *Nature*—one of the world's leading scientific journals, published in the United Kingdom—contacted Kullander and me with questions. The editor, who seemed genuinely interested, received our answers and was apparently satisfied. No article was ever published.

Another person with whom I came in contact was Brian Josephson, Nobel laureate in physics, who for many years had been annoyed about the niggardly treatment cold fusion had received over the years. He was interested in Rossi's invention and among other things he came to my defense in a heated discussion that arose on Wikipedia. I had found an article about the E-Cat on Wikipedia and realized that I had information to contribute, so I wrote a few lines, referring to my own articles as the only available source. Soon I was questioned and a long discussion followed in which Josephson repeatedly defended my position and my reporting. Around the same time an article about the E-Cat in Italian Wikipedia was deleted. The content was deemed too ill-founded.

I now needed to see the E-Cat with my own eyes and participate in a test and I agreed with Rossi on a day a few weeks later around Easter, which fell at the end of April that year. It was a good fit because I could travel from Stockholm to Italy with my family and stay a couple of days extra if something unexpected happened. We travelled to Italy often to stay in contact with family and friends and to enjoy the country's best aspects—the pleasant climate, the wonderful and varied cuisine, and the contact between people who were light-hearted and relaxed with a generous dose of heart and empathy.

As occasional visitors we were spared the many difficulties of Italian daily life—corruption, bureaucracy, nepotism, power games and a constant struggle to defend one's rights. I was fascinated at the number of highly skilled individuals I met with a passion for living and a commitment to work, volunteer or professional, but whose energy was largely diffused in different ways by the countless unnecessary obstacles that

Italian society offered constantly. It was sad to see, because together they seemed to have such a strong potential, a power of possibilities. Yet Italy, as a whole—if one can generalize about a country with so many different realities, so many different cultures and even languages—found itself in a kind of permanent crisis in which credibility in the government was and always had been minimal.

That no one counted on the government was perhaps unsurprising for a people who for thousands of years had seen rulers and armies from the North, South, East and West claim power over them, appropriately or not. The people learned that you had to arrange things for yourself and your closest friends—*l'arte di arrangiarsi*, as the Italians call it. Since no one counted on the government, no strong driving force safeguarded the common interest, so someone else's interest could always obstruct one's own. But you could also say that heart and empathy comprised values that were strengthened when circumstances put people to the test. Furthermore, the Italians had been socializing in urban environments for thousands of years.

This contrasted with my own country, Sweden, where belief in the government was a fundamental value but where heart and empathy sometimes were overlooked, perhaps from habit or because the need was less since everything was so well organized. The fact that social interaction in an urban environment was something we had learned during the last hundred years also made Sweden different. Maybe this was why contact with Italy gave me the liberating feeling of having found a complement to the social values where I came from.

That Easter we spent in Tuscany where we often traveled because my wife had her roots there. In late April it was already warm and pleasant for us northerners who lived through Sweden's long, dark winters, but the Italians still strolled in thick clothes along the boardwalk. A few days after our arrival I took an early train to Bologna—a journey with two changes of the train that ironically takes longer than the flight from Sweden to Italy. That morning the train was cancelled for unknown reasons. I had to take a taxi to the next station a few miles away, where another train would take me further in the right direction. The last stretch between Florence and Bologna offers the high-speed train *La Freccia Rossa* (The Red Arrow), which zooms flawlessly at over 200 miles per hour between Rome and Milan. Both the price and punctuality contrast starkly to other rail travel in Italy which normally costs little but pushes the Italians' patience to the limit because of its unreliability.

Once in Bologna I was greeted by Focardi, with whom I would first spend a few hours. Since we had not met before, he told that he would have a newspaper under his arm as a sign, but even in railway station full of travelers it was easy to recognize the old professor—somewhat short and plump, in casual dark suit and black sweater, a thin, dark-gray thatch of short hair sticking up, strong, bushy eyebrows and a pensive look behind the heavy glasses. We exchanged greetings and walked to the old physics department at the University of Bologna where Guglielmo Marconi, as a teenager in the late 1800s, took interest in Professor Augusto Righi's experiments with electromagnetism. This led to Marconi's developing his wireless telegraph, though he had to go to the UK to gain support for his technology.

Professor Sergio Focardi in his office at the

Department of Physics at the University of Bologna, April 2011. Photo: Mats Lewan

With his considerable age and failing health, Focardi walked slowly and told me carefully, again, about his background—how he had experimented with cold fusion with Professor Piantelli at the University of Siena but eventually stopped, how he had met Rossi in Lido di Spina and how they had started collaborating in Bondeno, how they had started to make various measurements on the E-Cat and how he had soon found that it produced large amounts of thermal energy. I learned that he had lost touch with Piantelli in some kind of discord, possibly due to Piantelli's feeling betrayed by Focardi. Later I discovered that Piantelli said that he was equally baffled as to why they hadn't kept in touch.

I had recently realized that in 1995 Piantelli had been granted a patent for the technology he and Focardi had experimented with—long before Rossi's 2008 patent application. He had handed over the patent to Siena University, which let it lapse.[39] But in November 2008, a few months after Rossi's application, Piantelli had submitted a new application. Since he had worked with an unknown reaction using nickel and hydrogen, he seemed to have something to defend if Rossi's technology proved successful. I didn't know then that the interest in Piantelli's work would be intense and that his new patent application would be approved a few years later, with Rossi's still hung up.[40] I did not know, either, that just a week after my visit to Bologna he would submit another application.[41] But I was curious about what Piantelli had developed and how far he had progressed with it, and noted that I should contact him.

After a nice lunch at Focardi's home, with his wife, we drove in his car to the industrial premises outside Bologna where the earlier E-Cat tests had been performed. The afternoon heat was now comfortable and the gates stood wide open to the hall that I recognized from photographs, with its high ceiling, bare white walls and gray concrete floor. Rossi, dressed in a light blue suit, greeted us, in a good mood as usual. Besides Rossi, I met others for the first time, including Professor Christos Stremmenos and Rossi's wife, and a journalist from the Italian state television Rai News.

At last I stood in front of the device that might change the world—an insignificant piece of soldered copper pipes with a pair of valves mounted, a couple of wires attached and a curve at one end where the copper chimney stood, a black discharge hose for the output steam attached. I performed all the checks that Levi, Kullander and Essén had also undertaken—no hidden wires, no hidden devices under or inside the table on which E-Cats stood—four of them, one wrapped in insulation. I also began to take the same measurements as the others, and new checks—in the wave of interest in Kullander's and Essen's report critics had noted measurement deficiencies that might permit cheating or at least inaccurate results, and I tried to fix those shortcomings.

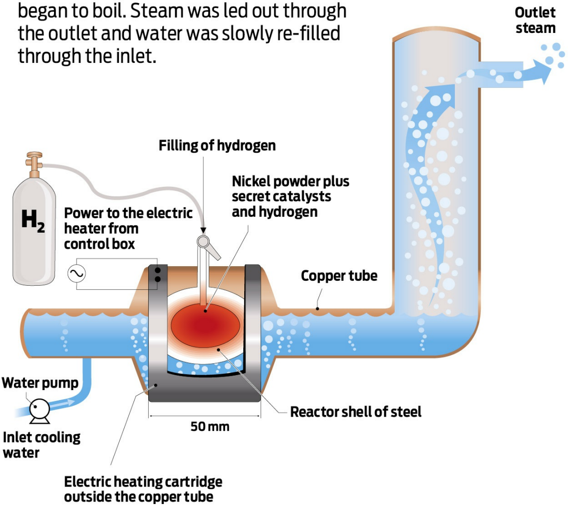
Before starting the experiment, something unexpected occurred. Rossi had just turned on the hydrogen when I realized that we should have checked that there was no hydrogen in the device before filling it. I asked if he could empty the hydrogen and refill it. When Rossi's technician opened a valve on the top a small cloud of nickel powder squirted out, along with the gas. I had two considerations—one, there was the nickel powder inside the E-Cat; the other, Rossi's restrainedly worried glance when the powder sprayed out.

My interpretation of his reaction was that the powder and its exact amount was important and I wondered whether the event would cause problems. But Rossi started the reactor anyway and it seemed to work, though I saw him speak discretely with his technician after a while before the reaction, according to Rossi, became stable. The device made little noise. A small pump ticked steadily as it fed cold water into the copper tube in which the hot reactor was supposedly located. A faint sound of boiling water could be heard through the insulation, and from the three-meter-long black discharge hose poured a modest amount of hot steam and a little condensed hot water. The experience was not particularly remarkable—no sensory input could prove that the device was anything but an electric kettle. Only the measured values could reveal that it might be a worldwide sensation—electrical and cold-water input, outlet steam temperature and how much water was evaporated.

While the device stood and boiled water, invitees moved between the small room and the larger room next door. Some came, some went. I did interviews, including Professor Stremmenos, and I was interviewed by Rai News. Meantime, Rossi sometimes monitored the test, sometimes talked with invitees or sat at the computer. The whole time he was focused, whether checking the test or talking to someone. He could fix you with an attentive and friendly gaze, his head slightly askew, listening carefully to what you said. Meanwhile his brain seemed constantly

Schematic diagram of the E-Cat as it appeared in early 2011.

Before starting, a very small amount of hydrogen was filled from the hydrogen canister. The reaction was initiated by heat from the electric heating cartridge. After a while the unknown nuclear reaction between the substances in the reactor chamber began. The reactor then became hot and heated the water that eventually began to boil. Steam was led out through the outlet and water was slowly re-filled through the inlet.



active, prepared to analyze every piece of information it received and put that information into a broader perspective. This didn't mean that Rossi always paid close attention to others. He always listened but he seemed to have a well-considered opinion about things he was familiar with and did not let anyone compromise his view unless the arguments were particularly convincing. But he willingly admitted his ignorance in other areas in which he had little experience.

The test lasted two hours, after which Rossi started to slow the reaction and cool the reactor. I collected readings and notes, and eventually we were off to a restaurant in Bologna where Levi, whom I had not met before, joined us for dinner. Bologna is known for a rich and abundant culinary traditions with roots dating back to medieval times. The restaurant matched my expectations—simple and pleasant, with carefully prepared traditional dishes. The conversation was relaxed, as it tends to be around the table in Italy, ranging from physics and the E-Cat to food, wine and people. Leaving the restaurant, I chatted with Levi. He told me how he had met Rossi and his evaluation of the device. For him, no doubt remained about its being genuine.

Giuseppe Levi in Bologna, April 2011. Photo: Mats Lewan

“I would say that for me the phase where, through experiments, I would find out whether it worked or not is over. Now begins a phase of precise measurements," he noted. But it would take a few years before he could do this.

Back at my hotel room I sat down to make calculations. My plan was to publish a report the following day but soon I started to become uncertain of the result. My calculations showed that the developed thermal energy was less than at any previous test whose results I had seen. Also the water flow was less—so small that the electrical cartridge heater was almost sufficient to heat the water to boiling. However, once at that temperature it could not also evaporate the water, i.e. transform all the input water to steam, which requires significantly more energy than just heating the water.

At this point the margins suddenly became small and possible sources of error important. I was unsure whether vapor alone was released into the black hose. Did water seep out through the hose without being vaporized? Was the measured temperature, above 100 degrees Celsius, proving that there was only steam, measured incorrectly? Maybe the pressure was considerably higher inside, thus raising the boiling point, as in a pressure cooker? Could the problems possibly depend on the nickel powder released? Towards early morning I gave up and slept. Anxiously.

Next day I contacted Levi and Kullander to talk things over. They calmed me somewhat but Kullander said that if I was not sure it would be useful to repeat the experiment. So I left Bologna, contacted Rossi and agreed to meet again a week later. I rescheduled my flight to Stockholm and tried to stop thinking about the experiment for a few days and instead enjoyed the beautiful days of spring in central Italy, bliss after a long, dark winter in Sweden.

On April 28 I returned to Bologna. This time it was just me, Rossi and his technician. Rossi was now more relaxed, wearing brown pants, unbuttoned blue shirt, beige sweater and a mossgreen quilted jacket. He seemed relaxed but still as focused as before, apparently concerned that I would get the measurements and answers I needed. We undertook the experiment in peace and I measured vapor temperature, thermometer calibration and steam flow from the hose carefully. Later, I would experiment with boiling water using power equivalent to Rossi's device, led the steam through a hose and observed the flow of steam as a comparison—both at home on the stove and with a friend whose electric kettle I destroyed by sealing all the gaps around the lid, causing its electronics to overheat.

These were unscientific methods yet a useful comparison—steam in a tube does not behave as violently as one might think when watching the wild bubbling in boiling water. It was vital to discuss the experiment with a professor of thermodynamics at the Royal Institute of Technology in Stockholm, who did research specifically on heat transfer during evaporation. He cleared up several issues regarding the steam, issues that critics argued could cause erroneous measurements. The steam was discussed constantly and many critics referred to it when explaining how everyone, including Rossi, had been deceived by the measurements and the tests. I hoped that I had reduced the level of doubt. I also considered that Levi had run the E-Cat without boiling and that Focardi had tried various methods. But this assumed that Levi and Focardi could be trusted, which not everyone was prepared to do.

With the new test completed I returned to Stockholm, compiled the material and, in early May, we published an article about the tests with my two reports, including all measurement data, so that readers could form an opinion based on observations and look for flaws and errors.

"*Ny Teknik* recently participated in two new tests of the Italian 'energy catalyzer,' providing more accurate measurements to reduce possible error sources," the article started.

We also put up on the website a short video I had recorded in which I explained the whole measurement setup and went through all the components, from the current powering the electric heaters to the steam pouring out of the black hose. This was the first time the public had the chance to see the whole experimental setup in detail. Again the discussion took off, not least on the basis of my video and of the steam flow which many thought seemed far too weak and unconvincing. Surprisingly few reacted to the fact that I had stepped outside the traditional journalistic role by not only reporting what happened but also undertaking my own investigations. In this case, I had no choice. Like the term 'investigative journalism,' which usually refers to social phenomena, I thought that I might call my approach 'investigative science journalism.' Again I was encouraged by many readers who thanked *Ny Teknik* for letting them sit in the front row and follow the strange events through the articles. Others continued to attack me for giving space and attention to something they said must so obviously involve fraud.

A week later a new piece of the puzzle arrived. The Italian Patent Office had decided to endorse Rossi's patent application and grant him a patent on his invention for 20 years from the filing date—until April 9, 2028. This was just after the patent issue led to discussion in Wikipedia. Given that many considered patent applications weak, the Italian patent seemed sensational. But upon research I found out that the application was made just a few months before the Italian patent rules were harmonized with the European rules. Rossi's application, made before the EU adjustment, was approved through a relatively formal procedure without in-depth technical review. But it could possibly weigh positively in the assessment of the more important international patent application, managed by the European Patent Office, or EPO. We sorted out the patent details in a new article. When published, I noted that the English version this time got more hits than the Swedish. The patent issue seemed thus to acquire international interest.

During this time Rossi wrote in his blog that he had signed a major deal in the U.S., and soon he told me that it involved his friends in the company LTI—the company he co-founded in the late '90s to investigate the potential of thermoelectric generators for the U.S. Department of Energy. Eventually he helped me to connect with Craig Cassarino. In a long interview, Cassarino told me the whole background—how he and his people met Rossi for the first time, about the adventures with thermoelectric generators, when Rossi talked about the E-Cat for the first time, about their visit to Bologna and the testing in the U.S. and how they finally formed the company Ampenergo, which through the recent agreement had become Rossi's U.S. partner with rights to royalties on all E-Cat sales in North and South America. What particularly piqued my interest in Cassarino's story was the broad perspective on Ampenergo's approach that he described.

Andrea Rossi with the first version of the E-Cat *in April 2011. The one wrapped in black insulation is in use, while the one nearby is without insulation. Photo: Mats Lewan*

"It's not just a technology we're creating in the industry here," Cassarino said. "A lot of pieces must come together to build this matrix. Many pieces of the puzzle need strategic thinking, such as how we transition into a new energy source. That's what makes this very exciting."

He explained that when looking at all the different areas where Rossi's invention could be used—everything from aerospace to heating plants—each area had its technical challenges. And that the strategic planning required in building a new energy technology was about just that.

"Let's put it this way: it has the potential, if done correctly, to change the world—you know, everything from reducing carbon dioxide in the atmosphere to giving low or cheap energy to people worldwide who cannot afford to put food on the table."

Cassarino and the Ampenergo co-founders had been staying under the radar for a few years to be sure that all the basic pieces were in place and that they were not creating buzz around a castle in the air.

“We had to do a lot of work ourselves. As you can imagine, trying to call a major corporation saying that you’ve got something in LENR... I mean ‘who the hell are you guys?’ So we’ve really tried to keep it low key, talking with top scientists, top business people, to help us structure this. Because this is huge and we don’t want to just go out there right now and tell the world. We want to be prepared for this.

“Strategically, it’s really about partnering with the right companies. You know it’s not just about money, it’s not just about technology, it’s not just about companies and their capacities, it’s trying to understand how all those pieces fit together.”

Cassarino also testified that it was not easy for the decision-makers and top researchers they had contacted, whether they were working on the government side or in industry. On one hand, the connection to cold fusion was so controversial that everyone was afraid of being associated with it—if it turned out that the technology didn't work, their credibility would be lost. On the other hand, if it worked and the public found that these people had missed a chance to bet on a revolutionary technology, their credibility would go down the tubes anyway.

"So they're trying to walk this thin line, you know—sitting on the fence, as they say."

I asked Cassarino if he had ever doubted Rossi and his technology. He answered by telling me about the tests they had done to ensure that the E-Cat really produced energy, but also raised a very different perspective.

"The one thing that convinces me that he has something, and that he's not trying to pull the wool over anybody's eyes, is his three 'legs' we've discussed from the beginning—he wants to live here in the US, he wants to clear his family name from all the past stuff that went on, and he wants to get credit for advancing this science."

These three perspectives were, for Cassarino, ways to understand Rossi's driving forces and assess his motives. He added that both Rossi and his own people needed money to develop the technology and the business, and that they wanted to be rewarded financially, especially considering all the time and money they had invested, but that financial reward was never Rossi's primary goal.

"I guess that's a long way around my saying 'I personally believe he has it'," Cassarino said.

37. F÷reningen Vetenskap och Folktro
38. http://fragelada.fysik.org/resurser/col
39. http://www.google.com/patents/EP0767962
40. http://www.google.com/patents/EP2368252
41. http://patentscope.wipo.int/search/en/d
docId=WO2012147045

CHAPTER 11

Improvements and disagreements

Rossi's top priority in the spring of 2011 was to complete the megawatt plant to be put into operation in Greece that October. With the plant up and running, all doubts would be silenced—about whether measurements of this or that had been done correctly, whether the physicists involved were independent or not and in general whether the device worked. With a megawatt of heat generated steadily by the plant, nobody could any longer say anything critical about the process. Everything could then take a new turn and the discussion could focus on how the technology could be used, improved and evolved, and what kind of new physics could explain the process. This was what I thought.

Rossi would also be paid but he argued that the money would not only be used in the company. While studying the technology during his time in prison, he said he had taken a drastic decision: he had promised God that if everything went well with the invention he would use half the money to cure cancer among children from families who couldn't afford to pay for care. While Rossi was driven by a strong desire to compete and to achieve results, he seemed to think constantly on God's providence and that there was sense in everything that happened. An event for which he expressed particular gratitude was the meeting with the Swedish physicists Kullander and Essén in late February 2011.

Beyond the support of their report upon visiting Bologna, their knowledge had given him new and important ideas, particularly the report on Ikegami's research on cold fusion that Professor Kullander had given to him. During the flight back from Stockholm via Paris to Rome, he was so focused on the new ideas that the trip seemed to take mere seconds. Back in Rome, he immediately started to prepare an experiment using a modified reactor, according to the new ideas. He was enthusiastic about his plan in an email to the Swedish professors: ‘God wanted us to meet,’ he wrote, then began to work day and night on the new design. After two days, he wrote again: ‘I won!’

He told me that through stubborn work with his experiments he had managed to increase the reactor efficiency by about 30 percent. “I’m living the best time of my life,” he concluded the e-mail.

It later turned out that this was only a first step in what Rossi described as a powerful enhancement of the reactor. He continued the development from the ideas he got during the flight home and three months later, in late May, he reported achieving almost ten times more power than the device I had seen in April—27 kilowatts. He claimed that radiation levels increased significantly, a clear sign that it was indeed a nuclear reaction but, since it still consisted of low levels of relatively harmless gamma radiation, it was sufficient to increase the lead shielding to render radiation outside the device harmless.

Furthermore, he eventually managed to obtain a huge improvement: after starting the process the reactor was now so stable that he could turn off the electric heating cartridges entirely for some intervals. Thus he should in one blow be able to clear himself from the eternal debate that constantly followed all kinds of experiments with cold fusion: whether the energy produced exceeded the input. If no energy was put in, the whole net energy issue became instantly irrelevant. It was also a step towards making the device more useful—the smaller the electrical input energy, the greater the possibilities of using the technology in places where access to electricity was poor. Such places in poor countries were affected by perhaps the most common example of how cold fusion could revolutionize the world—access to clean water. A cheap, clean energy source that produced heat could be used to desalinate sea water or to boil or distill contaminated freshwater. It would then be a considerable improvement if the apparatus could be self-sustaining for periods.

Earlier, when Rossi had tried to run the reaction without heat from electric heaters, he first had had to push it so hard with increased heat input that it became unstable and difficult to control. These were the occasions when he had suffered explosions. When the reaction had reached a self-sustaining level, it continued to amplify and the increase could no longer be stopped. With the sharp rise in temperature inside the reactor, pressure eventually became so high that the structure gave way and some part—usually a valve—detached and flew off like a projectile through the room. But with the new reactor the reaction seemed to be both powerful and more stable.

Rossi had become convinced of this after several tests but he found himself in a dilemma—for several months he had been building the E-Cats that would be included in the megawatt plant in Greece. Rossi claimed that he had produced the important nickel powder and the innermost elements of the small reactors at his secret Miami facility, while other parts were manufactured in Bedford, New Hampshire, as well as in Rome, Bologna and Ferrara, in Italy. Initially the plan was to build the plant from 100 ten-kilowatt modules—the model he had shown at the first public trial in Bologna in January 2011. In February, he built the new, smaller version at about three kilowatts which he felt was more stable, so he changed the design to a plant with 300 such modules—the units he said he had been producing lately.

However, with the latest model in his hands he felt that it would be unreasonable to deliver an older product that from the outset was surpassed by a new and better iteration. After a test in Bologna in July 2011, when he had shown Professor Stremmenos the new model and had let it run for 40 minutes with the electric heaters switched off, he decided to discard the parts he had produced so far and instead start from scratch. The megawatt plant in Greece would now be built with 52 reactors of the new model. I noted that these were changes that could be expected of an engineer who was optimizing a design but hardly something in which a scammer would indulge.

On July 4, 2011, a few days before the test with Stremmenos, Rossi met Kullander and Essén again. Sweden had just gone into the holiday season, meaning a summer lull in the streets of Stockholm and Uppsala. But Kullander and Essén were working and Rossi met them on a trip to Uppsala, along with their colleagues, including Bo Höistad, emeritus professor in nuclear physics at Uppsala University and Lars Tegnér, physical chemist and former Director of Development at the Swedish Energy Agency. Professor Ikegami, who was visiting Sweden, also participated.

They sat for a whole day and discussed various physics theories that might explain the process within the E-Cat. Again, it was clearly far from a theoretical explanation. They agreed that the efforts to build a theory were a mess, that more experimental data were needed before meaningful theoretical work could be started. Still, Rossi, who had already based the improvements of the new reactor on Ikegami's cold-fusion research, was now strongly influenced also by his theoretical model, though I would only understand this a few months later.

But the main reason for the meeting was that during the spring Rossi had suddenly promised an E-Cat to Sweden. The idea was that independent measurements could be carried out at Uppsala University. No one involved wanted information on the test to get out but the plan was to let the renowned Svedberg Laboratory in Uppsala perform measurements on the device on Rossi's behalf, to be paid for by him. To provide independence, Kullander, Essén, Tegner, Höistad and Ikegami would form a reference group that would evaluate the work and guarantee quality.

"We thought that we—a bit older, with no career to risk—would take on that role," Kullander said later. He was referring to the fact that it was still risky for researchers to get involved in cold fusion. The risk was severe: attract suspicion and be ostracized from the scientific community. The Swedish plan was to run the test in October the same year, but in the end it would take much longer.

An independent measurement on an independent site was demanded loudly by many critical *Ny Teknik* readers and around the world. I had by now noticed that those who commented on my articles as a whole could be divided into different categories. Some groups were predictable: the convinced optimists and the hardcore critics, stubbornly hammering at each another, and the more pragmatic, hopeful and skeptical, who with more or less enthusiasm awaited conclusive proof that the device worked or not. Beyond them was a group I had greater difficulty understanding: individuals who were most skeptical, though seemingly exhibiting faint hope that the device could work. Above all, they were outraged that no impeccable and independent measurements were made that could establish with certainty whether the device worked or not.

I wondered why they were in such a hurry. Soon the matter would be sorted out, perhaps as early as October, not far away. Just a few months' waiting—or that is what I imagined. Yet they did *not* rush to acquire information—many thought I should stop reporting and not restart until everything was scientifically proven. *Ny Teknik* should apologize, they thought. I wondered if their anger was due mainly to moral outrage that a fraudster could go free and maybe fool other people, though it was unclear how such fraud could be accomplished and with what consequences.

Or was the uncertainty itself annoying? The promise of a new, revolutionary invention that could solve the world's energy and climate problems was filled with so much hope that the uncertainty was maybe too provocative, a sort of logical and informational vacuum demanding to be filled with factual proofs. After all, what claims could they make on Rossi? Rossi himself was quite convinced that his device worked. He had not yet taken anyone's money, as far as I knew, and if he did, our readers would most certainly not be hit first. Rossi wanted to complete the large Greek plant scheduled for October, and who had the right to force him to do something else? To devote his time to producing a refined demonstration that could satisfy all requirements? I got the impression that no conceivable demonstration would be convincing enough.

An attempt to define this group of critics was the concept of pseudoskeptics, people claiming to be skeptics but driven by a need to defend an existing, established view. This runs contrary to skepticism, a view founded by the Greek philosopher Pyrrho about 300 BC and a fundamental part of the scientific method. It implies doubt over things neither scientifically proved nor disproved, but also openness towards such things. In this lies an awareness that our knowledge is limited.

The skeptic thus takes no position while doubt persists and does not consider a failed experiment or evidence as a rebuttal. On the contrary, the skeptic continues to study experimental results even when flaws are found, and is open to the unknown. The pseudoskeptic lacks the skeptic's openness to the unproven but believes himself or herself to be a skeptic via a critical attitude and gives the impression of being one.

The Danish Professor of sociology, Marcello Truzzi, popularized the term in science. Truzzi characterized a pseudoskeptic as one who denies phenomena or claims when there is doubt, who discredits rather than investigates, who criticizes scientific claims without presenting supporting proof for the criticism, or presents counter-claims based on plausibility rather than on empirical evidence. With that description, the pseudoskeptic's attitude could seem inoffensive and common. I also encountered, daily, many who suspiciously and almost routinely rejected anything contrary to widely-established scientific beliefs.

What distinguished Rossi's fiercest critics, and what puzzled me most, was how violently they reacted. Some thought it was an unhealthy trait and called them 'pathological skeptics.' Others felt that this attitude had infected skepticism itself. These included the American author Michael Prescott, who in his essay "Why I am not a skeptic," on his blog[42], attacked pseudoskeptics of all stripes, concluding with a description matching what I had seen among Rossi's severest critics:

"They wish, above all, to be certain—and when reality doesn't oblige them by offering clear-cut answers, they turn away from reality and seek refuge in pre-existing theory."

Prescott continues:

"In their quest to prove themselves right, they lose sight of the ambiguities and paradoxes of life. In their desire to be safe and sure, they turn

away from anything interesting and new.

"They are creatures of comfort and routine, not explorers. They cannot think outside the box. They will, in fact, deny that there is or ever could be anything outside the box—and they'll heap scorn on anyone who suggests otherwise. They'll call names, cry fraud, and holler that civilization is in danger and the barbarians are at the gates. They'll do anything, really—except examine their own assumptions with a remotely critical eye."

Lack of self-criticism was thus a characteristic trait in this group. I thought that these people must lack one of our most primal forces, an essential quality for anyone wanting to learn more and advance science: curiosity. Or maybe their desire for security and fear of the unknown was so great that their curiosity was suffocated. I also noted that some who opposed this attitude reacted just as violently in return, using the term 'pseudoskeptic' contemptuously, almost as an insult, maybe revealing a similar lack of self-criticism in them.

These reactions vs. the new and unknown were interesting. I imagined that they were universal behavioral patterns that run through all ages and cultures, and that each reaction had its value for technological evolution in society, so that it could advance in balance with what society and people could handle. I also saw them in a broader perspective: that one of the most fundamental strengths of nature and the universe, perhaps also one of the most underrated, was and remains diversity.

§

At this point international attention for Rossi's invention grew slowly. The reason: Defkalion, a few weeks earlier, had called a news conference in Athens to present their activities and future products. When the news conference began on the afternoon of June 23, 2011, in Athens' *Palaio Faliro* neighborhood about 150 people attended—the media, representatives from several Greek authorities and companies, and international guests. At the podium on stage sat Rossi, Xanthoulis and Stremmenos, who responded to a wide range of questions from the participants.

Gradually the technology started to seem much more real. Defkalion had worked quietly and intensively to take the technology from invention to product and presented sketches of a finished appliance—a 22X18X14-inch box that, apart from Rossi's E-Cat, contained a series of control and security features and was supposedly suitable for domestic environments. Though basically a new and unknown technology, the unit seemed mature and unremarkable. Xanthoulis stated that concerned EU authorities were ready to certify product safety for the EU market. In addition, each unit sold would be monitored by Defkalion via wireless to a mobile network, regardless of its location, worldwide—an early example of 'the Internet of Things,' a vision of billions of gadgets, devices and sensors connected to the Internet.

Stremmenos had named the energy device

Hyperion—in Greek mythology, a titan who was the uncle of Deukalion’s father *Prometheus*. It would be sold in different power classes: models that produced only heat and models with a small extension for electricity generation. Sales were scheduled to start in 2012. There were also plans for a much larger design, sized like the megawatt plant that Rossi was building. Xanthoulis explained that it was mounted in 20-foot containers and could deliver outputs of 1.15-3.45 megawatts. Perhaps to avoid unnecessary anxiety, Defkalion stated that the science behind the product was not related to cold fusion but recognized that the discovery of the technology spurred debate in the academic world. Defkalion’s Press kit said:

“This is tough because it’s basically telling very smart people that what they have learned, known, and taught is no longer true; a difficult pill to swallow for anyone.”

During the news conference, Xanthoulis also described production plans—a factory of 65,000 square feet under construction in the city of Xanthia able to produce 300,000 units per year, and another planned factory, twice as big, in the same city. A third factory would manufacture the reactors with Rossi's secret design and deliver them both to the other two factories and to other plants worldwide. The third plant would be owned directly by the Cypriot company Praxen, which controlled Defkalion and had signed the formal contract with Rossi, or more specifically, with the company EFA. To handle international interest in the invention, Praxen-Defkalion would, under its contract, sell licenses in other countries to companies that wanted to establish local production and sales. During the news conference, Xanthoulis also explained that those who were making the substantial investment in the project were of Greek origin living in Canada and South America. After a couple of hours Xanthoulis, representing the investors, ended the news conference, followed by the usual mingling. With this, the ball was rolling for Defkalion.

I sat on a balcony on the Tuscany coast and followed the news conference at a distance. The waves lapped along the beach and the sun shimmered on the water but I had my eye on developments and wrote a summary. At *Ny Teknik's* website the discussion on the technology flared up again when we published my article later that day. In Greece, dozens of newspapers reported on the news and it spread on the Internet among blogs and online newspapers. But the greatest curiosity was directed towards Defkalion's new website that soon reached a couple of hundred thousand visitors per day. The commercial interest was obviously great—after only a few weeks, over 850 companies from 63 countries had contacted Defkalion and expressed interest in doing business.

Around the same time, a Defkalion email leaked on the Internet—an email sent to interested companies—revealed that a license to build Hyperion products in a specific country would cost €40.5 million, or about $52.5 million US—per factory.

This included training and help to establish production, but the amount was still significant. When I read it one day in early July, I noted that if the whole thing were a scam it had now reached epic proportions. To that I had surely contributed a lot. The thought was vertiginous. I also recalled the news conference and the polished image of mature products ready to be installed in ordinary households. Hadn't it all gone a little too quickly, given that Defkalion had participated in only a few tests of Rossi's device?

Indeed it had gone somewhat too fast, or at least not as Defkalion had wanted. The first thing that caused great irritation among the Greeks was Rossi's contract with the American company Ampenergo. I suspected this already when in mid-May we at *Ny Teknik* published the interview with Ampenergo's vice president Craig Cassarino. Hours after we published, Defkalion's Communications Officer Symeon Tsalikoglou called me. I saw the Greek number in my cell phone and wondered what could be going on.

"Hey, it's Symeon. We read your article."

He asked a couple of questions about the content. Apparently the Greeks had not known anything about Ampenergo or the agreement before reading my article. The problem was not Rossi's collaboration with Ampenergo but that the agreement referred to royalties on contracts throughout North and South America, whereas Defkalion had an option on licenses for production worldwide, except for the U. S.—that is, even in South and Central America and in Canada. The issue was particularly sensitive because the investors behind Defkalion lived in Canada and South America.

The next stumbling block for Defkalion was the final check that the technology worked—the test that according to Defkalion would be carried out under the control of a group of scientists appointed by Defkalion and Greek authorities, namely the Greek Atomic Energy Commission, the Institute of Nuclear and Particle Physics (Demokritos) and the

University of Patras. Four professors would testify that the device produced heat for a long time and that radiation around the device was below prescribed limits. The test was a prerequisite for Defkalion to provide Hyperion products with the European ‘CE’ mark certifying that a product meets basic requirements in areas such as health, safety, performance and the environment, and allows it to be marketed in Europe. Nine days after the completed and approved test, Rossi would have access to the €15 million that Defkalion should have deposited into an escrow account. But according to the Greeks, Rossi had not agreed to come to Greece but wanted to make the test in Bologna. They also said that Rossi didn’t accept the professors’ demands for a test with 48 hours continuous operation. Instead, Rossi conducted the test in which he tried the new reactor model with Professor Stremmenos in Bologna in early July—a test that lasted only one hour.

From Rossi’s perspective the situation was the opposite of what the Greeks believed. He did not perform the test with the four professors in Greece because the €15 million, supposedly to be deposited in an escrow account in February 2011, never arrived. Stremmenos hoped to resolve the situation by conducting the July test himself, along with Rossi, according to oral orders from Prime Minister Papandreou via Antonis Karras, Stremmenos friend who had accompanied him when he briefed Papandreou in spring 2010. He then sent a report of the test to the Greek government. Though Stremmenos served on Defkalion’s board he could not formally represent the Greek authorities and the test was thus probably of limited value. Besides, it was too short, Defkalion thought. Rossi’s answer was then that the test with the Greek professors had to be done in August, if the money was deposited in the escrow account, but since August is holiday season in Southern Europe it would probably be September instead. At that point, Defkalion decided to send a letter to Rossi and warn him that it was a breach of contract.

Rossi, on the other hand, was now in the U.S., his priorities elsewhere. He had contacted an organization that might be more important to him than any other in the world—the U.S. space agency NASA. NASA had invited him to a meeting to discuss his technology. He had initially been skeptical because he did not think that the E-Cat remotely had the properties required for use in spacecraft. "Let *us* decide that," NASA responded. So on July 14, 2011 he went to Marshall Space Flight Center in Huntsville, Alabama for the meeting.

It was special moment for NASA: the space shuttle Atlantis had lifted off a few days earlier for the last expedition in the U.S. Space Shuttle program —number 135 since the program started 30 years earlier. At two o'clock in the afternoon Rossi stepped into the hall where about 25 representatives from NASA and other invitees had gathered. Many were engineers and nuclear scientists with Ph.Ds. He told them about his technology and responded fully and patiently to all the questions, except for the secrets of the catalysts. He realized eventually that those present had followed his activities closely and knew much more about it than he had expected.

One reason for NASA's interest was the ability to avoid the risks of radioactive materials in future satellites and spacecraft. It could involve both plutonium-based generators for electricity supply, in satellites such as New Horizons (then traveling to Pluto), and new types of rocket engines with nuclear fuel for operation in space. The advantage with nuclear fuel was that it required so little physical space vs. all forms of chemical fuels and batteries—around one million times less, because each atom involved in a nuclear reaction releases about a million times more energy than in a chemical reaction.

The same relationship also formed the basis of all observations of cold fusion—the heat produced from a small amount of material in the experiments was so great that it could not be explained by chemistry, thus should be some form of nuclear reaction. There were no other alternatives. Energy based on nuclear reactions was therefore of great interest to NASA but in all previously known and manageable nuclear technology, radioactive fuel such as uranium or plutonium had been used, including the U.S. Air Force work going back to 1946 but subsequently cancelled. The major problem with such fuel was the risk that the launch failed and the rocket exploded. Large amounts of radioactive material—in the worst case, plutonium, which is also very poisonous—would spread in the atmosphere and land, with unforeseeable consequences.

Rossi's technology did not have this problem. If it worked, it was based on some form of nuclear reaction and was thus very compact. But the fuel itself was not radioactive or toxic—it used small amounts of the harmless metal nickel and ordinary hydrogen. It would be ideal for NASA, which had already been affected by intense protests at the January 2006 launch of New Horizons with 11 kilograms of plutonium on board. NASA had estimated the risk of failure at 1 in 350—a small but certainly not negligible risk. The type of plutonium used for the generator on board was also running out. It had been manufactured during the Cold War until 1989; the amount remaining would suffice, at most, for two or three more vehicles. The Russians had earlier used nuclear generators on spacecraft and the re-entry of these devices raised concern worldwide—one spent craft the size of a school bus had already burned up on re-entry and ended up in the Pacific.

If Rossi's technology delivered what it promised, NASA, with its qualified engineers, could develop it for everything from power generation in spacecraft and space bases to motor applications for space operations and even in conventional aircraft. The fact was that NASA, unlike virtually all other important organizations, openly expressed its support and interest not only for the new type of nuclear reactions, LENR, but also directly for Rossi's E-Cat.

Already, in April 2011, Dennis Bushnell, chief scientist at NASA Langley Research Center in Hampton, Virginia, spoke about the technology in a high-profile interview with Evworld.com. He mentioned Rossi's device, specifically, as a promising example and said about the area, in general: "*I think this will go forward quite rapidly now. If it does what it is capable of, by itself, it completely changes geo-economics, geo-politics and solving climate and energy.*"[43] And after Rossi's meeting with NASA, Bushnell stated in the Italian magazine *Focus*: "*Also at NASA we are studying the experiment of Rossi and Focardi and will buy several E-Cats once they are ready, to test them. If they meet expectations, we will face something that can overturn the economic and political scenarios of the world. And solve the climate problem.*"[44]

This was jumping ahead, because it would take time before the devices would be on sale. Clearly, however, NASA would gladly test Rossi's technology to get to know more, for at the meeting in Huntsville those present basically didn't learn more than they already knew, among other ways through my reporting, which contained much uncertainty. The NASA engineer who organized the meeting, Michael Nelson, planned to propose to Rossi a test at NASA, but he never got that far as Rossi anticipated him with the same proposal. Rossi was even prepared to pay the cost of the test, which NASA estimated at $50,000. At that point the situation was clear for NASA and preparations for a test procedure were started. After the meeting, one of the managers at NASA wrote to me:

"So far, my impressions of Andrea are that he sincerely believes in his technology. He is not acting like someone who has nothing. Even if this is not proven out, I have no personal reason to treat Andrea disrespectfully."

He noted the expression Rossi used in the United States—that he 'played football with his own bones,' meaning that he did not risk someone else's bones, only his own.

"He absolutely believes in what he does," he wrote.

To Rossi, the NASA contact was valuable. If he could get NASA to test and verify the function of the E-Cat, it would beat any other test in the world. Still he was in a difficult situation regarding Defkalion, who accused him of breach of contract because of his contract with Ampenergo. From Rossi's perspective he was not guilty of breach of contract but rather Defkalion itself was, since the agreed €15 million had never been deposited into an escrow account and it was five months since the deposit should have been made.

In light of what happened a few months later, one might wonder about Defkalion's real motive but the question would be difficult to answer. Rossi felt, in any case, that the Greeks had delayed payment and he assumed that they had funding problems. As the weeks and months passed he had begun to worry about two things. The first was a warning from his legal counsel that if he waited too long without taking action it could be considered that he passively agreed to give up the terms of the agreement. The second was that the opening of the megawatt plant in Greece in October 2011 was approaching. Rossi understood that after all his public promises about the inauguration no one would believe him if in October he said that it had been postponed for financial reasons. Everyone would then conclude that it was all a big scam, as many had believed all along.

Rossi thought that this was the game the Greeks were trying to play. If they could drag out the proceedings long enough he would not be able to find an alternative customer and would have to inaugurate the plant in Greece, without Defkalion's financial guarantees. So when after five months he still could not agree with them and saw an opening in his contacts with NASA, he took the opportunity. Instead of letting NASA try a single

E-Cat module, he suggested that they implement the megawatt plant test. This created quite different economic conditions than those NASA had discussed. Rossi no longer wanted to pay for a test but instead wanted NASA to buy the plant, just as Defkalion was supposed to have done: $15 million into an escrow account, available to Rossi if the test was approved. In fact, he had suggested this to NASA even before the meeting in Huntsville on July 14 and was then told that this kind of deal was beyond NASA's reach. So an agreement seemed difficult to make.

A possible solution emerged via a proposal from an external funder—a group consisting mainly of a fund manager, TEM Capital, and the company Continuum Energy Technologies, CET. Rossi claimed that there were contacts also with the aerospace giant Boeing that had already shown interest in his technology. The TEM Capital founder, who was also CEO of CET, John Preston, was an award-winning entrepreneur who had followed the E-Cat development without Rossi knowing. Preston had extensive experience in technology companies in the energy and environment sectors. Among other things, he had been responsible for commercializing technology developed at MIT and had seen hundreds of new technology companies being born. He had also acted as an advisor to both the U.S. Department of Defense and NASA. The companies invited Rossi, who again flew to the U.S. in early August. What happened next is not entirely clear but based on several sources, including Rossi, it was likely as follows:

Before Rossi's trip, discussions were held between several people, including chief scientist Dennis Bushnell of NASA, Jim Dunn, an engineer and entrepreneur specializing in fuel cells and alternative energy sources and previously Director of the NASA NE Regional Technology Transfer Center for 15 years, Jamie Childress, a research engineer at Boeing's Phantom Works development activity, John Preston from TEM Capital and Rossi's U.S. partner Ampenergo.

Dunn and Preston represented investors with equity primarily from the crown prince of the United Arab Emirates, where there was intense interest in new clean-energy sources. One immediate application was water desalination, which daily demanded millions of barrels of oil in the Middle East—oil these countries would rather sell for $100 a barrel, given that 'peak oil'—when world oil production reached its peak—was supposedly approaching.

While Rossi then was in the U.S. for a few days in early August, he had meetings with NASA and Ampenergo at Marshall Space Flight Center in Huntsville, where he had visited a few weeks earlier. Dennis Bushnell was busy and could not attend but sent instead Roger Lepsch, aerospace engineer at NASA's Langley Research Center in Hampton, Virginia. Another participant was Robert Hendricks, from Glenn Research Center in Cleveland, Ohio, one of NASA's most experienced engineers. From Ampenergo, Craig Cassarino and Karl Norwood attended. Rossi also had meetings with Jim Dunn, John Preston and Ampenergo, possibly in part via telephone. And when he soon afterwards flew back to Italy he brought a letter of intent giving the group rights to manufacture and distribute Rossi’s technology in North and South America, possibly also throughout the world, later—sources were conflicting on this issue.

The agreement also meant that Rossi would sell the megawatt plant to the Americans. Under a separate agreement between CET and NASA it would now be tested at the Marshall Space Flight Center in Huntsville, Alabama in late October and not, as previously planned, in Greece. An initial $15 million would be paid into an escrow account, using the Greek model, to be made available to Rossi after successful plant operation. If the test succeeded, an additional $135 million would be paid for the rights to manufacture and distribute the technology. In addition, investors would cover the costs for NASA’s test. Overall, Rossi estimated that the contract was worth around $1 billion US through planned orders, especially from Abu Dhabi for water desalination—a perfect application for a heat source with low energy cost. At the last moment Rossi had thus gained a new opportunity to implement the promised October inauguration and tied up a significant customer, if —always and ever that significant 'if'—the technology worked as expected.

42. http://michaelprescott.freeservers.com/im-not-a-skeptic.html
43. http://lenr.qumbu.com/110606_evworld_bu
44. Focus, p 36, no 226, August 2011.

CHAPTER 12

Rossi ends the agreement

Rossi had during this period prepared a letter to Praxen-Defkalion, telling them he was terminating the agreement. When he returned to Italy he sent out a press release about this to me and to Peter Svensson of the Associated Press. Just us two.

When I received the message on a sunny Friday afternoon, on August 5, 2011, out in the Stockholm archipelago, I was surprised, to say the least. I stood, cell phone in hand, looking at the children playing on the bridge, and thought: was this a way to pressure the Greeks? Did Rossi hope we would publish the content? AP had not yet written a word about him and would undoubtedly keep a low profile. Then I started thinking about Rossi's character, as I had come to know him over the past months.

I remembered an occasion in Bologna when Rossi, after a test, drove me to the train. He had always had a penchant for fast cars. Already in the book *Petrolio dai rifiuti,* the author Luigi Bacialli mentions his new red Alfa Romeo. His car in Bologna was also an Alfa Romeo, a silver *Brera*. Pininfarina produced about 20,000 to 2010. Rossi's was a 2.4 JTDm: 210 horsepower, top speed 140 miles per hour. I had just over half an hour to spare and had to catch the train to make a connecting flight. At a motorway entrance Rossi took a wrong turn and we had to double back. Rossi stepped on the gas, the engine rumbled and while I was pushed back into the seat by the acceleration Rossi did a fast, precise calculation, speaking intensely, of how long it would take to get to the railway station—we had a 15-minute margin, he concluded. As we zipped up the left lane, I realized that Rossi was one of those drivers whom you see sometimes in Italy who pop up out of nowhere in the rearview mirror, without understanding where they came from.

Rossi was definitely competitive, I thought, recalling the incident. He had already shown that trait as a young long-distance runner. Maybe his determination to succeed and win could sometimes cause him to make up his own rules. I did not know those rules. Not even after talking with him about the press release could I determine his intentions. But I realized that Rossi usually achieved his goals—of course, I arrived in time for the train. I asked myself, holding the press release: under which conditions did he do it this time?

I never got an answer. Much later, I talked to two of Rossi's friends—Luca Aldrovandi and Giuliano Guandalini—who mentioned his competitiveness. Aldrovandi referred to Rossi's huge performance as a 19-year-old long distance runner, setting the Italian record by running over 175 km in 24 hours.

"He still has that desire to achieve results, the joy of fighting for an idea and to beat challenges that seem impossible," Aldrovandi said, stressing that Rossi always stuck to the rules. But what the two friends emphasized in describing him were his strong personality, his boundless energy and his enormous enthusiasm.

Guandalini considered his unusually sharp intellect, his speed and his accuracy as Rossi's most prominent features; Aldrovandi emphasized Rossi's cultural background and inclinations, especially in history and philosophy. They agreed that it could be a challenge to work with him.

"He works very well, for example, with his colleagues, as long as they don't say stupid things. Then he can react violently—I've heard really harsh words directed to qualified individuals, university professors, and I have heard him get irritated, perhaps beyond what's normal. So I do not really believe that he is not collaborative, that he cannot work in a team, but rather that the people who work with him have to adapt a little to his ways, and be careful not to say nonsense. Otherwise Rossi reacts badly, really badly. A little too badly," Guandalini told me. In effect, they were describing someone who would not and could not suffer fools. But they also saw another nearly opposite aspect, or possibly the opposite side of the same coin.

"He is a great enthusiast who sees dreams come true. Because really, he is a very jovial character, though it does not seem so—a very nice person, who is also positive, optimistic, sometimes even too optimistic," Aldrovandi pointed out.

"Rossi has this serious weakness that if you suggest something he thinks that everything is already done. If he meets someone who shows interest, he thinks right away that he has a deal done. He is sincere but by nature he is a bit childish in this way," said Guandalini.

That could explain seemingly exaggerated statements Rossi made later about his activities on his blog, *The Journal of Nuclear Physics*. He gladly described possible events and outcomes as if completed, and his critics, of course, quickly took advantage of this.

"He talks too much. He should keep quiet a bit more," said Guandalini.

His friends' comments also reoriented my picture of Rossi as competitive. If Rossi liked to drive fast cars it probably reflected not just his competitive desire but just as much his enthusiasm and naivety that his friends noted—even playfulness. Rossi described another aspect when I asked him if negotiating with him was difficult.

"Dealing with me is not difficult. You just have to understand the basics. I am extremely direct. Because after what I have gone through in my life, at my age, I am no longer willing to lose time. So it is meaningless to not be direct, because sooner or later it all comes out. You'd better say it right away. It's one of my character traits, perhaps a weakness. My wife use to say that if I were appointed a diplomat I would be able to trigger a war even between the U.S. and Canada."

In the end this had little to do with the decision to break with Defkalion. Both Guandalini and

Aldrovandi were to some extent involved through a minority ownership in EFA, the company that owned the commercial rights to the E-Cat in Europe, with Rossi's wife as principal owner. Aldrovandi was also company CEO when the agreement with Defkalion was signed. And Guandalini and Aldrovandi subsequently defended the decision on much the same grounds as did Rossi—that the Greeks had not fulfilled their part of the agreement. Before I had finished considering Rossi's motives, I also got Defkalion's view. On the evening of August 5, the same day I received Rossi's press release, Xanthoulis, representing Defkalion, called me.

"Hello, it's Alex," said Xanthoulis.

He told me at length about how he looked at how Rossi acted, explained why they warned him of breach of contract three times, and wanted to hear what I thought about Rossi's motives.

"It's totally illegal, what he is doing. I don't understand. Because he will be destroyed," Xanthoulis said.

He was sure to have right on his side, since Rossi did not perform the test in Greece as agreed. And he was sure that in a legal battle he would win and, among other things, could block Rossi's patent application. Xanthoulis seemed to think that Rossi had tried to blackmail him. Much seemed to be at stake. According to Xanthoulis, companies in 47 countries were already willing to pay €40.5 million each as a license fee to Defkalion and he claimed that agreements were already signed with 17 of them. So Xanthoulis would rather not pick a fight—even if he thought he would win and that Rossi would then perish. Instead, he had recently reiterated to Rossi that he would pay the €15 million once the test with the Greek professors was concluded. Moreover, he had offered him €5 million in royalties for each country that signed an agreement, plus €100 per product sold, supposedly an increase over the original agreement.

Meanwhile Xanthoulis was being pressed by his own lawyers. He pointed out to me that he was working with one of London's largest law offices, which instead of cash fees received a 1.5 percent share in the company and therefore had strong interests in Defkalion's business. Xanthoulis also talked about the professors appointed to control Rossi's technology in a 48-hour test—the test that should underlie the €15 million payment. He said he had offered to deposit the amount in an escrow account at the Bank of Cyprus but that Rossi did not accept the bank or the requirement to perform the test in Greece. He further told me about Defkalion's first CEO, Aurel David, who had apparently left the company, taking with him all technical documentation, and sold it to a German company that in turn, according to Xanthoulis, had offered Rossi €150 million for a contract. He also seemed to know details of what Rossi was doing, claiming among other things to know that Rossi currently had 7,000 in his bank account—it was unclear which currency. Yet he did not know how to act.

"I don't know how to handle him, Mats. Honestly. I'm just shocked."

Perhaps the most astonishing thing, especially in light of what Defkalion then did, was that he claimed to know exactly how Rossi's technology worked, though Rossi in his press release stated that no knowledge of the technology was transferred. "But I'm not going to play games.... I'm not a cheater. If he has to be paid, his work has to be paid. But his problem is scientifically solved by us. We believe that his reactor cannot operate more than 24 hours. When we requested 48 hours it was a problem. But my scientists discovered the problem. I cannot reveal it right now but we can fix the problem. It's very simple but they didn't think about it. Just like Rossi never thought that out of his product he can create electricity. He never thought about it. We told him.

"But the first problem was with the 48 hours. He had a huge fight with one of my scientists, Mr. John Hadjichristos, because we were insisting on 48 hours. But we know the problem; we didn't tell him of course, but we know the problem.

"I know what he's got in the reactor, I know everything. It was [from] spectroscopy made by the University of Siena[45], [using] equipment made by the University of Siena. It understands everything that's inside the reactor. So we know the components.

"Personally I believe that his technology works up to a certain point. We have made five tests up to now, with our own scientists. It works up to 24 hours maximum. It needs a lot of improvement that we have done already. We can certify six months right now, under our technology."

I did not know what to think but later I would be relieved that I had recorded the conversation. In retrospect, it would prove to contain more than I realized at that moment. Xanthoulis seemed unsure of how he should act now. But before he hung up he said:

"I still think I can save Rossi."

§

A few days later it was clear that Xanthoulis eventually chose not to attack Rossi. Directly after the weekend he called me with his official message.

"We continue the project. We still have a lot of trust in Mr. Rossi. We believe in the technology. But as you understand we are receiving a lot of pressure, also Rossi is receiving a lot of pressure internationally. And we believe that some people are more vulnerable to the pressure and some people are not accepting the pressure. I believe we are on the second scale. This will be fixed, I believe," he told me, in a strained voice.

A little later I received a statement via e-mail which, among other things said:

During the months since January 2011, both interested parties (Andrea Rossi through EFA and Defkalion Green Technologies) have received strong international pressure and to many degrees [have been exposed to] business *traps from banks, financial partners, etc. to cancel the project.*

The business implications of this project on international energy interests are tremendous and have created tensions [in] establishing a business-as-unusual (sic!) environment. Defkalion maintains its capability to handle these pressures, and stands next to Andrea Rossi who is apparently also facing similar challenges. (...)

We remain confident in the future, we remain confident in our long-standing partnership with Andrea Rossi, and we remain committed to materialize (sic) the project – despite all the existing and continuing pressures to discredit and eliminate the work done by Andrea Rossi and Defkalion Green Technologies.

Had Xanthoulis shown courage? Had he gone against his lawyers, believing that the project's value to the world was more important than getting it right in a financial dispute? Or was simply too much at stake—were business opportunities in such a unique and potentially revolutionary invention so great that you had to retain at least a piece of the pie at all costs? Save what could be saved? Defkalion's investment to take the technology from invention to a product had so far amounted to €7 million, according to Xanthoulis. Since the Greeks had gone into the project long before anyone realized its value or even thought it was possible, it would be a shame to give up now. Investors could certainly contribute more if the agreement could be saved, maybe also compromise on the geographical rights. But did any chance remain? Rossi might be willing to renegotiate from scratch but he would certainly let Defkalion wait a while. He was also at odds with the Greeks on another point—the timing for introducing the technology to the consumer market.

Defkalion, recall, had in June unveiled its consumer product, scheduled to enter production in 2012. Rossi stubbornly opposed this and was instead intent on just selling industrial plants of one megawatt initially, like the one to be inaugurated in October 2011. The consumer market was much more problematic and had to wait because he did not think the technology could be certified for consumer use. Defkalion claimed that Greek authorities were prepared to issue a CE mark, if these authorities' representatives could verify that the device produced heat and did not emit radiation outside the casing.

Rossi had a hard time believing that claim. What certification company would be so foolish as to assume responsibility for the safety of a product without being allowed to open it and see how it was designed inside, he asked himself. It was one thing to approve a device for industrial use where the operation was run by staff trained and obliged to study manuals, who had been tested for operational skills and who had received special authorization upon a completed test. It was entirely another matter, as Rossi said, to put a device in the home of poor Aunt Maria who knew nothing about anything and just bought the device in a store and turned it on. But long before Rossi terminated the agreement with Defkalion he had been convinced that the Greeks, in practice, would have had to do as he wished. In the end, they had no choice. Now: would they have the chance to think it over?

One Greek who seemed to respond calmly to the conflict was Professor Christos Stremmenos. Asked by the blogger Daniele Passerini, a personal friend of Giuseppe Levi—a man who with great dedication had followed Rossi's adventure—Stremmenos replied with an open letter. Stremmenos noted that in his life he had tried to serve three values: the scientific truth and its contribution to humanity; the value of culture, democracy and human civilization; and his country of origin, Greece—not in the patriotic sense, but as a value-bearing figure through time. He described how he had, since 1989, done research in cold fusion with limited results and emphasized his respect for Rossi's and Focardi's crucial contribution in this area and its possible impact on Earth's climate and energy. With his primary commitment to science he had also helped bring Rossi's technology to Greece. He regretted the breach in the agreement between Rossi and Defkalion, which he thought had purely financial motivations. And he concluded:

"With the firm conviction that those who have given us this groundbreaking technology deserve absolute respect and consideration, I am consoled by my inclination to always with optimism look at the forest and not at the individual tree."

Only later would I realize that Stremmenos was not as calm as he seemed but rather upset, and that he had not been in contact with Defkalion since June 2011 because he felt that those responsible for the company had started to behave unethically. I also realized that Rossi had no plans to undertake business with Defkalion again. Later I would wonder if, behind Xanthoulis' hand, seemingly outstretched toward Rossi, lay a completely different emergency plan. I had by now realized that Rossi was not easy to cooperate with, but for those who had the goal in mind opportunities beckoned.

45. Xanthoulis later changed this claim to the University of Padua.

CHAPTER 13

Reversals

Discussions on Rossi's device didn't stop in the summer of 2011. On the contrary, they became increasingly intense, especially when it came to the quality of the steam produced during the experiments and the significance it might have for calculating the energy released. In late July a long report on the technology came from an American writer, Steven Krivit, who for many years had written about cold fusion and LENR and had thus gained a certain influence in the area. His website, *New Energy Times*, featured comprehensive and accurate reporting of research in the field—a valuable information source. The problem? Krivit was working alone, without editorial staff or an editor to verify the integrity of his work, including fact-checking. From a journalistic point of view this was a weakness. He also had no physics education. He had contacted me in spring 2011 after my first few articles. My reporting may have surprised him since he had dominated much of the reporting in this area in recent years. I began to suspect this when he called me from California one evening in early summer.

“You scooped me,” he admitted, somewhat reluctantly, referring to the acclaimed video we had offered on *Ny Teknik’s* website after my visit to Bologna in April, showing the whole experimental setup for Rossi’s apparatus, comprehensively, for the first time. He asked if I wanted to accompany him on a visit to Rossi in mid-July but I declined, mostly for practical reasons but also because I did not know him well enough to work with him.

Krivit’s late July report[46] showed that he had assessed the tests differently from me. After his Bologna visit, where he participated in a relatively short test, he stated that you could draw no conclusions about the net energy produced. It could even have been zero, he claimed, meaning that the E-Cat did not work. His report leaned on reasoning, observations and calculations by scientists with extensive experience in steam. It said that if the water didn't boil properly and the steam was low quality, i.e., with a large quantity of water droplets in it, and if a lot of water also flowed through the E-Cat without having evaporated, thermal energy from the electric heaters was enough to explain the results. He summed up his report as follows: *"There is good work in the LENR field, worthy of attention and funding. This is not it."* [47]

Some of the analyses, however, were made based on scant information, including how the steam appeared in the video that I had recorded and published. Knowledgeable observers also had a contrary view on this steam issue. Moreover, Krivit's conclusions were similar to arguments I had heard from another source: the Italian technical consultant Adriano Bassignana, with whom I had been in contact since May 2011. With all kinds of technical discussions about the steam, Bassignana tried eagerly to convince me that Rossi’s device did not work and pointed out that a rapid revelation could be useful for me as a journalist. These observations made me suspicious. In one email he wrote: *“It might be a really good scoop to uncover the game before someone else does.”*

It turned out that Bassignana was also in contact with Krivit. But, distilling the situation, there was a theoretical point of Krivit’s and Bassignana’s conclusions. Though no one could prove that such low-quality steam could be formed from boiling water in a vessel that looked like the E-Cat, and though I had both felt and heard water boiling strongly inside the device, the discussion was enough to put heavy pressure on me in my journalist’s role. Krivit also placed *Ny Teknik* on a list of *‘sources that are specifically focused on supporting the Rossi claim.’*

I had by then realized that my method for ensuring that no water flowed right through the E-Cat, without vaporizing, possibly didn’t work. Uncertainty gnawed at me. Was the E-Cat a hoax? Was Rossi a clever fraud? Or was there something fundamental, such as the steam issue, that neither Rossi nor anyone else who participated in the tests had realized?

Whatever I thought of all I had heard and seen, I couldn’t make the fraud hypothesis fit. Rossi, Focardi and Levi had told me that they performed tests without boiling water, with only heating, and in that case the problem with the steam was irrelevant. Surely I had at least to trust Levi and Focardi, didn’t I? Rationally, they had nothing to gain by lying. Could Rossi then have taken them for a ride some other way? I had trouble believing it. Moreover, I still could not see any credible way in which the fraud could be perpetrated. Whether the puzzle could be unraveled or not, the uncertainty about the steam remained. Even Kullander felt that the steam quality had to be better controlled, as did NASA's representatives.

There was another perspective. Basically Krivit's report was less a statement about Rossi's technology, more a critique of the relatively low scientific level of tests he had conducted. *'A scientific failure,'* as Krivit—not a physicist—put it. Note that the most important contributions to the report, according to Krivit himself, came from reputable scientists in LENR who reasonably were disturbed by Rossi's unscientific behavior. Their concern was that Rossi was a rascal and that the consequences when the hoax was revealed would be disastrous for research in this area, already under a cloud. They believed, rightly, that it would take years to rebuild minimal confidence in their research if such a scam were to be widely reported.

Professor Piantelli, whom I contacted in late summer, had a similar attitude at the scientific level. He was, as usual, in Tuscany where he lived just outside Siena. There he had a small vineyard as a hobby, alongside his research and academic work at Siena University. Piantelli was very friendly and courteous. During our talk he appeared as the meticulous and scrupulous scientist that several people testified that he was. He did not mention Rossi directly but he made clear that he considered Rossi's work and the tests carried out as a pitiful circus that only corrupted true science. Piantelli wrote to me:

"I understand that your work is not easy in a world where everything is desecrated and destroyed by media and even more by unwise blogs where you find excesses similar to those that are unleashed by supporters on the soccer field. Unfortunately, also science, the one with a capital S, is treated badly with all the deleterious consequences that it entails."

His criticism extended to the 1989 Fleischmann and Pons presentation and he opposed "public demonstrations," which he said became "spectacles, without benefit of research." On the contrary, he thought that they impeded those who worked seriously and with limited resources. True science is carried out quietly in laboratories and the results discussed by people with specific skills, at special meetings, not in pointless debates, Piantelli meant. He particularly stressed the fundamental scientific steps or rules that Galileo Galilei—often called the father of science—formulated about 400 years ago, also called the scientific method. In brief: start with reproducible experiments from which one builds a hypothesis that is then refined via logic, mathematical laws and natural laws; a verifying experiment either confirms the hypothesis and puts it into a larger context, or proves it invalid. The perfect scientific work, in short.

Like many others, Piantelli noted that in cold fusion or LENR, not even the first step—reproducibility—was fulfilled. In general, he argued that commercial interests often led to haste, leaving the scientific method behind, which was risky. Piantelli said that this was also one of the explanations for the serious accidents in nuclear power. Nuclear power simply was not thoroughly analyzed scientifically.

The conflict is classic in technology development. The counter-question: what it costs humanity to delay the use of important advances and discoveries. The history of technology also shows that it is impossible to prevent immediate application of new technologies and discoveries, whether scientifically explained or not. Exactly how the lifting force occurs on an airplane wing, for example, still awaits full scientific explanation, though Bernoulli's principle, formulated by the Swiss scientist Daniel Bernoulli in 1738, contributed to solving a crucial part of the problem.

Piantelli had started his research in LENR by coincidence when in August 1989—the same year that Fleischmann and Pons made their high-profile news conference—he performed an experiment linked to cancer research within his main field of biophysics. Piantelli told me that when he conducted the experiment, containing nickel and hydrogen as in Rossi's device, the temperature suddenly increased and the experimental setup was destroyed.

"I walked away angry. I had destroyed an experiment and it's always bad. Very disheartening. But then I thought more about it and in the early '90s I tried to make a specific experiment, and then came up with the first results that led to everything else," he wrote in an email.

He continued with the experiments, eventually with Focardi, never believed in the cold-fusion concept but assumed that it was a different LENR phenomenon. Now he claimed to have obtained better results and had also come a long way towards a hypothesis about how it actually worked, but he was also careful to avoid excessive enthusiasm. The results would eventually be presented at conferences and in scientific publications. In support of his research a few investors had formed a small company—Nichenergy—which in time might commercialize the results. It was still a way to go, Piantelli noted, and emphasized that shortcuts in science were impossible—it just meant that you broke Galilei's rules, risking accidents, as he had stated before. Eventually he summed up one of the pillars of modern philosophy of science:

"In science one must always doubt that what is found experimentally is an artifact, and the researcher must try to show that it really is an artifact. Only when one has exhausted all possibilities can one accept the outcome as real."

I understood Piantelli's and Krivit's reasoning. In science, there is every reason to be careful, logical and methodical. Rossi had long doubted that what he experimented with really worked, until he met Focardi. But his doubts may not have been systematic and scientifically based, as Piantelli advocated. On the other hand, Rossi was no scientist and didn't pretend to do scientific research. He was an entrepreneur. To me it was enough that what he showed was reasonably credible. Since the device had huge potential I could wait for scientific explanations and waterproof evidence. For Rossi it was enough that customers noted that the device worked and were willing to pay for it. Soon enough it would be time for explanations and proof but maybe it was not even a question for Rossi. Once that happened the requirements would be the same as of all other scientific work. Possibly, however, Piantelli was right that the risk of accidents was greater before the physical aspects were elucidated in detail.

I also tried to evaluate the interests of people who wrote to me insisting that I highlight one or another sign that Rossi had tampered with the tests or that the results were not correct. Some perhaps had something to gain from Rossi's adversities. In fact I expected much more powerful attacks on my reporting and against Rossi from the tremendous interests that were threatened if the technology proved to work. Still I continued to wonder where the truth was and to ponder on my role. I had received a critical email from Krivit: *“This would be a very good time for you to reflect carefully on your role, responsibility and reputation in this matter,”* he wrote.

He was right. Basically, he and other critics played an important role: they forced me to constantly seek better answers and to continually consider my responsibility. If I had the opportunity to draw attention to something that might work and could serve humanity invaluably, was it my responsibility to do that? Or was it my responsibility to highlight possible weaknesses in the performed tests, to prevent a possible scam from acquiring larger proportions? What responsibility did I have if the technology was shown to work and I had helped contain and discredit Rossi?

I needed to get better and more accurate data on the E-Cat's performance to make my reporting more credible. In early September I asked Rossi if we could perform a new test. Rossi was now busy getting the megawatt plant ready to go on line in October but despite this priority he immediately cleared an afternoon for us to meet in Bologna *"I have arranged a gap at four o'clock on September 7,"* he wrote. After some consideration, I decided to go. I picked up a couple of new instruments and prepared myself for measurements we had not done in previous tests. Rossi agreed to everything.

On September 7, 2011, I got up at four AM to catch the flight that would leave just after seven o'clock. It was relatively cool in Stockholm but I was lightly dressed and looked forward to the summer heat still lingering in Italy. In Milan, I had time to go into a hardware store to buy Italian electrical plugs that I needed for additional measurements on the electric power supply of Rossi's device. There was the usual hustle and bustle in the train station and I sat on a bench and mounted plugs and cords while crowds passed by. The train I had intended to take remained at the platform due to a technical glitch, so I had to find another. Soon I was in the high-speed *Freccia Rossa* that quickly took me to Bologna.

When I arrived by taxi at *Via dell'Elettricista* and was admitted to the industrial premises, a surprise awaited me. Before me stood a dark blue shipping container with the doors wide open. Inside: the 52 E-Cats comprising the megawatt plant. I realized immediately that I had harbored persistent doubts about whether that plant actually existed in the material world and that Rossi really was building it. I was not alone. Many were convinced that the October launch would not happen, that it would be deferred for one reason or another—the classic fraud pattern. Many did not believe that any megawatt plant would ever be built. Now there was no doubt. What I saw in the container was not built for fun, or even to cheat. There were far easier ways out. The plant in the container was real.

Black-clad E-Cats were mounted along both long sides of the container in neat rows of four. In the cold light of a fluorescent bulb in the container roof you could see all the wires and tubes from each device. On the front of each unit sat a yellow and a red valve, one for hydrogen and one for steam, and electrical connections. The steam-outlet tubes were all connected to a thick insulated tube running inside the container all the way to its short side. On the outside, the same pipe emerged saucily straight out one meter, with a big red handle on the main valve to release a fat one-megawatt jet of steam. One spot inside the container was empty, waiting for the E-Cat that we would test that evening and night in the little room where all the other tests had been performed.

Rossi laughed contentedly at my surprise. I asked if I could photograph it and he seemed to hesitate for a moment—maybe he just pretended to decide, to seem more spontaneous. "Yes," he said, with a smile. "The scoop is yours. No one else has photographed it." He knows exactly what he's doing, I thought, but I did not mind taking a series of images of the container, inside and out, with the 51 modules and all the details.

I assembled my instruments and agreed with Rossi and his technician Carlo Leonardi about how we would set up the measurements. After an hour we started and the hours continued with measurements and observations, with a short break just for a real pizza and a glass of cold beer—welcome when working with a device that produces steam on a late summer evening in southern Europe at close to 30 degrees Celsius ambient, outside.

The E-Cat that we tried was the new model that Rossi had developed in the spring and tested with Professor Christos Stremmenos in early July, after which he decided to discard the previous parts of the megawatt plant and start afresh with 52 units of the new type. When I reached Bologna, Rossi had just completed another thorough test of the device. Just one day earlier, NASA and the U.S. consortium with whom Rossi had signed a letter of intent had been on site with a team of scientists and representatives, including Michael Nelson, who had organized the meeting when Rossi visited NASA at Huntsville in July. They had been there to observe a test of Rossi's device—an approved test was a prerequisite for the contract to be completed. NASA also asked to inspect the megawatt plant to see that it was a securely designed system. Among the visitors was Craig Cassarino from Ampenergo, Jim Dunn, who had established contact with investors, and a representative from the Abu Dhabi funders. The delegation had been in Bologna for two days and according to Rossi had been present at a test that lasted several hours.

The special feature of the new model was that it could be run at intervals of about half an hour with self-sustained operation, without electrical energy input—just as Rossi had demonstrated to Stremmenos early in July. In this procedure, the electric cartridge used to launch and support the unknown reaction was then turned off, which should end the controversy about whether the E-Cat produced heat on its own, especially in a longer test, since total energy would be greater and the possibility of a hidden energy source would be smaller or non-existent. Rossi said that the American visitors had been very impressed. He explained that they had been standing with astonished faces when he finished the experiment with a little flourish. He had removed the water-supply hose and let the hot water remaining inside the device—about five gallons—flow out of the valve at the bottom. Since the water inside was still boiling, the effect was violent: a veritable fountain of steam and boiling water was ejected into a large barrel under the valve. After several hours of operation, most of the time without input energy, this was impressive.

Rossi said that NASA has given the system a 'pass' grade, so the last formal obstacle to the launch in October was overcome. The plan was to ship the container a week later. Once dockside in the U.S., NASA would make sure that it passed customs, citing national interests. Though the container housed basically empty metal cans, valves, hoses, cables and insulation, the entry of unspecified and unlabeled equipment could otherwise have become a significant problem that could entail lengthy delays.

In Bologna we performed essentially the same test as NASA, but considerably shorter. Already after the first half hour without energy input, we discontinued the test. The clock was approaching midnight, I had got up at four that morning, we were all tired and I thought I had enough data. Rossi finished by opening the fountain of water and steam, as he had done for NASA. We packed up and I took a taxi to the hotel.

Later that night when I went through the measurements I had done, I realized that it was a mistake to have stopped that early. It would have been valuable to have had a few more hours of operation but by then it was too late. The problem: when you measure a phenomenon and make changes, all other conditions should as far as possible remain the same from one test to the next. That way you can see the results of the change or changes. But Rossi was not a scientist but an engineer and his main goal was to constantly develop and improve the design. With constant changes in a new design, it is easy to err on what to measure and how it should be done, especially if you are rushed. I was a journalist, not a scientist. Additionally, I had to carry out measurements and document my findings from a journalistic point of view, simultaneously, which was not trivial. But this was my only opportunity. As long as no documented, independent measurements were made elsewhere, this was all I could base my reporting on.

The measurements I made gave no conclusive evidence of anything but they indicated that the device released substantial energy on its own, without external energy input. They provided an order-of-magnitude result but could not give precise answers. I thought of Piantelli and realized a little gloomily that I had not lived up to his ideals by reporting such uncertain results. I regretted it. I would be accused of supporting Rossi on uncertain grounds. Slightly dejected, I glanced out the window into the street, where people walked in the late summer night, pulled the curtain and slept for a few hours.

When my editor and I looked at the material we concluded that it was worth reporting. There was public interest, my test was news. In addition, nothing clearly indicated fraud. I couldn't report on the NASA test, however, partly because it was confidential but mostly because I simply didn't have confirmed information about it, only Rossi's word. A week after the test in Bologna we published a report of my test, including all data, images and a video of the container with the megawatt plant. Among other things, I wrote:

"In a kind of worst-case scenario, one can conclude that the output power, without external energy, was at least about 3.5 kilowatts. At most,

it may have been closer to 8 kilowatts. The conclusion is no scientific proof, but should be viewed as a summary of our observations."

The images and video were straight news. The test was more controversial and discussions took off quickly, both on our website and in international forums, while the readings soared.

It is fascinating to see knowledgeable people sink their teeth into published material that still feels relatively thorough to the author. Of course many opportunities present themselves to further develop reasoning and provide expertise in specialized areas. I received emails with interesting analyzes of my test data, far more sophisticated than I had been able to implement. Yet my material was obviously weak. As it was analyzed, I could only regret that I failed to take full advantage of the unique opportunity in Bologna.

Rossi had enabled me to make further measurements on the device and to make them public. I was relatively free to measure different things and many interested readers clamored for better test data. I largely missed the opportunity. I could have provided both critics and supporters with more relevant data that could have given clearer answers to many questions. It was a salutary lesson I would remember. Furthermore, I realized that the opportunity would not come again. Now NASA would deliver the crucial answers in October, I thought. Perhaps Uppsala could make progress. In September 2011, Professor Kullander had started to prepare for confirmatory tests at the Svedberg Laboratory in Uppsala, aiming at an accurate energy measurement on Rossi's behalf. For Rossi, it would be a success if a reputable institution in the Nobel Prize country could verify that the device worked and a feather in the cap for the Swedish group to get ahead of NASA. Could Rossi organize the test by Kullander? It all started to look like a race.

A different aspect now emerged. Though Rossi had said earlier that a consumer product had to wait a few years, he began to plan for such a launch in November, in Sweden, because four Swedish entrepreneurs who followed my reporting—two with Ph.D.s in particle physics—had decided to join in and make money on the E-Cat. They had formed the British company Hydrofusion as an operating base. Before summer they had reached out to both Defkalion and Rossi and had discussed various forms of commercial cooperation. Defkalion's response was cool. When Rossi in August terminated the agreement with Defkalion, he began to consider seriously the possibility of a first launch in Sweden, a cold country with a strong need for heating. Also the technology level and interest in new technology products were high.

Moreover, Rossi always had a soft spot for Sweden, since that summer he had spent at Lidingö when he was young. During the E-Cat's evolution he had also established a further connection to Sweden through my reporting and through the contact with the physicists Kullander and Essén. A month later, when I visited Bologna, he seemed to have become convinced about Sweden as a pilot market and claimed to be working closely with the Swedish entrepreneurs for a launch as early as November. It seemed slightly unrealistic and felt like an example of what Rossi's friend Guandalini said about Rossi—that he became carried away too easily by his enthusiasms. A key question remained: could the product be certified for consumer use? But in early September, the Swedish entrepreneurs had received a preliminary communication from the Swedish Radiation Safety Authority[48]. Basically, it said that certification should not be a matter for the authority because it was not nuclear fission—i.e. the nuclear reaction that occurs in conventional nuclear power plants—and because no radioactive substances were used or formed, nor did any radiation exceed statutory limits. The officer wrote:

"Based on the description you provided on your experimental apparatus, it constitutes in my opinion, not a nuclear technology activity as defined by the Act on Nuclear Technology

Activities, since energy production is not done through a nuclear fission process. (A plant for the production of nuclear energy as of the Act on Nuclear Technology Activities 2 § 1a requires a nuclear reactor). Further, no radioactive materials are used or produced, so the Radiation Protection Act is not applicable. (...) My conclusion is that the whole thing is not an issue for the Radiation Safety Authority to evaluate for a permit."

At that point you had to put the mandatory European CE mark on the product—a kind of guarantee that it met basic requirements regarding aspects such as safety, health and function, much like the 'UL' (Underwriters' Laboratory) mark in the U.S. To arrange for CE marking, Rossi had to develop a finished product, as soon as possible, that could be tested by a certifying body. I wondered if he could make it by November.

It turned out that certifying a consumer product based on the new energy source could not be rushed. Rossi’s prototypes also didn’t look like a finished product and lacked the features Defkalion had presented in its drawings of a consumer version at its news conference in June. Such design work could be implemented by external consultants but time still seemed very short to prepare finished drawings, have them adapted to industrial production and have time to start producing the first series of products. Production engineering is a difficult discipline. To create a finished product appeared on the other hand to have been Defkalion’s strongest card and maybe still was. So I again had reason to learn Defkalion’s intentions.

When Xanthoulis had called me in August and told me he knew what was in the reactor, he also said that he had no plans to use that know-ledge. But through other sources I knew that Defkalion, despite the broken contract with Rossi, continued to meet with companies from different countries interested in licensing agreements. The offer was the same: €40.5 million in license cost per plant to manufacture E-Cats, half payable upon signing the agreement. But now no royalties per manufactured product were required, possibly because Defkalion hardly planned to pay royalties to Rossi.

The message seemed to be that the Greeks were hoping to re-establish contact with Rossi but Defkalion believed also to be entitled to proceed on its own under the old agreement and claimed to have the knowledge to do it. Interestingly, Defkalion, in meetings with potential licensees, claimed to have the technology and offered to show it before the agreement was signed. Interested companies could bring their own experts to verify the operation of the device but must first deposit €500,000 in an escrow account to which Defkalion would have access if the result was positive and the visitors decided to proceed with the business relationship.

I did not know what to think. To recreate the technology should not be entirely unreasonable, presuming correct, critical information. If

Defkalion had succeeded, a race to world markets could be expected, perhaps with legal fights and lawsuits regarding licenses and technology rights. I could hardly believe that the Greeks could further develop the core technology without Rossi—his experience gained during the development seemed comprehensive and should be hard to beat. But initially they could make money out of what they had. If they had anything.

Or was it all a grand fraud? If so I had every reason to report what I knew as soon as possible. I contacted Defkalion about the offer to showcase the technology and wondered if I could be involved in such a test. The answer was that perhaps they might arrange it if I waited until early October. But I couldn't get official confirmation that Defkalion had the technology. At best I would have time to get some kind of proof before Rossi pressed the start button of the megawatt plant at NASA in late October—the test now emerging as the most crucial.

What I did not know was that the conditions were about to change radically again. Just a few days after my visit to Bologna, with barely a month left until the launch date in the U.S., Rossi had received the final contract via email from the American consortium. He explained to me that it contained a surprise that he found hard to accept. As planned, a total of $15 million should be transferred to an escrow account where Rossi would access the money only after a positive test of the plant. But according to Rossi the Americans now also demanded to know exactly how the E-Cat was designed before the test started. Officially, the reason was that no equipment could be brought into NASA if the design wasn't known in detail.

This was not impossible to understand. It was difficult for NASA to accept the risk of accidents or explosions, especially when testing a plant with a brand new and virtually unknown technology, brought into the country by an individual inventor. From this perspective it would be sensitive to

NASA if the equipment were cleared to enter and an accident occurred. There was also, in theory, the risk of a 'Trojan Horse,' in its original meaning from the legend of the Trojan War, when the Greeks after ten years of fruitless siege of Troy beat the Trojans by leaving the 'gift' of a large wooden horse outside city and then pretended to leave. The wooden horse was hollow and full of Greek soldiers; when the Trojans fell asleep after their ecstatic victory feast the soldiers crept out and attacked mercilessly. Correspondingly, damaging equipment could possibly hide inside Rossi's plant—a risk that in theory was unacceptable to NASA but should be manageable by placing the container in a safe place and examining it with various sensors. After all, it was not the interior of the whole container that was unknown, only the small spaces inside each E-Cat module.

What was different from the letter of intent signed in August, according to Rossi, was not only the requirement to have all the technical details before the test started. The Americans also wanted exclusive worldwide rights to the technology, without committing to manufacture any products or even really to pay. On the contrary, they wanted the right to unilaterally terminate the contract without specifying why, even after acquiring all the secrets. Rossi seemed perplexed. *"It looks like industrial espionage more than anything else. Or they're kidding me! Only a fool would sign such an agreement,"* he wrote to me.

Ironically, the situation was similar to what had happened when Rossi in the late 1970s turned down an American offer of $3.5 million for his patent on producing oil from organic waste because the Americans refused a requirement to build 200 plants within two months. Now, just as then, Rossi decided not to sign and blocked the shipping of the plant. This was a critical situation if he wanted to fulfill the promise to demonstrate the plant in October. I wondered if the Americans had expected just that, and maybe tried the same tactic that Rossi guessed that the Greeks had attempted: assume that Rossi would make major concessions when he was hard pressed by his own deadline.

Again, Rossi seemed to see opportunities in Sweden as a solution to the problem. If he could organize an accurate energy measurement at the Svedberg Laboratory in Uppsala, quickly, and thus could get credible, independent confirmation that the technology worked, produced heat and was based on a nuclear reaction, the test of the megawatt plant would be less important. In principle, he could then test the plant himself in Bologna, or possibly in Sweden if his Swedish contacts could find a suitable partner. Moving a container through Europe took only one day and was a minor problem. I was again reminded that the whole idea to impress with a really big plant in a way looked like a legacy from his time with Petroldragon, when a high-capacity system was the only way to prove that the technology to produce oil from organic waste was practical and commercially viable on a large scale.

For the E-Cat, the situation was different. The technology itself was so special and groundbreaking that clear validation of a single module was sufficiently sensational. Furthermore, scalability did not necessarily mean large installations. Even a smaller module was an attractive product because it could power one or two households or, over time, be used in vehicles. Scaling simply required multiplying modules. The large plant consisted, moreover, of small modules. So clear, credible results from testing a single E-Cat would be as valuable as the launch of the megawatt plant, perhaps even more important, though it would generate less media exposure than a test of the big plant at NASA, especially in the U.S. But no immediate revenue.

Yet Rossi seemed intent on performing the Uppsala test within weeks. It seemed possible. Professor Kullander, in charge, had already started to form the necessary organization and the Svedberg Laboratory had a plan for an experimental setup that could remove all doubt about the energy measurement. At that point it looked as if the test could be implemented as early as mid-October. Rossi said that he had already tried a similar setup in Bologna with good results. The energy output levels he had measured with the electric cartridge heater switched off were, he said, near the values I had previously calculated from far less certain data, but the method was now more precise so the result should be more reliable.

But Rossi wouldn't settle for the Uppsala test. Suddenly I got an invitation from Giuseppe Levi at the University of Bologna to participate in a new test on October 6, with invited scientists from around the world. The basic idea of the test was the same as proposed for Uppsala—water would still be boiled by the E-Cat but to avoid discussions about steam quality the steam would heat water in a heat exchanger—a box with a bunch of small channels where the steam is cooled while another fluid, ordinary tap water in this case, is heated as it flows in the other channels adjacent to the steam. Measuring how much the water was warmed after passing through the heat exchanger would deliver a definitive answer as to how much energy the steam had brought from the E-Cat, regardless of steam quality. Levi also wrote that the test would last more than twelve hours, which sounded promising. It should leave little room for doubt.

Rossi was still in Miami, organizing the manufacturing of additional parts for the megawatt plant. He claimed that a motive to undertake the new test was drawing attention from what was planned in Uppsala and that he wanted to silence his critics and skeptics permanently. But it was probably just as much a publicity opportunity, among other things to make new contacts. And it brought Rossi a contact that later became crucially important for his business.

As before, the intention was that the test would remain confidential until it was implemented but soon the plans leaked out because one or more of the invitees revealed them online. Soon the discussion was in full swing. I received many emails with tips and questions, and many views on what should be done, and how. This time, expectations were high. Finally Rossi would undertake a proper, precise test with high scientific integrity. Finally, independent scientists could verify whether the device was producing heat through a new kind of nuclear reaction. Finally, there would be an end to the discussions. Those who thought or hoped that this might be the outcome were mistaken. I was, too.

46. http://newenergytimes.com/v2/news/2011/
47. http://news.newenergytimes.net/2011/08/ the-scientific-verdict/
48. Svenska StrσlsΣkerhetsmyndigheten

CHAPTER 14

The test that was not decisive

Two days before the test I flew from Stockholm to Milan with my family. We planned to visit my in-laws outside Milan and enjoy Italy's late-summer heat while the autumn chills came crawling back, home in Sweden. As soon as we landed we felt the mild evening air embrace us on the aircraft steps—always pleasant. We picked up our car and entered the ever-dense traffic around Milan, heading for the small town of Vigevano. The next morning we took a short walk down to the beautiful *Piazza Ducale*, built in the late 1400s—a charmingly livable space in the middle of an otherwise quite ordinary and relatively modern Italian city. It was nice to walk around in light summer clothes, take a *caffè* in the Piazza, stroll a little and enjoy the warmth.

This particular day it was also liberating to relax completely, isolated from thoughts of Rossi and his apparatus that had for months occupied more and more of my everyday life and thoughts. Lunch in the sun, fun with the kids and dinner at my in-laws. Perfect. Yet I could not relax entirely—in an email that evening I received a good tip on temperature measurement and realized that I had to procure my own handheld thermometer to bring to Bologna. I would have to buy it in Vigevano. In Stockholm, I knew exactly where to buy one but it was harder in small Vigevano. When I had given up on finding a lab thermometer, I discovered a digital kitchen thermometer after much searching—in a kitchen store in the house where my in-laws lived. "Right in front of you, where you never search," I thought.

When I left for Bologna early the next morning it was still dark outside and the dense morning fog slowed the traffic already in full swing on the small roads. However, at dawn the fog lifted as I drove onto the *autostrada* and then it didn't take long to reach Bologna, despite the intense traffic.

Upon arrival I was met by Rossi, energetic as usual, who welcomed me with a firm handshake. The industrial premises were nicely cleaned-up and in one corner, next to the container with the megawatt plant, was a staffed bar laid out with breakfast in good Italian style—croissants, small pastries, fruit juices and espresso coffee. In Italy, I thought, there is always excellent food, even when going to an industrial building to make measurements on an innovative water kettle, in the midst of all sorts of wires and tubes.

Rossi had asked me to come half an hour before the other invitees and to bring my measuring instruments. I had understood that it was because he wanted to avoid the situation in which all the guests brought their own instruments, since it could have become chaotic. He wanted instead, I believed, to handle matters cleanly and simply, with my instruments in addition to his own. Gradually I began to realize that Rossi was assuming that I would take care of the entire measurement process, something I had not anticipated. Rossi had said that the test itself would be controlled by researchers from the University of Bologna who had sent out the invitation and that they would use their own equipment. Now I realized that they had a passive role and could not even speak, since the planned research collaboration with Rossi had not yet formally started. I had also thought that Rossi would record the important temperature values of the water flowing through the heat exchanger, on a computer or at least electronically in the instruments, for subsequent analysis. Suddenly I realized that the only difference from previous tests was the heat exchanger, and that if values were to be measured and recorded I had to do the work. By hand.

I was disappointed but still hoped that Rossi would someday pull himself together and have proper measurements made. Not this time, I thought, and began to focus on the measurements—I had to roll my sleeves up and get to work. While the guests began to arrive I laid out my tools and prepared as best as I could. The atmosphere was relaxed and quite positive and after an initial presentation by Rossi we started the same procedures as in previous tests—filling hydrogen gas into the device, weighing the hydrogen bottle before and after, and checking all connections. This time, also, the E-Cat was weighed, somewhat amateurishly, with a bathroom scale, as the precision scales could not cope with its over-all weight of over 200 pounds. The idea was to show that it didn't lose weight during the test, so there could not be fuel inside that was consumed to produce heat. Soon the water hoses were connected and Rossi started the E-Cat by gradually increasing the power to the electric heater cartridge.

Startup took significantly longer than usual—almost four hours—and while I went back and forth to take notes on measurement values at regular intervals I had time to talk to those present. On site were, among others, the Swedes from Hydrofusion. They did not seem particularly worried, though they had already invested considerable time and money in the project. They knew that risks were involved but they were convinced that Rossi's technology worked and had enjoyed the comments and speculation on the Internet. Many people had the most fantastic theories about most things, with little confirmed information, and discussions flared up quickly on details in various online forums. The Swedes contributed to the situation by occasionally posting videos, without comment, on the site Ecat.com—a domain name they had purchased early. But they only showed one video at a time, against a black background. Apart from that it was completely anonymous and many wondered who was behind it.

On site in Bologna was also Roland Pettersson, who had met Rossi when he had visited Uppsala in February 2011. Pettersson was a retired Senior Lecturer in Physical and Analytical Chemistry at Uppsala University and a friend of Sven Kullander. He had conducted research on cold fusion with Hidetsugu Ikegami. He followed my measurements with great interest as we discussed various ideas about the experiment. It became clear that he had quite a good understanding of the process within the device and even far-reaching theories about how it all worked from a physics standpoint.

That was no coincidence. Pettersson based his ideas on Ikegami's theories, the basis for their joint research. The results of that research had inspired Rossi to make changes in the reactor in February 2011 and he was influenced increasingly by Ikegami's theoretical explanation of the phenomenon. Ikegami had started to sketch his theories in the late 1990s. He had retired after a successful career as a researcher in nuclear physics, mainly at Osaka University in Japan. Among other things, he created one of the world's largest 'ring' cyclotrons—used by nuclear physicists to accelerate core particles to nearly the speed of light, let them collide and then draw conclusions about new particles created at the collision. A similar process is used by CERN in the Large Hadron Collider, in Switzerland, the world's largest and highest-energy particle accelerator, to explore the Higgs boson and other elementary particles.

From the mid-1980s Ikegami also had a connection with Uppsala. He had conducted research there with Sven Kullander, collaborated with Bo Höistad and had been awarded an honorary doctorate by the University of Uppsala. About the end of the 1990s he started to think about cold fusion, similar to the concept Fleischmann and Pons had presented. Fleischmann and Pons had used a rod of palladium in which they imagined that the nuclei of heavy hydrogen—deuterium—were packed so tightly that they finally fused into helium. They imagined a fusion reaction similar to the one in the sun, which released a lot of energy, though not at tens of millions of degrees as in the sun, but practically at room temperature. Ikegami wanted instead to shoot the deuterium nuclei against molten lithium metal. In the lithium melt it would be so difficult for the deuterium nuclei to move that they would more probably participate in a kind of fusion with lithium, which should lead to helium and release energy (see appendix on nuclear reactions). Ikegami proposed the experiment to Kullander in the fall of 1999 and sought someone who could help him with the practical setup. They contacted Pettersson, known for his skill in designing experimental equipment—everything from work on the lathe and milling machine to glass blowing—but who had ended up as director of studies, a position in which he did not thrive.

"I was really tired of the paperwork. I was losing my mind. Then Ike came to see me. He needed a melt of lithium in a glass cup and also needed to produce electrical discharges. He needed a fixer and a discussion partner. I was a practical guy and had built a vacuum system he could use. You could say that I was picked up, and I was very happy for that," Pettersson told me.

Ikegami and Pettersson received a half million Swedish kronor, about $70,000, in research grants from the Swedish Energy Agency. Lars Tegnér was the program officer for the project and they began the experiments. The results were largely successful and supported Ikegami's theory. Among other things, they showed that nothing happened while lithium was solid but started when it began to melt, at 180 degrees Celsius. The first report came in 2002 and a final report was published by the Agency in 2006 with the name *Ultradense Nuclear Fusion In Metallic Lithium Liquid*.[49] The summary stated:

"As stated in the reports, a number of positive events have been registered. Given the importance this type of results may have on the world's future energy supply, it is of course of paramount importance to have unambiguous results. Therefore further measurements are required which can demonstrate the reproducibility and through which one can find the optimal configuration for energy yield in this

type of reactions.”

But the report gained little attention. When the results were presented at the Swedish Academy of Engineering Sciences, IVA, skepticism was great. As usual with cold fusion, the difficulty of repeating the experiments contributed. Moreover, the theory was an unusual, unorthodox combination of chemistry and nuclear physics, though in line with what many had noted in cold fusion: an elusive phenomenon that required expertise from several different areas.

“The theory is one of the few that can provide any kind of explanation. Ikegami has a tremendous intuition and very strong knowledge of physics and chemistry. But he is not an experienced theoretician—he is doing great leaps between different areas and concepts, and many find it difficult to get to the heart of his theories. But if what he is basing his findings on is real, then it will be very interesting,” Kullander said later when plans were being made to have a new look at

Ikegami's and Pettersson's experiments.

The advantage of Ikegami's theory was also that it did not require revolutionary rewrite of established physical models but rather described possible phenomena in unexplored areas on the borderline between different branches of physics and chemistry.

Co-author of the report from the Energy Agency was Kjell Fransson, research engineer in nuclear physics at the Svedberg Laboratory, along with Toru Watanabe, head of development at the Japanese company *Sakaguchi*, which funded a parallel part of the project in Japan. The idea was that further experiments should be done with funding from Sakaguchi but an economic downturn ended this effort. Earlier, Sakaguchi had had plenty of money and, according to Pettersson, had supplied prestigious technology, far from its business origin with electric irons in the 1920s.

"Once when I was there they said 'go into the next room' and when I came in I saw a model of the nose cone to the U.S. Space Shuttle. The company delivered the heat shield for the nose cone! But that was confidential," said Pettersson.

With saved funding from the Energy Agency, Pettersson and Ikegami could perform one more experiment in 2009 in Japan. They found one of the problems was that the surface of the liquid lithium was covered in just three minutes by oxidation, though almost no air remained in the powerful vacuum they used. When the surface was covered, the reaction stopped. The atoms of lithium, the third lightest element in the universe after hydrogen and helium, are so small that in liquid form they penetrate almost anything and react with everything—they even eat glass. Pettersson and Ikegami concluded that they needed to embed the lithium in a different material to keep it clean and Pettersson started thinking about this when he visited Rossi in Bologna. Possibly lithium could be one of the elements Rossi added as a catalyst. With a little lithium embedded in the nickel powder, the conditions could favor the reaction with which he and Ikegami had experimented. That lithium in liquid form was required in Ikegami’s and Pettersson’s experiment tallied well with Rossi’s reactor having to be heated for the reaction to start. I talked to Pettersson about these thoughts and began to understand his curiosity and interest in Rossi’s technology.

Another Swedish piece of the puzzle that appeared was the Swedish Volvo Group—the division that built trucks and was still Swedish-owned. A Volvo employee had learned of Rossi’s technology even before I started reporting on it and through my articles the interest had increased. The matter was raised at management level in the division’s Powertrain activity, which builds truck engines and transmissions. They had already had initial contact with Rossi and now one of Volvo’s representatives was in Bologna. Soon he talked with the Swedish Hydrofusion people and with Roland Pettersson.

Rossi had previously hinted that he hoped to engage Volvo to host the test of the megawatt plant, now that the collaboration with NASA and the U.S. consortium had collapsed. So I was curious to talk to Volvo's representative. When I did, I realized how Rossi tended to whitewash his business opportunities. I guessed that if he did so he probably also believed in it himself, much as Guandalini had described to me. It corresponded well with the slightly more nuanced picture of Rossi I was getting. Like most inventors and innovators, he was apparently driven by strong conviction about what he developed, so much so that he in some degree tended to modify reality. It was typical because it was also a way to cope with the laborious process of breaking new ground and developing innovations that few had even approached.

I understood from Volvo's representative that the company was cautious in its relationship with Rossi and wanted a degree of certainty before taking decisive steps towards collaboration. It seemed reasonable but differed from the picture

Rossi had given me. On the other hand, it was also reasonable of Volvo to express the matter conservatively, talking to a journalist.

Along with the talks between the Swedes, similar low-key discussions were held among the invitees in the industrial premises. Later, Rossi told me that one attendee was an American professor who had come independently, uninvited. Rossi had welcomed him kindly, from pure intuition, while not admitting other curious individuals who had shown up. Probably it was a fluke since this uninvited guest later catalyzed one of Rossi's most important collaborations.

Meanwhile a lunch had been served at the bar with a simple but tasty pasta, sliced *prosciutto di Parma* with arugula salad and various other snacks, and of course wine of different varieties for those who wanted it. I chose a glass of *prosecco*. But the mood was cautious, especially because of the long boot time. In practice, everything suggested that the device did not produce more energy than input through the electric heater and there was curiosity about what Rossi was doing and if he had encountered any problems. As we discussed this, Rossi described an incident from the night before. He said they had driven the E-Cat harder than usual and suddenly lost control of the reaction. He had immediately eased the hydrogen pressure—the way he normally slowed the reaction. He had also maximized cooling-water flow, yet the water in the device kept boiling violently. He eventually asked attendees to leave, including the radiation-protection expert David Bianchini and the technician Carlo Leonardi, while remaining himself in the small room. The significant heat generation had continued further for a while, and the risk was high for a burst through the high pressure inside the reactor, but the reaction had eventually slowed.

The testimony from Bianchini and Leonardi was important. It was the first time someone other than Rossi himself told me about how the reaction surged, another sign that the technology was real and based on a nuclear reaction. Hardly anything else could behave that way. I wondered if the reactor could have been damaged and wasn't working as it should. But Rossi was adamant and said that he was using only one of three reactors that he claimed were inside the device. He said he intended to turn off the electricity supply entirely and run really long in the desirable and important self-sustained mode, which required perfect stability. And stability would be easier to achieve with only one reactor activated.

The reactors would not have suffered but the seal of the box that held the boiling water had been destroyed by the incident. Rossi had not had time to redo the seal properly, which was apparent since hot water started to drip from the device. For an hour the water was collected in a bucket under the table where the apparatus stood and simmered—this signified a real demonstration since a faked test would hardly have been staged with leaking equipment.

Shortly after I had been told about the incident Rossi explained that he was pleased with the stability and turned off the electric heater cartridge. The device was now running independently. It seemed promising but I soon realized that questions remained. I did not think that the temperatures I saw on the instruments matched what I felt with my fingers outside the water hoses and took out my kitchen thermometer to make a control measurement. It still didn't tally, but on the other hand error sources could explain this, not only because my thermometer seemed to differ in calibration from Rossi's but also because I had to measure at the hose outlet, 30 feet from the heat exchanger.

I discussed aspects of the temperature measurement with Rossi and some of the researchers but I did not become any the wiser. But we identified details that would later be discussed after the test and they would show once again that Rossi had difficulties taking seriously the requirements of how a proper test should be performed. He didn't seem as though he wanted to hide anything but was rather so convinced that the E-Cat was working correctly that he had difficulty understanding the expectations of clear data and carefully prepared demonstrations.

The test was continued into the balmy late-summer evening, with the gates to the premises wide open. I continued to note the measurements and was interviewed by Italian media. Once again I found myself with multiple, parallel roles—journalist, measurement engineer and interviewee. No matter what my role, it was reassuring to note that the device continued in self-sustained mode and I was hoping that Rossi would let it run for at least five or six hours. But after nearly four hours he wanted to stop, to have time to open the E-Cat casing before everyone left, as he had promised. He released the hydrogen and increased the cooling-water flow, and it was interesting to see how thermal energy continued to be released unabated after several hours of self-sustained operation.

This observation, not the measurements themselves, convinced me that the test was successful when I sat down to write my report later that night. It was impressive that after nearly four hours in self-sustained mode, the device was still very hot outside, despite the insulation, and that it still boiled unabated inside despite new cooling water being pumped in continuously. It couldn’t be explained with anything but a reaction with an intense heat release inside. I realized how hard it can be to believe in an unknown phenomenon despite the evidence of one’s eyes. For well-known phenomena, simple proof is enough. But with the unlikely and unknown, even strong evidence is not acceptable as obvious and sufficient. The brain resists, rejects the new. Now, if Rossi’s technology were proved and become widely accepted in a few years, I imagined on the other hand that people would look back and marvel at how difficult it was for Rossi and others to draw attention to the phenomenon he was working with, as difficult as it had been for people to believe that the Wright brothers had flown with their aircraft before it was an accepted truth.

Andrea Rossi during the test on October 6, 2011, in Bologna. In the background is the second version of the E-Cat, with a large reservoir where the water is heated. Photo: Mats Lewan

When the E-Cat had finally cooled, Rossi opened the insulation around the heat exchanger and showed where the temperature sensors were positioned—the chosen position would later be discussed intensely since the sensor measuring the output water temperature was fairly close to where the hot steam entered the heat exchanger and heat transfer might influence the measured value. He then opened the cover of the E-Cat to show what was inside—a big block with cooling fins. The block was not opened, but Rossi said that it contained a thick shielding layer of lead, encapsulating the small reactors with the nickel powder, catalysts and hydrogen inside.

At almost midnight the guests began to depart into the warm late summer night. I stayed a little longer, took a few extra pictures, gathered my instruments and talked for a while with Rossi. The test had been shorter than I had hoped, it was worse prepared than I had expected, yet it seemed successful on the whole.

In the middle of the night I checked into my hotel nearby and immediately began compiling the readings. It was late but because the test this time was known in advance the expectations of a report were high. I was the only one with the measurement values and the next day was Friday. A report could not wait until Monday so I had to go to work. This time I had at least not made crucial mistakes. The shortcomings of the arrangement were obvious—the thermometers should have been calibrated better, the position of the temperature probes should have been discussed and tested in advance, all data should have been recorded electronically—but I had no part in this. I had not even been prepared for my role as responsible for collecting data. If I hadn't picked up pen and paper there would probably not even have been any data. I sat for a few hours with the data compilation, then began to write my article for *Ny Teknik*, in Swedish and English. Meantime, I uploaded videos to the editors. The measured values indicated a clear heat production from the reaction, though I stayed conservatively on the low side to compensate for the uncertain temperature measurements. Again, it was the long operating time in self-sustained mode, without the slightest sign of waning heat, that had made the strongest impression on me.

At dawn I was finished and had time to rest for an hour before I was awakened by the mobile I had forgotten to switch off. By then our web TV editor had cut the videos and a friend of mine had been looking over my English translation. Everything was ready for publication and I went down to breakfast, slightly dizzy from lack of sleep. Outside, a thunderstorm passed that would lower the temperature by ten degrees Celsius in just a few hours. The sun came out soon after the storm and though it felt chilly, briefly, it did not take long before it was pleasantly warm again. When I was halfway back to Vigevano I was told that my articles were live on our site. Now I needed to relax for a while and when I arrived I lay down and fell asleep in an instant.

§

The next day we took it easy in the morning and went down again to the piazza for a *cappuccino* in the morning sun that still warmed us pleasantly, though it was now a few degrees cooler. Eventually we got into the car and went off to visit relatives in Parma—halfway back to Bologna. I had planned to relax from work with Rossi and his technology a few days but it soon proved impossible. The comments below the article on our website were pouring in and many seemed to demand an answer. The criticism was, as usual, intense and this time also justified—the test could and should have been prepared thoroughly, but I had no control over this. Measurement uncertainty was also evident, already revealed in my report. This time I also got a lot of emails with detailed questions about the measurements. Among other things some people, even more than before, began to make advanced calculations from the data that we had published, to try to refine the analysis.

I sat at my laptop for hours that day, responding to questions and comments, and the in midst of it all another interesting element appeared in the discussions: Rossi's former partner in Greece, Defkalion Green Technologies, had made a statement on its website. Defkalion criticized Rossi's tests, claiming that he was using equipment that Defkalion had developed and stating that the company now had its own core technology based on improvements of "Rossi's invention and similar inventions."

Professor Christos Stremmenos, who had established the contacts between Rossi and Greece and was formally still Director of Research and Development at Defkalion, wrote an open letter in Italian shortly thereafter, harshly criticizing the company, and sent it to me and blogger Daniele Passerini. I was not surprised because during the Bologna test I had asked Stremmenos about the Greeks' role. He had stated briefly that Defkalion behaved fraudulently and that he hadn't talked with the company for three months. That the company really was committing a fraud was one of my hypotheses. But to give Defkalion a chance to defend itself, I sent a translation of the letter to the company and soon received a restrained but carefully expressed response from the company chairman, Alexandros Xanthoulis—an open letter to Stremmenos. Xanthoulis stressed that Stremmenos was not in a position to criticize Defkalion because he still had a formal role as a board member and R&D manager, and that Stremmenos could not know what Defkalion really had developed since he had been absent since June.

I continued to wonder what Defkalion could be doing, if it really could have developed a proprietary technology, if the technology was a copy of Rossi's, was its own proprietary version, or was simply a large-scale fraud. I still had no idea. Defkalion's gambit was only the beginning of what would come up in connection with my report on the most recent test.

Back in Stockholm I received an email from Jim Dunn, who had assembled the American consortium with Rossi and his U.S. partner Ampenergo, which had led to the agreement in which NASA had been involved. Like many others, Dunn asked me many questions, to assess the uncertainty in the measurements I had made in Bologna. I answered the questions and soon found myself in the middle of an email exchange between several involved people from different organizations who openly shared their thoughts on what had happened so far. I received confirmation of the agreement Rossi had mentioned previously but, apart from that, several things differed from Rossi's version. The test carried out the day before I arrived in Bologna in early September, with representatives of NASA and the U.S. investor, which Rossi had described as a success, had—according to the Americans—been a minor disaster. First, they felt that he had changed the test protocol by failing to implement a 'control' run: operate the E-Cat without hydrogen and use helium gas instead. With helium the process should not work and if an active run with hydrogen produced more energy than an identical run with helium this would in itself be enough to prove that the device worked. Much later, I would understand that it was not so easy because the process—if it existed—needed such minute amounts of hydrogen gas that mere traces remaining in the nickel powder were enough to make it work a little. And it was difficult to purge the hydrogen gas completely, once loaded. One would have to build a new, completely clean reactor to make a valid control run.

The second problem for the Americans was that Rossi, unanticipated, had used the new model—the large, water-filled box he had tested with Stremmenos in early July the same year and had showed me the day after the Americans had left. When the test started the E-Cat had also seemed not to work properly. According to the Americans, Rossi had refused to admit these problems and eventually the situation had become troublesome when Rossi stubbornly claimed that everything went well and simultaneously behaved badly towards the guests.

I imagined a pressed Rossi, convinced about his technology, unable to accept other people's views on how it should be verified and demonstrated. I wondered whether he could have let the test fail on purpose, more or less deliberately, to dispose of a partner whom for some reason he did not trust. I knew that he was suspicious of anyone who wanted to collaborate with him or evaluate his technology. He was constantly on guard and I felt that he could tend to suspect such people of being spies or imposters, rather than trusting them, thus risking disclosing too much and being cheated. I would return to this thought on several similar occasions and when I later asked him about this he replied, after a moment's reflection: "It's not impossible."

On one hand the suspicion seemed to make it difficult for him to gain the collaboration he needed. On the other hand, I realized that with such a potentially revolutionary technology he had good reason to be wary. I reminded myself that he seemed to have strong intuition that he always relied on, both in terms of technology and people.

Regardless of what lay behind Rossi's behavior and the problems in the test with the Americans, it had all apparently become so uncomfortable the next day that when the guests returned to the test premises they finally decided to leave. But because the investors were convinced that the technology was interesting and had heard of similar research by Professor Piantelli, they decided quickly to arrange a meeting with Piantelli in Siena, on the way to Rome for their return flight. The group stayed in Siena for a few days and it all ended with an agreement drawn up with Piantelli and Nichenergy that was tied to his research. The plan was to rapidly increase the pace of his research. Apparently Piantelli had run experiments with self-sustained operation for hundreds of days but the released energy was significantly less than in Rossi's experiments, though higher than in many other cold-fusion experiments. The agreement was important, yet Rossi's technology seemed the most promising.

In addition to describing how the visit had played out, the Americans also gave a different picture than Rossi of why the agreement had been cancelled. Basically, the investors had a negative perception of Rossi based on his behavior. The Americans denied that any surprising details had been incorporated in the final draft or that there was any requirement to disclose the design before it was paid for—which Rossi had said was a reason for not going ahead. Possibly Rossi's interest had cooled when NASA had made clear that it was not possible to test the megawatt plant in a few days but that it would need to remain on site for several months. Rossi could not yet accept leaving his devices in someone else's hands without being present at all times. It was due partly to the risk of an accident but also reflected his fear that someone would open the device, analyze it and reverse-engineer the design, perhaps a legitimate concern.

Nevertheless, the agreement with the Americans could still have been saved until Rossi, on his blog, stated that he would start selling consumer products in November, ironically the same day that the Americans were preparing a response to him. The investors assumed that Rossi had found a new partner, which in a way he had, with the Swedes at Hydrofusion, and decided to end negotiations. I learned of the great disappointment among the U.S. investors. They were disappointed that Rossi had torn up a contract worth $150 million and lost the opportunity to be celebrated as the inventor of the technology. They also felt that he had stubbornly refused to listen to what was expected of him—a simple approach to implementing an elegant and convincing test. They discussed the matter with me because I was someone to whom Rossi possibly listened. They still wanted to get Rossi on board again and NASA confirmed its interest in evaluating Rossi's technology as potentially one of the most promising in LENR, an area in which NASA was making determined efforts.

Perhaps the most striking effect was that everyone seemed to want to save Rossi from himself—ironically, about what Defkalion's president

Xanthoulis had expressed when I had spoken to him shortly after Rossi's statement that he had cancelled the agreement with the Greeks. Everyone involved seemed to believe that Rossi's technology probably worked, that Rossi had made decisive contributions in the field and that he had reached further than anyone else. But they also noted that he was difficult to work with and was not ready to listen to what others expected of him. He also seemed to have difficulty delegating responsibility for parts of the work that others could manage better. As the discussions continued, a plan developed on how Rossi could perform a proper state-of-the-art test, managed by a reputed institution. This was what I had hoped for with the planned test in Uppsala—neutral, irrefutable verification from the renowned Svedberg Lab that the device produced so much net energy that it had to be a nuclear reaction. This would end all the discussions and recognize Rossi's technology definitively… if it worked.

But Rossi had postponed the test in Uppsala at the last minute, to give himself time to solve some minor problems that would enable him to get the megawatt plant ready on time. The Americans, on the other hand, did not know that the Uppsala test was planned or had been postponed. They concluded that a rigorous test should be performed prior to, or at the latest in connection with, the test of the megawatt system. They were convinced that the large plant was unlikely to work and was even dangerous, as designed. NASA had even stated in September that it would never be approved for NASA evaluation by the security officers.

But if a small, strategically crucial test should be carried out simultaneously with the big test, time was a crucial factor. Just days before, Rossi had announced that the megawatt plant would be tested on October 28. He stated that a client was willing to buy the plant if it worked as advertised, according to criteria in the agreement. He did not reveal the client but hinted about a specific category, leading me to conclude that it was a military organization. Rossi stressed that the client would use the plant only for producing energy.

I was as uncertain as the Americans whether the plant would work, particularly if it was possible to measure accurately how much net energy it produced. But this time I was at least sure that I would not be responsible for taking measurements because Rossi's customer had to have its own inspectors on site to verify that the plant met the contract terms or the purchase wouldn't be concluded. The deal was important for Rossi, who now claimed to have expended his last financial resources. But it was also a matter of prestige: Rossi had promised to put the famous plant in operation in October and now couldn't back down. The Americans were worried about this. They suspected that the customer could be a secret intermediary, intending to sell the 102 included E-Cats, for example to Defkalion or to some unknown player in China. Then there were the consequences of a failed test.

Rossi assured me that his client could not conceivably re-sell the plant, reinforcing my suspicion that it was a military organization. But there was no guarantee of a successful test, though Rossi said he would energize the plant, incrementally, before October 28, and that he was prepared to postpone the test if he was not sure it worked.

A failed test would be a significant loss of prestige for Rossi and would scare off investors. This was the Americans' concerns. But if a convincing test of a single module could be implemented simultaneously, focus could move from failure of the large plant. Instead, definitive proof that the technology itself worked could be highlighted. The problems with the large plant could then be regarded as a minor technical detail that could soon be resolved.

Another thing that the Americans noticed was that the competition seemed to be increasing. They wondered, as I did, what Defkalion was doing and had received signals that the Greeks planned some kind of launch to beat Rossi. If Defkalion had a mature, functioning product almost ready for launch, a failure would be fatal to Rossi, regardless of who had the rights to the technology. Defkalion also seemed to have asked Piantelli to collaborate. From this perspective, the Americans were at least happy to have been the first to sign an agreement with him.

Beyond Piantelli and Defkalion other researchers and companies in LENR were active, including the U.S. firm Brillouin Energy, founded in 2009, whose founder Robert Godes had been working on the technology since 1992. Brillouin Energy was also working with nickel and hydrogen, and six months later Godes would state that the process was the same as Rossi's, Defkalion's and Piantelli's. In addition, he stressed that nickel was not the fuel but was a catalyst, congruent with Ikegami's and Pettersson's conclusions.

In addition to researchers and companies working openly with similar technologies, other projects were proceeding privately. Time seemed to have come for the new type of energy source and a standard thesis in the history of technology is that pioneering inventions usually show up in several places simultaneously, in different places and independently. A classic example is the telephone. Typically Alexander Graham Bell is called the inventor, with his 1876 patent, but many believe that the Italian Antonio Meucci was actually first with his *telettrofono* and a prior patent application he could not afford to pay for. Furthermore, American Elisha Gray had also filed a patent application just hours after Bell and several other inventors had been working on similar ideas for a couple of decades.

All this made me see Rossi's situation in a new light. I understood that he was not all that easy to work with. He had broken abruptly with two business partners who both seemed to have a credible plan to verify and industrialize the technology and to develop finished products. Meanwhile, he refused stubbornly to listen to what the world expected of him. Even if this behavior correlated well with other inventors, it looked bleak for Rossi. Indeed, many authors of many groundbreaking inventions were never rewarded for their efforts during their lifetimes.

Rossi could be left behind if anyone could master the technology and reach out with mature products before him. He would then have far less return for his work than the $150 million he was offered by the Americans, if any return at all, probably not even recognition of his potential contribution to science. But Rossi didn't seem to worry much about competition. "They are on the wrong path. I still have not seen anyone who has really understood anything. And frankly, it is clear that we do our best to deceive," he told me.

At *Ny Teknik* we published a new article in which I described three thorough analyses of my data from the test in October by three independent individuals, through significant efforts. Two indicated a clear net energy while the third left the question open. At the end of the article I mentioned what both our readers and all others expressed: the need for a rigorously conducted experiment. [50] But Rossi would not listen. He was now focused on testing the megawatt plant and did not want to talk about any other tests. He was convinced that those other tests could never lead to anything anyway and said that there always seemed to be something to question. The idea that it could be the audience and the world that needed to determine what was a sufficiently well-conducted demonstration did not seem to strike him. If the big test went well and he sold the plant to the yet unknown customer, he was still set to perform the test in Uppsala later and I tried to at least help make it happen as soon as possible.

The engineer Domenico Fioravanti had now entered the plot. On behalf of Rossi's potential customer he was to monitor the test of the megawatt plant. Later he described Rossi's situation at this time:

"The Rossi I personally contacted in mid-2011 was in contrast to his public statements a 'one-man band' who fought to publicly demonstrate what he was already extremely convinced about. He had no doubts and you could see this from his frenetic activity, from the amount of money he had invested in the project, and from a number of trivial design flaws that forced him to continually modify his prototypes and spend a lot of money and, most importantly, lots of working hours. He had not given and did not give the time to expand on a wide range of banal technical aspects or do market research to find the right component that would have allowed him to avoid embarrassment. His method was to mount, test, make mistakes, correct and start over. All this was done under pressure from the media, while he was also in financial difficulties caused by the non-payment of the first installment under the agreement with the Greeks, which in turn prevented him from paying for the commitments he had made, for example with the University of

Bologna. The comments that followed were poisonous and all negative, since the non-payment [to the University of Bologna] 'proved,' according to the general twisted mentality, that he was an impostor."

Meanwhile, Defkalion remained a center of attention. In my last article I mentioned that the Greeks, as reported to me independently, were still offering licenses to manufacture and distribute E-Cats at €40.5 million and were offering to let interested companies come and verify the technology with their own instruments against a payment of €500,000. Defkalion immediately contacted me and confirmed the information but pointed out that the €500,000 would be refunded if the customer was not satisfied and decided not to proceed. I updated the article with the confirmation and soon received a surprising email showing that NASA was interested. Shortly thereafter I got a request from the Americans for Defkalion contact details. The following day, October 24, 2011, I received a copy of their email to Defkalion, expressing interest in coming to Greece to validate the technology. I had also been told that if Rossi's technology could really be verified by researchers at Uppsala, both Volvo and the Swedish-Swiss energy company ABB were interested in a substantial investment. Add the sales collaboration with Hydrofusion. It all felt surreal. The general public still knew nothing about the new energy technology yet established organizations had already begun to take interest and to prepare for large investments.

A few days before October 28, I called Rossi in the evening to ask how it went with the test of the megawatt plant.

"Well," he said, quite out of breath, "it looks good." He had just returned from his industrial premises and was sitting on his exercise bike to resolve the accumulated tension of the past few days. He said that the installation was complete, that they had made a test run and that he was satisfied. There was no longer reason to believe that he would have to postpone the test with the customer. You just had to hope that everything went well, for his sake. Or, as Jim Dunn put it in an email to me: *"We must all pray for him. He is a man 'on a mission' and out to prove he is right. No stopping him now!"*

49. http://webbshop.cm.se/System/DownloadRe p=Energimyndigheten&rl=default:/Resourc

50. http://www.nyteknik.se/nyheter/energi_m

CHAPTER 15

Half a megawatt but no answers

It was no disaster. No plant had exploded or ran amok, which had worried many. But it wasn't a success, either—not the major media E-Cat breakthrough others had thought or hoped for.

I had again traveled to Italy with my family, on October 27, this time to Pisa where we landed in the evening and set off towards Bologna by car. A violent rainstorm had swept over the Italian west coast days before and caused havoc with floods and landslides, among other places in the five delightful tourist villages of Cinque Terre, in the Liguria region south of Genoa. Another landslide had fallen on the coastal highway close to La Spezia and swept away a big truck. Since the road was closed, the truck traffic, usually intense at night in Italy, now took other routes, including our route to Bologna. The traffic looked like an evacuation as in classic disaster films, with mile-long convoys of trucks in the dark, along the curvy highway across the Apennine Mountains.

As in a video game, I followed the highway curves between the red and orange lights on the trucks, and late that night we arrived at our hotel outside Bologna. I could not help but think of the climate changes discussed intensively in recent years and also if Rossi's invention could be an important and unexpected solution to the problem, assuming that global warming was due to fossil-fuel emissions. In that case it was urgent to develop useful products from the technology and to spread them worldwide.

The next day I went early to the now-familiar industrial premises on Via dell'Elettricista. Outside stood two large diesel generators—one would be used primarily during startup of the large plant to power the electric heaters in the E-Cat modules, the other was a backup. Behind a plywood fence stood four big chillers to handle the steam from the plant and condense it into water. Inside the hall stood the container with the 52 E-Cats inside. I counted another 64, spread on the container roof. Next were two large vats, several feet high and wide, filled with water that would be introduced via two pumps into the 116 E-Cat modules—107 according to Rossi—to be evaporated by the heat of the unknown, possibly nuclear, reaction. Along the floor ran cables from the generators and water hoses from the cooling units back to the water tanks. Outside the container doors stood a small control panel on wheels, to monitor the functioning modules.

The atmosphere was frenetic. Rossi greeted me cheerfully and briefly and continued his preparations. He sprang back and forth in the hall with concentrated gaze and serious mien. The same morning engineer Domenico Fioravanti, who would verify the test on behalf of the still anonymous customer, had demanded a change in the water-flow system to better control the water pumped in, resulting in minor, last-minute work.

I knew that the weak point of the whole setup was that the customer was anonymous and that the validity of the results would depend on trust in the report Fioravanti would put his name on, later in the evening that same day. My intention was to verify some of the readings, such as the electricity meter on the diesel generator, but Rossi was very busy and I quickly gave up—I would still not be able to control everything and discussions would be endless. It instead became a day of talks and discussions among the invitees who this time had to hang around in a hall adjacent to the one where the test was conducted. They talked quietly about, among other things, how long the test would go on, what could go wrong and what results could be expected.

Over all, about thirty people were there, including Levi and his colleague Professor Ferrari from the physics department at the University of Bologna, Professor Focardi and Professor Stremmenos, the Swedes from Hydrofusion, Rossi's wife and family, blogger Passerini, a couple of journalists from the Italian magazine *Focus*, the American Sterling Allan who ran the website PESwiki.com on new energy sources and Peter Svensson from the AP who at the last minute had confirmed his presence, plus a couple of more or less anonymous individuals who reasonably represented or assisted the client. Someone working for the Italian energy company *Ansaldo Energy* was part of this group.

Shortly after ten AM we heard the diesel generator start but not until several hours later were we invited to examine the plant—a few at a time and only for a few minutes. After lunch, I had occasion to glance into the hall where the plant stood. Rossi was still rushing around, clearly stressed. He had to show the customer and Fioravanti that the technology worked under the terms of the agreement. Everything else was secondary. He showed me around briefly and explained that the plant was now in self-sustained mode, i.e. with the power disconnected, boiling water into steam that was cooled and condensed in cooling units outside the premises. But there was little I could control. I had to document the scene with photographs and video, then it was time to leave. I felt a certain resignation. I knew that the result would not be especially significant because it was difficult to verify that the measurements were indeed correct and that Fioravanti really worked on behalf of a customer. Moreover, the steam would inevitably be discussed again—steam quality and whether all the water had evaporated.

I talked for a while with the man supposedly representing the client—a casually but stylishly dressed Italian about fifty years old. When I asked his name he did not answer but instead asked politely for my name. I got no further. When the test was ending I instead exchanged a few words with Fioravanti, who appeared to be a very experienced engineer. He seemed happy with the results and confident in his measurements. He had no sympathy for the discussions on steam quality—those engaging in such arguments did not know what they were talking about, he said.

Towards the evening Rossi organized a kind of impromptu news conference where he, in front of the guests, read Fioravanti's report. It had obviously been written in advance, with the day's measured values entered by hand. Nothing about the measurements seemed more advanced than what had been done in all the previous tests—temperature of the input water and the outgoing steam, and water-flow rates. Nothing in the report revealed additional calibration or alternative methods that could verify the result further. Probably it would have been futile. For the problem of the unknown customer persisted.

Andrea Rossi during test of the megawatt plant in Bologna on October 28, 2011. E-Cat modules are mounted inside and on top of the container. Photo: Mats Lewan

A different view, however, which I had encountered earlier in this story, was well formulated by a person who participated in the tests both on October 6 and 28: *"Such a disorganized test like this one is a guarantee that it is real. It can only mean one thing: Rossi has* *really discovered what he claims. If it were a scam, everything would be perfect and staged in every detail, but here is leaking water on all sides, and he must constantly control the situation. It's working."*

Despite the water leaks, as a whole it was also a kind of success in that nothing went completely wrong—no accidents, no explosions and no dangerous leaks of hydrogen gas or vapor, which many had feared. It had all stayed seemingly on track, without surprises. The only surprise was actually when a car turned up into the area in the afternoon with three persons—father, son and a friend—who had driven 150 miles from the small town of Belluno, near the beautiful Dolomite Mountains in northern Italy. They opened the trunk and laid out a small *aperitivo* with cured meats like *salame* and the local flavor of dried beef from the neck—*ossa col*—assorted cheeses and a couple of bottles of the Italian sparkling wine *Prosecco Valdobbiadene*. Nothing could have been more Italian. The three were simply enthusiastic supporters of Rossi and wanted to take this opportunity to offer local specialties, always appreciated in Italy. Every corner of the country has its traditions and interest is always intense in food, wine and cooking. It was delicious, of course, and appreciated. It was a pleasant and unexpected moment around their tailgate but apart from this the day offered no surprises.

Over time, however, I would begin to understand that the test had not been as trouble-free as it had seemed, but on the contrary quite dramatic. And two years later, under a pseudonym, Domenico Fioravanti described in a post on the web forum Cobraf.com how the problems had started when the power to the electric cartridges had been turned off at 12:36 pm. The plant then went into self-sustaining mode with just the heat from the reactors, which the military customer wanted to verify, but at the same moment the temperature began to rise in some of the reactors that apparently were not getting enough water. Steam had begun to enter into the pipes where the cooling water was pumped in and created an imbalance in the flow of water, and to save the situation, half of the reactors were disconnected. In retrospect Fioravanti would conclude that the problems were due to various design flaws concerning pumps, expansion tanks and gaskets. But he also noted that the test was successful anyway and that he had decided to stop earlier than Rossi had planned, when the plant had been running in self-sustaining mode for five and a half hours, which was enough.

"Rossi had intended to continue until after eleven o'clock pm, without thinking of the guests who were snacking in the room next door," Fioravanti wrote.

Earlier, about a year after the test, Fioravanti revealed in the same online forum that four reports had been written from that day.

"One was the public little patch that was shown at the insistence of Rossi, asking to give the presentation everyone knew he had promised. A horrible thing, that Internet. Two others were

compiled by people who were present at the test, but who did not have the right values and they were therefore technically empty. One report was compiled in a comprehensive way and presented to those who had ordered it. Rossi was not informed of the contents of that report until four months later. It was critical in terms of the thermo-mechanical design of the plant, but positive regarding the energy produced in self-sustaining mode. Period."

But on that day, I knew nothing about this. And till late in the evening I didn't know when I would be allowed to report something, or even what; AP had long been promised exclusivity by Rossi on the test of the large plant but late at night Svensson said that he would not, for sure, be able to publish anything. He seemed to have been told by his editors either to disclose the unknown customer or reveal the falsity of the technology. When none of this was possible, AP hesitated to publish. This matched the media's reticence about cold fusion over the previous 20 years. I could understand the

AP's viewpoint. As the months had passed, demands for conclusive evidence had increased and in the present situation there was little to report, especially given the uncertainty around the anonymous client. Thus the rest of us were free to publish and since Sterling Allan, an outspoken Rossi supporter, preferred to publish his report on the same day as the test, October 28, counting US time, we agreed to push the button at two o'clock next morning, Italian time, or eight in the evening US East Coast time.

When almost everyone had left I sat down in private with an exhausted but seemingly satisfied Rossi to share my thoughts—what I had seen, how I had seen him behave. I had planned to wait until the next day but Rossi rarely postponed things and preferred to talk immediately. He sat on a wooden chair, his legs outstretched and his arms crossed. He had taken off his jacket and was wearing suit pants, a light-blue shirt and a dark-red tie. Though very tired, he looked spirited. Out in the big industrial premises the megawatt plant was cooling. The industrial area was deserted. Everything was quiet.

I started talking about the possibility that Defkalion had something going on but he seemed sure that it was mostly empty talk. I tried without success to get him to tell me more about what had happened when the Americans visited in early September. I revealed my view of innovators—characters we had known at *Ny Teknik* where we often reported on small businesses built around innovation and the characteristics we had observed that recurred with skillful inventors:

- Innovation is their baby, and no one is allowed to touch it.

- They often want to be also entrepreneurs but are rarely good at it.

- They tend to believe that good technology sells itself.

- They often fail to understand that the road to a finished, salable product is as difficult as the road to the invention itself.

- They have difficulty realizing that this requires different skills—a team with a CEO, a marketing manager and a product manager, and fiscal controls.

- Sometimes they end their days poor, forgotten and bitter, entangled in endless litigation, though they have made breakthrough inventions, often because they will not let others in.

That inventors have these traits is reasonable. You could say that they are necessary in the difficult process of going down a path no one else has ever trod, to reach the invention itself. Like many inventors, Rossi claimed to know all this. But I wondered how aware he really was and if he was ready to let others in when it mattered. Finally I asked again about an independent test but Rossi seemed as sure as before that it would not lead anywhere. In my eyes, the only reasonable thing was now to give all priority to the test in Uppsala, but I knew that Rossi instead planned a trip to the United States.

When we parted I started to upload pictures and videos to my editors, then started to write an article in which I tried to find a reasonable balance between an apparently successful test and the fact that the customer was unknown and the report unverifiable. Of course the discussions started again but there was no direct evidence of something new that could move the discussion ahead. I felt dull, as the same situation was repeated again and again, and realized that my own role became more and more exposed as the story continued without acceptable evidence. Sure enough, Krivit published a negative post, critical both of my reporting and of Rossi. He credited me for enabling Rossi *'to perform his magic show for so long'* and wrote that I *'consistently failed to ask Rossi tough questions, turned a blind eye to crucial inconsistencies and acted as Rossi's scribe by writing his technical reports for him.'* [51]

I listened, reflecting on what I could do better. I noted that many had begun to shake their heads at

Krivit's writings, partly because of his systematic attacks on Rossi but also because he had stuck to a particular theory as the only real explanation for the LENR phenomenon, despite many other advanced suggestions that there was still too little data to start building meaningful theories. Just six months later I thought that Krivit had gone to extremes when he and a man calling himself Gary Wright separately wrote e-mails to my editor-in-chief and to the CEO of our publishing house, Talentum, making various allegations against me.

Gary Wright, apparently collaborating with Krivit, had contacted me a few months earlier to ask for information about Rossi, then executed a campaign against Rossi on the web, where I also got my fair share. To my editor-in-chief and our president he wrote that I was Rossi's active partner and had published false articles about Rossi. He based his criticism on his allegation that I had refrained from reporting on a visit to Rossi by the Florida Radiation Protection Authority—an event we at *Ny Teknik* did not consider newsworthy. Krivit wrote that he had been forced to clean up my mess because it was his area of expertise or journalistic ‘beat.’ He also wrote that I harmed the field and disgraced *Ny Teknik* and he suggested to our president that ‘a science journalist who does proper science journalism’ should be selected for possible further reporting.

Rossi, on the other hand, was convinced that Krivit was paid by someone who had tried to denigrate his work. He used the nickname ‘The Snake’ to describe Krivit in his own comments on the website *The Journal of Nuclear Physics*—Rossi’s blog and his forum for public contact. Other nicknames Rossi started to use were the *Clowns* and the *Puppeteers*, referring to Defkalion and other individuals or organizations he saw as enemies. The word *Puppets* he used for individuals he believed to be acting on the enemy’s mission.

One might think that Rossi was unnecessarily arrogant in his criticism of his “enemies” and that this scared many, but in retrospect he was possibly right in not underestimating the competition. It was also clear that criticism of him was growing and I realized that it could turn on me, though I basically had no other stance than that the technology had such potential that I had to continue to monitor it provided it was not proven to be based on mistake or fraud. An independent test would be most welcome.

A special motive for Rossi to make such a test should be to gain scientific recognition for his work as soon as possible—before anyone else. After all, he was certainly not alone in LENR. Hundreds of scientists had, since Fleischmann's and Pons' presentation in March 1989, been working in the field and had published many reports. Apart from Piantelli, at least a dozen researchers worldwide had presented more or less promising results in the context of public research, plus a few private companies that claimed to be on track. As in Piantelli's experiments, the power was often much weaker than Rossi had achieved and, above all, the fundamental problem with most experiments remained others' difficulty in repeating the results. However, much progress could be achieved quickly and, as the attention grew around Rossi, motivation grew for others to step up their work.

Scientists mentioned frequently included the Americans Michael McKubre, George Miley, Peter Hagelstein and Brian Ahern, and Rossi's compatriot Francesco Celani who attended Rossi's first public test in January 2011. A year later Celani became the focus of a promising experiment, seemingly repeated successfully by others. And Piantelli, Celani or any of the other scientists could perhaps soon produce results approximating Rossi's. Since they were already working in a more traditionally scientific way, they could implement rigorously conducted and documented experiments before him, thus lead the world with a scientifically acceptable demonstration of LENR's potential as an energy source. This, if anything, should cause Rossi to conduct an independent test. Furthermore, the scientific community, media and the public seemed increasingly to expect clear evidence from Rossi.

Rossi received numerous proposals from institutions and actors who offered to carry out such a test. He declined consistently, again deeply suspicious of all who wanted to sink their teeth into his device. There would be no more public tests, he declared, claiming to focus on building and selling large plants, and on initiating commissioned research in Bologna and possibly also in Uppsala. He still had plans for a test in Uppsala, but not to convince the critics and the public.

“You surely don’t think that a test in Uppsala will change anything, do you?” he exclaimed when I discussed it with him. He argued that those who did not want to believe what he had shown so far were either paid to criticize him or were driven by other interests or by deep-rooted jealousy. And they would not change their minds. “Look, that’s not why I'm doing it. I can assure you that the last of my problems right now is to convince those who currently are negative."

What instead seemed to drive him were increased opportunities to get scientific credit for what he had accomplished, perhaps even a Nobel Prize. I could not blame him for this but I hoped more than Rossi that a positive test in Uppsala could be a major breakthrough, at least for those basically open to the technology's validity but who wanted properly documented and reliable measurements. So I kept in touch with Professor Kullander of Uppsala and made sure that nothing fizzled out by mistake. I spoke again with Rossi and realized that he was set to make the test there after all. Both he and the Uppsala group wanted to keep it secret, to create as little attention as possible.

An interesting idea that emerged, discussed during this time, was an alternative way for Rossi to spread the invention to the world. The idea grew, not least because no one really understood how

Rossi intended to arrive at finished products, industrialization and manufacturing. He seemed convinced that initial production would be artisanal manufacture of individual plants—an activity he would largely handle with his own staff. Due to the enormous demand that could grow if the technology suddenly became widely accepted, this seemed untenable. The idea that emerged was therefore based on a completely different model—that Rossi could transfer rights to use the technology to a foundation funded in collaboration with some of the world's wealthiest donors. Perhaps they would even stand in line to be involved in saving the earth from climate problems.

The foundation would license rights to develop and build applications around the technology to companies worldwide against a modest financial contribution, with the requirement that those companies buy or lease the reactors from Rossi. The idea was that product development would explode and that many different kinds of finished products, like those Defkalion had sketched, would soon be developed. Perhaps it would even be possible to get Defkalion on the train if the Greeks, against all odds, had created a competing technology. Rossi would receive revenues from hundreds or thousands of companies but would have no hassles with production engineering and could instead focus on developing the core technology.

Such a foundation might be started as quickly as in one or two months. Though significant risk existed for the technology to be copied or reverse-engineered once on the market, the model would ensure satisfactory sales volumes and license control for Rossi. The idea was interesting, as was Rossi's reaction. I started by asking what he most of all wanted to achieve with his work.

"To make sure that this technology provides the most benefit to mankind," was his concise answer. In addition, he hoped for recognition of what he had accomplished. When I described the idea of the foundation, he said: "It's an idea that is very beautiful from an ideological point of view but it's like those things, like Marxism for example, that from a theoretical point of view are wonderful, but that cannot be applied practically because the incentives are lacking."

He meant that if you let people and businesses have easy access to the technology, without needing to make investments, it would be crushed by powerful financial interests. Because Rossi said there was no doubt that the world's true rulers—he meant the multinationals—wanted to stop the technology. Without proper incentives, he believed, no actor would have a chance against them.

"It's like fighting with bows and arrows against tanks. You can develop this technology only if you create an organization that is sufficiently powerful to defend itself. If we do not create a structure that is a war machine they will crush us like fleas."

Only by requiring substantial commitment and investment and in return giving exclusive access to the technology could you convince enough big, important companies to commit to it, Rossi meant. If knowledge about the technology instead was available to all, the major players would abstain. In addition, Rossi had little trust in foundations as organizational structures in general. He noted coldly that the feelings that drove the vast majority of people were not ‘nobility and holiness’ but rather greed, envy and predation. Because of this, in the best case, if the people involved were honest about 30 percent of foundation revenues would be used to achieve the real purpose. Otherwise, only a few percent.

He continued to explain that for the same reason he would not trust foundations when it came to the promise that he still maintained: half the profits of his business would go to care for children with cancer. He would, through his own activity, identify children whose families could not afford health care and ensure that they could come to a medical facility where his company paid the bill.

The money would not take the detour through any organization nor via the sick children's parents—to avoid the 'father-drove-a-Mercedes' effect, as he put it.

I understood his point. Certainly powerful interests wanted to stop the technology. And if there were any country where the knowledge of power games and vested interests had a history of thousands of years, it was Italy. Already Niccolò Machiavelli from Florence wrote in his classic work on exercise of power, *The Prince*, from 1532: *"There is nothing more difficult to take in hand, more perilous to conduct, or more uncertain in its success, than to take the lead in the introduction of a new order of things. For the reformer has enemies in all those who profit by the old order, and only lukewarm defenders in all those who would profit by the new order."*

My own belief was that the world had developed new structures, through the Internet, that spread knowledge globally in an instant and through movement around open source, where the basic idea was that everyone contributes as they can to build a structure from which everyone benefits. I thought that, combined with broad public opinion on climate issues, this could provide other opportunities for a more transparent way to spread a revolutionary new energy technology.

I was not sure of my case. Rossi was sure of his. The question remained: what would happen if one day it suddenly became clear to the world that his technology really worked and what forces would then start to influence Rossi in one direction or the other? Then I also realized that in the end Rossi was maybe not in such a hurry to prove to the *whole* world that his technique really worked.

51. http://news.newenergytimes.net/2011/10/catalzyer-extraordinary-scams-require-extraordinary-claims/

CHAPTER 16

Defkalion comes back

Throughout the autumn I considered one matter more than any other, a question to which I still could not find an answer: Did Defkalion really have its own core technology under development or were the Greeks planning the world's biggest scam, selling licenses for €40 million apiece? Rossi claimed to have reliable information that the Greeks had only an empty box. His hypothesis was that they continued to collect leads and that they would then turn to him with a fistful of interested customers and a proposal to re-establish a partnership. I was not convinced that Rossi was right. I saw many indications of the opposite.

I tried to get better information through my network of people who knew different parts of the story but none had a good answer. But on November 14, 2011, Defkalion sent out a press release stating that a product was now almost ready and would be presented within two weeks. Defkalion included images from experimental setups in an apparently small, simple lab. What that meant was almost as difficult to answer as before. Was a viable technology shown? Could Defkalion really have succeeded in six months with the challenge that hundreds of scientists had worked on for twenty years, unsuccessfully, that had taken Rossi and maybe even Piantelli over ten years to develop? Could they have done this in the small lab the pictures showed? The questions were unanswerable. The prototype in the pictures was basically identical to the sketches Defkalion showed at the June 23, 2011 news conference when they had intended to use Rossi's reactor as an energy source. Nothing in the pictures revealed whether the Greeks had developed their own core technology to generate heat. But the message's tone was confident.

I continued to discuss this matter with my contacts but it was still mostly guesswork from everyone. If Defkalion had its own core technology it was natural to suspect that there was a connection to Rossi's technology—perhaps a leak, even industrial espionage? It was impossible to ignore the hypothesis but it might be an in-house development based on published results, helped by talented researchers.

I got another viewpoint from one of my sources—a person who had visited Defkalion to discuss a commercial venture. He testified that the Greeks had told him laughingly that they had fooled Rossi. Now I recalled my conversation with Alexandros Xanthoulis when he called me in August, the day Rossi announced that he had canceled the contract.

"I know what he's got in the reactor, I know everything," Xanthoulis had told me. Then: "We have made five tests up to now with our own scientists. It works up to 24 hours maximum. It needs a lot of improvement that we have done already. We can certify six months [of operation] right now, under our technology."

We had at that time decided not to publish anything from the conversation. The challenge was that Rossi and others involved constantly stated things that were difficult or impossible to verify, making it difficult to select what was reasonable to publish. To us, hearsay was anathema. Above all we wanted to report on what we had been able to observe. But since Defkalion now claimed to have developed its own technology so quickly, Xanthoulis' statements during the call acquired a certain public interest, so we chose to publish a summary. A few months later we might have declined.

It was a delicate balancing act. Reader interest was always intense, though many readers continued to criticize us for even dealing with the issue and described me as incompetent and gullible. For me, this balancing act was less about such considerations—the technology was potentially so disruptive that it had to be followed.

The balance was more about what could be verified and what were speculative and unsubstantiated statements. As time passed, we became more restrictive at *Ny Teknik* because we had no further personal observations upon which to base our reports and almost nothing of what I was told could be verified. But after contacting Defkalion by phone for comment, on November 29 we published an article entitled: *Defkalion: "We have Rossi's formula."* For safety, I had then secured copies of the recording from the earlier conversation with Xanthoulis. Depending on how the story developed, the content could be important in future disputes about the technology.

The next day Defkalion made the expected presentation, covering basically the same product shown in June 2011 but with much more detailed data. It was a box they called 'Hyperion,' weighing 45 pounds, sized like a laser printer—22 x 18 x 16 inches—with the magical heat source inside, and tubes, pump, control electronics and other essential items needed for simple uses, such as a heat source to anything, from heating homes to powering a generator and producing electricity. The price would be around €5,500 or $7,000 US. For this you would supposedly get a device much like Rossi's E-Cat, producing thermal energy for half a year from a single charge of fuel with a little nickel powder and hydrogen, at a cost of maybe a few tens of dollars, financially competitive with public-utility sources, while reducing or eliminating the climate-changing effects of conventional power-generation sources.

Judging from the data, Defkalion's Hyperion was better than Rossi's. It offered faster startup, several different nominal power levels to choose from and higher efficiency, i.e. the need for less electric power to start and run it. Above all, it looked like a finished product, unlike Rossi's. But it was still just a 'paper' product, virtual 'vaporware.' No documented test data were presented and the 21 pages of technical specifications could have been thrown together by any technical consultant in a week. There were pictures of lab prototypes but they did not prove in any way that a functioning heat source was inside. In any case, Defkalion now claimed to have contact with 850 companies in 60 countries interested in licensing the product.

In an interview the next day, Xanthoulis provided further information: The idea of developing a proprietary technology began in July 2011, with full activity launched in August. Twelve prototypes were now operating. A factory of 120,000 square feet would be ready in four months in Xanthia, Greece. Defkalion's lab would within a few weeks move to a 27,000-square-foot lab in the same facility. Nineteen license agreements had been signed. Licensees would put €500,000 into an escrow account before finished products were tested. Half the €40 million license fee would be paid on the transfer of know-how, the other half after ten days of operation of a finished factory. Defkalion also claimed 40 employees and 27 researchers working with the development. Xanthoulis told me that among everyone at

Defkalion only two had complete information about the technology—he and another person he would not name.

"I'm in danger sometimes. We should not expose the other person to danger," said Xanthoulis.

Along with the Hyperion specifications, Defkalion announced that a number of institutions had shown interest in undertaking independent tests and that such testing would be conducted in early 2012.

I still did not know what to think, if not for another piece of unexpected information so startling as to be almost comical. The story seemed to have no limits to its twists and turns. What I was told, from which I considered a reliable source, was that the CIA had followed the Greeks' work in secret and reported, at about the time the first Press release went out, that Defkalion had made the technology work stably. The timing made sense. Defkalion might have needed a couple of weeks from when the reaction worked to compile all the material and prepare the technical documentation. The information intrigued me but I realized that I would never be able to verify it. On the other hand I knew about at least one group ready to go to Athens to test the technology: the American group that in late summer would have signed a contract with Rossi to let NASA test his megawatt system, the group that after the contacts with Rossi had collapsed and had also asked me for contact information to Defkalion in late October, after my article in which I reported that Defkalion welcomed institutions wanting to do independent testing.

Jim Dunn, representing the group, was now coming to Europe. After visiting Piantelli in Italy he would proceed to Athens to meet with Defkalion. After his visit he wrote to me that he had a three-hour meeting that went well. He had talked to the chief technology officer for over an hour and went through 35 printouts of computer drawings, discussing concepts and plans. He had concluded that it was a real product. Moreover, he believed that the Greeks had a lead of 18 to 24 months over Rossi, whom he now thought was out of the game.

“Rossi is ‘toast’,” he wrote. Dunn was an experienced engineer with particularly strong knowledge in energy so his assessment seemed credible, though not even he had seen any operating reactor at Defkalion.

Just a couple of weeks later another American with long experience in LENR visited Defkalion for several days—Michael Melich, a professor at the Naval Postgraduate School in Monterey, California. Melich conveyed his impressions to an acquaintance, Jed Rothwell, well-known in the area. Rothwell had for many years run the site Lenr-canr.org—a sort of online library of almost everything ever published on LENR, much more than many people thought. Without naming names, he summarized Melich’s story on Vortex-l—an online forum where invited researchers and others could discuss scientific subjects not widely accepted. Cold fusion belonged there and Rossi and Defkalion were among the topics of conversation.

Melich, who had evaluated Defkalion thoroughly, had described to Rothwell that its engineering and business operations were promising. The staff was professional, lab equipment was top-notch, as were the scientific and engineering levels of operation. Neither he nor Melich, however, had participated in a test, yet he ventured to say that the emerging products were revolutionary—the best, based on LENR, ever produced.[52] Over all, much seemed to support the contention that Defkalion had succeeded. The question remained: if they had succeeded, how had they done it. I would wrestle with that question, going forward. The upcoming tests would be important to confirm that the technology worked. If it did, Rossi—who still refused to believe that Defkalion was onto something—had a tough competitor.

But Rossi had not been idle. After the test of the plant in October he said that he had continued to work with the plant in Bologna with the anonymous military customer who also, according to Rossi, had ordered twelve more plants. Many didn't believe a word of this. In mid-November—a few days after Defkalion's Press release—the Swedes behind the company Hydrofusion opened the website Ecat.com with full content. The site looked professional and after a few days Rossi announced that it was now his official website.

Then came the first sign that Rossi might yet believe that Defkalion could have a real product in the pipeline. A few days later, on November 21, he offered public sign-up for interest in a consumer version of the E-Cat costing around €4,000 ($5,200 US), targeting 10,000 'interested' sign-ups—a big enough number to be able to mass produce and minimize costs. He received notifications via email but they could also, somewhat more rationally, be handled automatically via a form on Ecat.com. Around the same time I published the first interview with Hydrofusion's CEO Magnus Holm, who had a Ph.D. in particle physics from Chalmers University of Technology in Gothenburg, Sweden. I could thus reveal who was behind the site, which had long eluded interested visitors with a series of anonymous videos about Rossi and his technology. Among other things I asked Holm his opinion of the skepticism about Rossi.

"Until he makes an independent test, there is obviously a small chance that it does not work. We are willing to take that risk because it's such an amazing technology if it works. Further support that it's real comes from the fact that all independent physicists who have observed the tests are positive and have expressed belief in the mechanism. I have little sympathy for the crowd of skeptics who insist on spending substantial time and energy just to be able to boast 'what did I say' if it should turn out to be wrong," he responded.

Meanwhile, I still hoped that the independent test in Uppsala would be implemented shortly, but it was postponed yet again for various reasons. Jed Rothwell described Rossi's unwillingness to make accurate and widely accepted tests of his technology. Like others, Rothwell compared Rossi to Thomas Edison, who behaved similarly around

1879 when he developed the light bulb.

"Edison knew he had solved the problem, but he had a lot of work left, [so]more intellectual property [was] there for the taking. Low hanging fruit. He did not want his competition to take him too seriously. On the other hand, he needed more big bucks from the investors and banks. It was a delicate balancing act: how to keep up the excitement while triggering the lowest possible level of serious competition. Rossi is doing exactly the same thing. I recognize that is his strategy. He is hardly keeping it secret. Countless inventors and companies have done this. It does not mystify me at all. To people unfamiliar with business it looks crazy." [53]

I asked Rossi about the matter and he replied bluntly that it was true. In addition, Rossi identified Edison as one of his two role models in the world of inventors. The other was Edison's rival and antagonist Nikola Tesla, considered a main character behind the development of commercial electricity—Edison favored direct current in the nets while Tesla was a supporter of alternating current, which is what we use today in our electricity grids, though DC is on the rise.

The opportunity to apply for patents may have contributed to Rossi's caution against showing too much, like Edison. At that time there was indeed only a public patent application from Rossi, an application that most regarded as flawed and few believed would lead to a granted patent, except in Italy, where it passed on the formal grounds of an older set of rules. Meantime Rossi had worked with many new applications and a year later claimed that he had submitted a total of 14 applications. Instead of considering independent tests, Rossi seemed now to be concentrating on three things, mainly in the United States: working with the military customer, developing a new control system for the E-Cat and preparing an automated production line for a consumer version. Already, on January 13, 2012, he had announced that he intended to manufacture one million units per year of a consumer model that he claimed was under development. It would be big as an ordinary laptop, easy to connect to existing heating systems and would cost $500-900 US. Rossi was aiming for sales to begin one year later or, in the worst case, within 18 months—an entirely new message compared to his earlier announcement, in which he had said stubbornly that the consumer market would not evolve for at least two years.

He stated that his strategy now was to kill his competition with a product that would be as cheap and simple as possible, with a target price one tenth of Defkalion's Hyperion. He had another novelty: he had developed a way to avoid the hydrogen canister. Instead, the small consumer unit was fitted with a small pill that could store a few grams of hydrogen, released when heated—a known technology but possibly hard to implement within the E-Cat. If true, he had a further advantage over Defkalion, whose Hyperion held a small hydrogen canister—a consumer-product certification problem, because hydrogen is explosive. The icing on the cake was that Rossi's customers could replace a cartridge of spent fuel in a few seconds, after six months of operation, if Rossi could deliver a unit able to operate that long.

The snag? Maybe none of this was true. Rossi gave no evidence of anything and many seriously doubted his claims. The issue was not improved by Rossi's constant stream of comments on his blog *The Journal of Nuclear Physics*. He handled the massive flow of reader comments and e-mails as they poured in, while he worked to build and run his business, which he seemed to be doing largely alone. His comments were often far more outspoken than one would expect from a company, especially in such a controversial area, and were sometimes contradictory. This did not increase confidence in Rossi, nor in the information he provided. Yet many people believed strongly in Rossi and sent encouraging comments to his blog. One pointed out that he always did what he said, and Rossi replied:

“I am delighted to see that you noticed that I always do what I say. It has been, as I already said, the most important lesson I got from my father: ‘Think well before saying a thing, but once you said it you have to do it’. “

I was in doubt until a month later when I received a report from Rossi and from several people involved in a test in February 2012, when the hydrogen pill had been used and a design of the small consumer version presented. I also got pictures of the design that showed how simple Rossi’s device could be—far simpler than Defkalion’s. Maybe he was traveling along a possible way forward, but it was a long journey. On the other hand I now found Rossi to be relaxed and optimistic, with great confidence in the future. Perhaps it helped that he claimed to have received funding from an external group to his company Leonardo Corporation in the United States. I never understood clearly what this meant but he told me, much later, that he was then negotiating with a major global group interested in working with him and that six months later signed a significant agreement.

At the same time a race against Defkalion seemed to take off. Ten days after Rossi's statement on the one-million series, Defkalion officially invited independent testing of the reactor inside the Hyperion and somewhat later they told me that visits by seven important groups were scheduled. Many who followed the story were skeptical of Rossi, while Defkalion's credibility gradually increased. Some, like me, wondered how Defkalion could have succeeded in developing the technology, while others thought it did not matter. The important thing was that it could benefit Mankind. On the other hand, many people thought that Defkalion's tests, if proved convincing, would reflect on Rossi and increase his credibility as well. There was also the hope of a public breakthrough for cold fusion, or LENR, as a revolutionary new energy source, especially among those who had believed in it for decades and had fought hard for it.

A few months later, in mid-March 2012, Alexandros Xanthoulis contacted me again and we had a couple of long conversations via Skype, where he gave me the opportunity to ask questions both about the current situation and the background.

“So, go ahead,” he said, lit a cigarette, took a puff and blew out the smoke. I found it hard to assess what was true in what he told me—I had still never met Xanthoulis face to face, just talked to him on the phone, making it harder for me to judge his credibility—but his narrative skills were impeccable. He explained that it was right after Rossi canceled the contract with Defkalion in August 2011 that he had decided to try developing a proprietary technology matching Rossi’s, though it might seem hopeless. He then also bought the shares of the other corporate owners, except from his lawyer’s office in London that still held a 1.5 percent share.

“Everybody told me: ‘you don’t have more than one percent chance to succeed.' And I couldn't have other people with me, going for only one percent," he explained.

Actually, the work with the proprietary technology had started in July 2011 when Defkalion disagreed with Rossi on how the tests were to be performed but when the contract was canceled their efforts were intensified. In September, the first signs of a reaction supposedly appeared—a small amount of gamma radiation.

"Since then we have gone a long way, through disappointments, enthusiasm, beer drinking, champagne drinking, again champagne drinking and lots of pizzas," Xanthoulis said. He told me that in November they achieved a stable reaction that started at each attempt—delivering the repeatability that had been so difficult in cold fusion—and that they had progressed to a fully controlled reaction sometime in early 2012.

"Now we can control it, start it when we want, stop it when we want, run it at the temperature we want, which was the main element of our research." Like Rossi, Defkalion needed to control the reaction by applying initial electrical power, though they said it was small. Unlike Rossi, who used powerful heating cartridges to heat the reactor, Defkalion appeared to sustain the reaction with repeated sparks from a kind of modified spark plug from conventional automobile engines.

"Sometimes if you don't control the reaction it can jump up 300 degrees [Celsius]. If you are at 800 and you add 300 then you will have metal melting. We made this small experiment with special glass, to see what happens inside. It melted, and this glass was good for up to 1600 degrees. It melted in three seconds. Seriously, three seconds," he exclaimed.

One thing I wondered much about was how they had managed to develop the technology in such a short time.

"I believe there's a very big piece of luck. How much I cannot tell you. It was God's grace, but we were very capable also. If you could see the amount of study and research we did you would be amazed. And a major thing is so much studying our people did, taking whatever was written about this from 1953 or 1954. They checked so many variants and ideas for things, and working they were closing, closing, closing, making tests, with the right combination of things. And it was not one person or three persons, it was 27 people working. You cannot do this kind of thing with three or four or five people. You need all kinds of scientists, chemists, engineers, physics, nuclear physics, astrophysics… And labor workers to screw together and take apart the pieces.

"A basic thing is the geometry inside the reactor. And don't forget, the Greeks are very good at geometry. We invented it."

I asked if it had been a difficult decision to dare to develop a proprietary technology and Xanthoulis replied:

"Good question. I have to tell you that at beginning it was not but when we had hard times I thought that it was a difficult decision and very risky, but we were pushed to limits. We had times with guys from the lab saying we cannot do it. We ran out of ideas. It was difficult to handle the psychology of the whole team, very difficult. Heartbreaking. Sometimes I couldn't even walk up the stairs, not because of being physically tired, but psychologically. You know, to keep such a big team together with the same scope, in disappointment, with enthusiasm sometimes, the pressure from everybody, and outside pressure, it's not easy. I had to remember all the lessons in business psychology from university during this last year. Starting with Rossi and finishing here.

"You need to be very stubborn too. And you have to have a vision for all the team. We didn't do it for money only. Every little child has the dream to do something for humanity at least until the age of 17 or 18. For us it lasted longer. We took a risk. It was huge risk. Believe me, if I would fail, then I had to emigrate. Because we spent a lot of money and it's easy to lose your face. You know how people respond."

Xanthoulis also presented Defkalion's commercial plans: companies in 72 countries had showed interest in licenses and 20 had signed agreements. The price for a national license to manufacture remained €40.5 ($53.5 million US). He also explained that revenues were likely to be greater from a business that adapted the technology for specific industries, such as ship operations, and that such discussions were ongoing with some of the world's largest companies. He also said that a Hyperion prototype would be finished in July, with industrial production starting in November.

My interest as a journalist, however, focused on the ongoing tests with independent groups. According to Xanthoulis four groups were involved: the Greeks, the European Commission and two others, one of which had to be connected to Professor Melich's visit. Later I learned that Melich's trips were funded through a grant from the New Energy Foundation, which among other things published *Infinite Energy* magazine, where Jim Dunn sat on the board.

Five tests had already been completed and Xanthoulis stated that reports from two of them would be published shortly. He also said that I could get one of the reports, with amazing results, the same day or the next day. It sounded like interesting news. An independent test that showed that the technology worked, whether from Rossi or Defkalion, would strengthen the credibility of cold fusion and was something I could report. When I finally received the report it was anonymous—it was not clear who was the author or who had done the tests—and contained no measurements or details of any test, just general reviews of Defkalion's technology, their sources unclear. Thus, there was nothing substantial to report.

I started to wonder why Defkalion had contacted me, and why now. I thought that Xanthoulis possibly hoped for a report by us that could strengthen his credibility. Because he had also told me was that he was holding discussions with investors. His own equity was substantially depleted—he stated that he had invested just under €8 million ($10.5 million US) and that he had to decide about an investment in exchange for “a very small percentage of the company” in a few weeks. I knew that Jim Dunn had expressed interest from the U.S. group that had wanted to invest in Rossi’s technology and had signed an agreement with Piantelli, and I had asked Xanthoulis about this.

“Ah, my dear friend Jim Dunn. To tell you the truth, they came to us to talk about cooperation and to become shareholders three months ago now. But two days ago I cancelled everything with them,” he had answered. Why? I wondered.

“Jim Dunn is still a very good friend, we talk every day. He is an excellent guy. But let’s say that Americans have a different mentality than us Europeans, and they think they can buy everything cheap everywhere in the world. Their proposal was not a fit for us, nor fair. But we are still friends with the guys and we haven't excluded to cooperate later."

Another thing also puzzled me. When I had talked with Xanthoulis earlier he had said that I could participate in one of the tests in the near future. A week later, when it became clear that we would not publish anything, I was told that Xanthoulis had "reconsidered his invitation for the time being."

No other reports were published nor was a finished Hyperion prototype presented in July. And the factory planned in Xanthia, Greece was never built. Instead, Defkalion announced in July 2012, in an email that breathed disappointment, that the company had left Greece after three months of trying unsuccessfully to find Greek financing or support from the government that would induce them to stay. In September it was clear that the new base instead had become Vancouver, Canada, which seemed to receive Defkalion with open arms. I still didn't know what to think about the

Greeks.

52. http://www.mail-archive.com/vortex-l@eskimo.com/msg59480.html
53. http://www.mail-archive.com/vortex-l@eskimo.com/msg55387.html

CHAPTER 17

Rossi’s industrial dreams and a test in Uppsala

At one point, when I talked to Rossi about his background and upbringing, I asked him what he thought of today’s Milan compared with how the city was when he was young.

“Milan then was *much* better than now!” he exclaimed. “It was much more an industrial city. Today Milan has become a financial and commercial center and it’s no longer an industrial city. It produces nothing anymore. In the ‘50s, ‘60s, ‘70s and ‘80s Milan was really the industrial capital of Italy. In the province of Milan, there were an incredible amount of industries, and people worked a lot. It was a wonderful city from that point of view where the main activity was work. If you wanted to work, Milan was the right place—it was the city that worked 24 hours a day, without stopping.

“If you went from the city center 20 kilometers out of town you just saw factories, one after the other, full of workers. You could say that Milan was a symbol of industrial Italy at that time, the Italy that became the fifth largest industrial power in the world then. The city has degenerated since the laborers’ children do not want to be laborers any longer. It is of course quite right from a certain point of view, for the love of God, but the problem is that over time fewer and fewer people wanted to work and instead they have fled in large numbers to non-jobs—a few jobs that are suited for a few people with special talents.

“So in the end we have a mass of unemployed people who are nothing more than individuals who had wanted to do an excellent job in contexts where they instead failed because they do not have the required capabilities. But on the other hand there is no one who does the jobs that has created the wealth not only in Milan, but throughout Italy.

"What has happened is largely that people are doing jobs that are not productive. Cities like Milan have become cities where you nowadays do profits in the financial sector, i.e. through speculation, which is a fake job. Not for nothing speculation comes from the Latin word speculum, which means mirror. If you place two mirrors in front of each other, you will see mirror images that are reflected infinitely. Thus you create a series of images that are not real because the only real image is the one that is in the middle between the two mirrors.

"On the other hand, the endless line of people that you see in the mirrors when the image is reflected endlessly, from one mirror to the other, is completely false, hence the word speculation, i.e. the creation of something that does not exist, using financial trickery. Much like the two mirrors, therefore speculation.

"There is no industry anymore. When I now pass through Milan it feels infinitely sad. For example, along *Viale Fulvio Pesci*—a wide avenue leading from Milan to Monza, where factories once stood one after the other, there were the largest Italian industrial enterprises, Pirelli, Breda, Salk ... You could go all the way to Monza and just see factories. When you go there today, you see nothing. You see crumbling factories, abandoned. Or factories converted to housing, as Pirelli, and to offices.

"There are no factories any more. And I find it ... yes, it's clear that there was pollution, but emissions can be cleaned. The truth is that Milan is no longer an industrial capital. The most important thing in Milan has become the fashion, the couture, it's all there."

I listened quietly to his description. It came clearly from the heart. Rossi had described a world in which he had lived, in which he had believed and now he was seeing languish. It was moving but I was not surprised. I had seen this side of Rossi before and I reflected that I saw our times from a different perspective. In my years as a technology journalist I had become increasingly fascinated at the power of technology and the way technology, almost insidiously, took a larger and larger place in our world, without people being fully aware of what it entailed. I noticed that many regarded the Internet as something that was more or less cut and dried and already in place, while I saw it as the beginning of something that had barely started.

I saw that artificial intelligence had gone from decades of hope and disappointment to become an area of great progress. It was not hard for me to believe that within a few decades machines, with a rate of development that doubled every two years, would match biological intelligence and even surpass it. This was combined with accelerating technology in several other areas that could potentially offer solutions to global problems and lift billions of people out of poverty and ill health. Those people could, in turn, contribute with more ideas and further development.

Among those who followed technology's leading edge was a belief that much of today's human activities would be handled by machines and robots, while work conditions for people would change fundamentally. Expectations did not stop at robotic factories that required specialized personnel for specific tasks but pointed rather to a situation where intelligent robots managed industrial production and other kind of work on their own and could also perform better than people. You might, for example, consider a YouTube video released by BMW in 2012 showing the robotic production of its popular 3-series car, with a few humans watching over but not intervening in a highly complex, almost fully automated production system, capitalized at immense cost, that produced hundreds of cars per day at highly competitive cost and at consistent quality, devoid of human error. But my expectations went far beyond that to robots and systems behaving like humans and making decisions, not only collaborating and interacting with us but also out-performing us.

So I suggested to Rossi that the society and the emerging economy could be based on structures other than classical, large-scale manufacturing yet could be productive via high degrees of automation—partly on a large scale but perhaps, above all, in small local contexts with people-friendly and cheap robots already under development such as Rethink Robotics' Baxter, intended to work side-by-side with humans, or 3D 'printing,' which could result in the manufacture of many kinds of products in small spaces, to the level of 'cottage industry.'

"May I make an objection?" said Rossi. "Which country currently has the highest rate of growth and is destined to become the most powerful country in the world and a leader of the world's production?" He meant, of course, China.

"And what is China's main business?" he continued, rhetorically. "Automation in foundries and textile mills is certainly high but China's production and exports are based on industrial production, made by a mass of half a billion workers. This is a fact.

“If we want to oppose this, robotic factories are certainly good, as you say, but then the robotic factories require specialized workers, because there are tasks that robots cannot perform. Volkswagen is fully automated, it’s all robotic, but in the Volkswagen factories there are hundreds of thousands of workers.

“Certainly there is automation and robotics but industrial production must be maintained. And the industrial production that was in Italy has unfortunately almost completely moved to China.

“Then, today’s worker is not the same as in the ‘60s, that’s for sure. The laborer of the ‘60s was a worker with his face and hands black, and he used the hammer and so on. Today a worker is a blue collar, all right, and the training he once had was simpler than the training required today, which is more technical. But you still need workers and you still need production and all this can be moved to China.

"That's the problem. Milan has not turned Falck steelworks from a polluting steel mill spewing red smoke, where workers were constantly in danger from a safety point of view, into a modern, automated steel plant. No, Milan has been completely transformed into a city with real-estate speculation. There are no more jobs. The same applies to Pirelli and to Breda. At Breda they made locomotives that were among the best in the world. Now they have made a gallery of modern art there. With all due respect to modern art, but still ..."

I had nothing to add. Rossi was right, in a sense, but I thought he was mistaken on the magnitude and rapid change in the world. I also wondered what would have happened if Rossi had a functioning technology and chose to make it freely available to anyone, according to the same philosophy behind the accelerating trend to open-source software. I thought the world was ripe for such a radical approach and that Rossi had had opportunities to find a good revenue model in such a scenario. This was, on the other hand, easy to hypothesize about.

Now Rossi planned, instead, a roboticized factory to churn out a million consumer devices a year. He had as yet no collaboration with any other company about this, only a specialist provider who would build the factory and design and develop the robotic line for the actual manufacturing. Skepticism was widespread. How would Rossi go quickly from sketch to a prototype design and testing of a finished consumer product, then mass production? Most seemed to think that the whole thing was a scam but at least I took Rossi at his word when he said he had contacts with a supplier for the plant. The catch, however, was different and went beyond product development to the issue of certification—as Rossi had previously thought.

In spring 2012 he had begun a certification process using an Italian consultant who worked for the

Swiss certification giant SGS. He said he also had contacts with the similar American organization, Underwriters' Laboratories, and an additional certification company. Initially Rossi said he had been told that certifying a consumer product would, against all odds, not pose major problems—much like the statement from the Swedish Radiation Safety Authority that since neither the fuel nor the waste were hazardous or radioactive, no special permits were required from a radiation-protection point of view. Thus the appliance should mostly be considered a water heater and easy to certify. But while SGS was working on certifying Rossi's large, megawatt-level industrial plant, tested in October 2011 by an unknown military customer, Rossi had received contrasting information: the condition for certifying a consumer product based on a completely new, untried technology was that industrial plants with the same technology had first been in operation for a few years. So in summer 2012 Rossi realized that he had for the time being to mothball the whole project, with the consumer version and the robotic factory. The decision gave his critics a field day. On the other hand, in September 2012 Rossi could present the certificate from SGS for the large plant, which surprised many observers.

“No special or critical problems were encountered during the work and therefore I expect it to be completed soon,” said the Italian consultant to me when I talked to him a week before Rossi made the document available. The certificate, however, considered only safety and said nothing about whether the product worked as advertised. Such a certificate would be issued later, Rossi promised, and the consultant suggested this. It would obviously be a strong card, because in practice it would acknowledge that the technology was valid. But it probably remained a long way to go to become reality. What happened before that, however, was that the long-planned test of the E-Cat in Uppsala was being implemented, finally, and I could feel the tension rise within me. My hope was that it would be crucial in determining the true functionality of the process.

On Saturday, April 21, Rossi and his technician Carlo Leonardi packed the 200-pound-plus box and a lot of other equipment into a van in Bologna. Flying the equipment was not an option; instead, car transport through Europe was chosen. Rossi had inquired with me about routing and they drove in daylight through Switzerland, Austria and Germany to the port city of Puttgarden, on the Baltic Sea, where they arrived on Saturday evening and checked into a hotel. In the morning they took the ferry to the Danish port Rødby, continued through Denmark, then crossed the bridge from Copenhagen to Malmö on the Swedish coast. Late Sunday night they arrived in Uppsala, where they checked into a hotel.

In Uppsala, Sven Kullander had agreed with the Svedberg Laboratory to perform the test, scheduled to last for 48 hours and financed by the Swedish Alba Langenskiöld Foundation. The test group included the head of the laboratory, Björn

Gålnander, radiation-protection officer Torbjörn Hartman and Lars Einarsson, a research engineer in physics and chemistry, as well as Roland Pettersson, who had participated in tests at Rossi's facility in Bologna both in October 2011 and February 2012. The group would in turn report to the same reference group planned at Rossi's visit to Uppsala in July 2011—Sven Kullander, Hanno Essén, Bo Höistad, Lars Tegnér and Hidetsugu Ikegami. I reminded myself about the connections between these people—Ikegami had done research with Pettersson while Kullander, and Tegnér had participated in a support group for the project. Tegnér was named project administrator in the final report from the Energy Agency in 2006, where he was Development Director.

The test group had for some time been working day and night with two technicians to prepare a thorough test setup where the temperature could be measured with highly accurate sensors in many positions and all the data stored in a computer, just as all the tests of Rossi's device should have been from the start. In addition, everything was to be continuously recorded on video. On Monday everyone gathered at the Svedberg Lab and the work began.

Rossi wanted first and foremost to show the Swedes that there were no strange details in the device, so he had planned to dismantle the E-Cat and show more of its interior than he had ever done before. It turned out to be a surprisingly simple design, almost banal. When the big box was opened and the fins that conveyed heat from the reactor to the surrounding water were removed, a few simple parts remained that together formed a flat, box-shaped space with roof and bottom, about eight inches square and less than an inch thick. Inside this space was a kind of sealed package where the nickel powder and the pill that released hydrogen would be placed. Over all, the fuel weighed only 55 grams, which was what made the technology matchless, if it now worked. If 55 grams of fuel in a small package could deliver as much heat as an electric stove operating at full power for several months, it was an incredibly efficient and flexible power source. It could certainly not be based on a chemical reaction but must instead be based on a hitherto unknown nuclear reaction. Just to deliver that much thermal power for 24 hours would be proof enough.

Now the assembly work began. Rossi and Leonardi went into a separate room and filled the fuel in the small package placed in the box—by weighing the little box before and after filling the fuel, the weight of 55 grams could be calculated. That the filling was conducted in secret was irrelevant. There were no known substances that weighed so little and could deliver so much power for so long. Fraud on this point was inconceivable. Measuring instruments could also verify that the content was not radioactive.

The little box was not yet ready but would now be glued together. Here was the catch: the pieces were glued with a ceramic, heat-resistant glue that needed to cure for 24 hours and normally Rossi would glue it in two steps, a total of two days. Now they didn't have this time. Rossi took a chance and instead glued it all together at once, to win one day. The plan: start the test on Tuesday and continue for two days. Then another problem arose: Rossi would not accept the sensors the measure group wanted to use for temperature measurement but wanted to use the kind he himself had used—thermocouples—though the measurement group's semiconductor-based sensors were very precise and calibrated against a special, precious reference thermometer that Roland Pettersson stored in the department's safe.

"I was a bit geek in calibration and over the years I had accumulated special reference weights, reference thermometers and even references to humidity in the safe, and now some of these came in handy," Roland Pettersson told me. Rossi was not convinced and a conflict arose at the Svedberg Laboratory. Both Roland Pettersson and Sven Kullander had to go there and try to pour oil on the troubled water and eventually the problem was resolved by going to Stockholm and acquiring the type of sensors that Rossi wanted, to complement the proposed sensors.

“He was a bit rigid and not as flexible. It had to be in his way, as he had measured,” Roland Pettersson said. “But he was a good person, very friendly and nice. The first time we met in Uppsala, Sweden, in February 2011, I gave him some of Ikegami’s writings and told him that I believed in him and his technology. It may have been positive and he was always kind and friendly to me,” he added.

Finally the entire setup was ready and on Wednesday evening, April 25, the experiment started. The test group planned to work in shifts so that the experiment could last 48 hours. A dinner was planned for everyone on Thursday night and I was invited. The dinner was actually meant to be a roundup after the test was completed but since startup had been a day late the dinner would occur in the middle of the test, while some participants would have to take turns to monitor the measurements.

Late Wednesday night I wondered anxiously how it had been going. The moment felt decisive. Shortly before one o'clock in the morning I received a text message from Rossi: "We are producing more energy than we put in," he wrote, meaning that the device worked. But for some reason I did not feel convinced. When I awoke in the morning I got a call from Roland Pettersson.

"At two o'clock in the morning I received a text message that the energy production was zero and that the experiment was discontinued. I would have started my turn at four o'clock but instead I could take it easy and go to the lab later in the morning," he said.

I talked later with Rossi and his explanation was that the gluing had failed with the halved curing time. For a moment I wondered if it were a whitewash and that Rossi knew that the device was not working but coolly went to Uppsala to build trust. But I had a hard time believing it. In any case it was another result that didn't lead anywhere. I realized that it would be months or more before new measurements could be done in Uppsala. Not that there were doubts with the Swedes, nor with Rossi—they even planned a new test a month later. But I knew that it had been difficult to arrange the occasion in April, to get everyone's schedules to match and find a week when Rossi could drive up to Sweden, so I had little hope that it would be possible to arrange a new test opportunity so soon.

Slightly dejected, I went to Uppsala on Thursday to attend the dinner that Kullander had arranged. He had announced that we would meet at The Stone House—a tall, narrow, small 16th-century house belonging to the Royal Society of Sciences of Uppsala, situated near the University building in the middle of town.

§

It was a chilly, rainy spring evening and I walked briskly from the train station under a small umbrella. No one had yet appeared when I stepped into the house but soon they dribbled in—the participants in the measurement and reference groups, also Ikegami, who was visiting Uppsala with his wife. Rossi and Leonardi, however, had packed and left earlier. The rest of us gathered for a drink in the small banquet room on the upper floor, with genuine furniture by the Swedish designer Carl Malmsten from the '50s and '60s, then sat at the table downstairs and had a good dinner. The atmosphere was relaxed and easy-going, and they were all curious about Rossi and his technology. It boiled down to one simple question that everyone was asking. As one diner put it: "I believe nothing. The only thing I want to know is if it works." We didn't find out this time, either.

Rossi told me later that he had benefited from the trip in a different way. Much as his jail time in Milan had let him ponder undisturbed for over a year the problem of cold fusion, during the return trip from Uppsala he had time to consider another problem that he had wrestled with for a long time. He hadn't managed to raise the reactor temperature higher than bringing the wall up to about 150 degrees Celsius. It was good enough for heating but to generate electricity you would need to power a turbine, requiring steam at about 500 degrees, preferably hotter. But as soon as Rossi tried to drive the reaction to raise the temperature further, sudden power spikes produced high heat but were hard to control—the same phenomenon that had made the reactors explode several times during Rossi's early experimentation.

Now he wanted to make a new attempt to escape the dilemma. He had 24 hours with nothing to do. Carlo drove and Rossi took pen and paper and sat down to think about the problem. The hours passed and the spruce tops in the monotonous landscape rushed past the window. Now and then a clearing or a lake appeared. Suddenly he had the solution. "You know, it came to me in the classical way, when you wonder why you didn't think of that before," Rossi would tell me later.

Carlo continued to drive. Outside the car window the gentle waters of Lake Vättern stretched out beside the road. Rossi had his idea. Steven Johnson, author of the book *Where Good Ideas Come From*, would have called it a slow hunch—something that festers for a long time in the subconscious and ultimately materializes, suddenly, as a clear and concise thought.

CHAPTER 18

A death and a fiasco

On August 3, 2012 Martin Fleischmann died at his home in Salisbury, England, at age 85. He had made a brilliant scientific career and was considered one of the world's leading electro-chemists when, at the news conference in Utah March 23, 1989 together with his research colleague Stanley Pons, he announced the spectacular news of their experiments with what they thought was cold fusion. During their career they had previously come up with several brilliant and innovative ideas that had first been considered highly controversial but later had proved fruitful. The claim that they could control the fusion at room temperature in a test tube, however, was apparently too bold and soon led to Fleischmann and Pons being ridiculed, mocked and effectively ostracized by the scientific community.

To his friend Jed Rothwell, Fleischmann had said: ‘People do not want progress. It makes them uncomfortable. They don’t want it and they shan’t have it.’ But even if Fleischmann later regretted the news conference and the cold-fusion concept, the message had stimulated continued research among a small group of scientists and entrepreneurs around the world, including Rossi. If that research was about to lead to what Fleischmann and Pons had hoped for—a new source of energy that could change the world—Fleischmann never received recognition for this achievement in his lifetime.

§

“You know that we are building up something really big in Sweden?” Rossi asked me one day in late August 2012.

Indeed, I had received such signs from Rossi and Magnus Holm, CEO of Swedish-British Hydrofusion, over the previous few months. Now the plans became clearer. Early that morning a colleague of mine received a surprising email from one Johannes Falk, representing a group of private investors in Sweden that had invested recently in the Swedish company Cassandra Oil. Ironically, Cassandra Oil had developed a new technology to make oil from old tires, basically what Rossi had worked with at Petroldragon in the 1980s but with modernized methods. My colleague had followed the business surrounding the Swedish oil technology and the investor group had confidence in him as a journalist. Now it turned out that they were also supporting Rossi's technology through an investment in Hydrofusion, and the e-mail to my colleague contained detailed information about the deal.

"By the end of next week, (...) two independent Swedish technicians will conduct a new measurement in Bologna. It will be done under the supervision of an inspector/measurement expert from the Technical Research Institute of Sweden," wrote Johannes Falk.

It inspired confidence. The Technical Research Institute of Sweden[54], SP, was a government-run organization with a high level of expertise and credibility. And SP would hardly participate in a measurement without ensuring that it was carried out according to the rules. A positive result was a condition for the planned investment—a share issue whereby signatories together received a relatively large share of Hydrofusion for SEK65 million, or about $10 million US, with subscription rights at a half million SEK, or $75,000 US. The money would be used, together with shares, to acquire a substantial portion of Rossi's company Leonardo Corporation, giving Rossi a small stake in Hydrofusion. In time, the investors saw the opportunity for Hydrofusion and Leonardo Corporation to merge.

One Friday in late August Magnus Holm invited me to meet with Johannes Falk, who wanted to tell me about the deal. I went in the pouring rain to an address on the peninsula Blasieholmen in central Stockholm, where the law firm Kilpatrick

Townsend had its offices. One of the firm's lawyers was Erik Nerpin, chairman of Cassandra Oil and proposed incoming Chairman of Hydrofusion, if the investment was made. We sat in the elegant but restrainedly furnished premises and Johannes Falk explained that the network with which he worked used to take an interest in activities that had difficulty obtaining funding from traditional venture capital firms, for various reasons. Such investors were also called business angels. Though they were reasonably familiar with risky investments, I guessed that they had doubts and perhaps a little suspicion for such a debatable technology and such a controversial person as Rossi.

"There is still a very high risk. But the reward is very large," explained Falk.

Through the deal, Hydrofusion—which already had a commercial license to sell Rossi's products in several countries—would get access to the core technology for developing and manufacturing proprietary products. Hydrofusion had already established local contacts with a number of industrial Swedish enterprises. Sweden could thus become a hub for Rossi's technology. This was precisely the kind of massive industrial support Rossi needed to get ahead—if his technology worked, of course.

"Magnus is indeed a very capable person," said Rossi.

Whether the technology worked might thus finally be verified by measurement, in Bologna. The measurement would be made on Rossi's new, higher-temperature version of his reactor—the one he had devised in the car on the way home from Uppsala in April. Hydrofusion had long been waiting for an opportunity to show proper measurements to investors who needed to form their own opinions on the technology's value. The time now seemed ripe because a month earlier, on July 16, 2012, Rossi had commissioned independent measurements on the new reactor, with positive results. Since the new reactor attained temperatures of about a thousand degrees Celsius, more than enough to create steam and drive a turbine, it could be used for electricity production, much more attractive for investment than the older model. Rossi had written about the test on his blog several times during the summer. A month after it was completed he sent the report to me.

I looked forward eagerly to finally getting a documented, independent evaluation of Rossi's technology but once I got the report I was slightly disappointed and confused. First, Rossi explained that most of those who had participated in the test could not officially expose their names, effectively making the report useless to me as a journalist. Without credible authors it had no value. It violated one of journalism's principal rules: *who*. Secondly, I immediately found significant errors in the calculations of the results, errors created partly because of a new measurement method that, unlike earlier approaches, was not based on the simple principle of boiling water with the heat from the reactor, known as flow calorimetry.

No water was heated at all. The new reactor, outwardly a 12-inch-long steel cylinder, thick as an arm, with a central through-hole, was during the measurement simply supported on a stand and radiated heat into the room as a hot plate or radiator. To calculate its radiated thermal power, the Stefan-Boltzmann law was used, a law of physics that derives the radiated power from the surface temperature of the reactor, measured with a kind of infrared camera.

The measurements seemed to have been carefully done. The problem was which surfaces of the reactor would be included, and how, and to me it was obvious that the report's reasoning was incorrect. I discussed the matter with Magnus Holm, who also had access to the report, and he agreed with me. We therefore recalculated the data and both concluded that the results were still clearly positive—the reactor produced significantly more energy than the input electrical energy, though not as much as the report stated.

Could I discuss the errors with Rossi and ask him to correct them? I still had the problem with the authors' names that were not public. Among them were the researchers at the University of Bologna who officially had to stay away from Rossi, mainly because of an ongoing conflict between them and university management about how the relationship with Rossi should be handled. The researchers wanted to be free to make observations and measurements of purely scientific interest because there was so little knowledge about the strange physical phenomenon. Management thought, instead, that Rossi should pay for the measurements or the university would seem to be providing free advertising for his business.

The first few times I talked to Rossi he said he wanted such commissioned research and that he planned to pay half a million euros for it to the University of Bologna, which I reported. I had even seen a draft agreement between Rossi's company and the university. But the project fizzled, supposedly because Defkalion never paid him and thus he could not afford to pay for it. When the university administration officially declared that the collaboration was shelved, Rossi's critics made a big deal out of this. Now the university management still wanted the money. There might have been justification not to give Rossi free advertising. On the other hand, paid research meant that the university would be entering into a business relationship with Rossi and could be accused of no longer being independent. The Uppsala researchers also made this point—at the April 2012 test they had taken care to finance the experiment with funds from an independent foundation. However it was done, the Bologna researchers could thus not officially sign the report and I did not, moreover, know the extent to which they had participated in the test.

Remaining as authors were only two people—the consultant who had worked with the Swiss company SGS's certification of Rossi's megawatt plant, and Domenico Fioravanti, the military engineer who had controlled test of the megawatt plant for the unspecified military customer in October 2011. I soon realized that the consultant had not even participated in the measurements but had only observed a similar test a month later. When I talked to him he would not comment officially. Thus, in the end only Fioravanti remained, which was little help—he did not respond to email and moreover, it was unclear how independent he was in his relationship with Rossi. However, he clearly had detailed knowledge of the report's contents. The fact was that Fioravanti had leaked the content on the Internet a week earlier, under his online pseudonym Cures that he had used before on Rossi's blog, among other forums.

Fioravanti was obviously enthusiastic about the results, which according to Rossi had contributed to his leaking. Moreover, he leaked the information while an acclaimed conference on topics such as cold fusion was being held by National Instruments —an American giant in professional measurement technology. National Instruments and its CEO James Truchard had long held a positive attitude towards cold fusion and less than a year earlier, in fall 2011, Rossi had contacted the company through the researchers at the University of Bologna who planned to use NI's instruments and software for measurements on the E-Cat. Rossi planned to ask NI to develop new control electronics for the megawatt plant, which he at the time claimed he was adjusting and improving according to requests from the military customer. Initially, he described the relationship with NI as positive but eventually the contacts ended in a way reminiscent of how Rossi had broken first with Defkalion, then with the U.S. investor group TEM Capital, related to NASA. The turning point came at a meeting with Truchard and others in spring 2012, when the two entities were intending to discuss closer industrial and financial cooperation. Rossi left the meeting, feeling that NI wanted the details of his technology rather than a partnership.

“I found myself surrounded by all kinds of scientists and instead of talking about partnerships and the like I got a long list of questions—crazy, just crazy questions, as if we were to construct the reactor together. On 999 of 1000 questions I answered that I’m sorry, but I will not give you that information. The only question I responded to was probably ‘how are you?’ and my response was ‘very good, thank you’,” Rossi recollected. “The meeting ended very badly, as if we were wondering why we had decided to meet. It couldn’t be understood.”

Fioravanti, who since the test of megawatt plant seemed to have regular contact with Rossi, commented on the event on the Italian web forum Cobraf.com that he used to employ:

“The only reasonable explanation I have found is that they were convinced that they were dealing with a person who was in trouble and was willing to sell cheap, just to cash out. But they

underestimated him—if you try to strangle Rossi he asks you to go to hell anyway, without caring about the consequences.”

Rossi cancelled the contacts with NI. When the company’s annual ‘NI Week’ was held in early August the same year Rossi perceived the program as a mild attempt at giving back, though he called it buffoonery. What he was referring to was that NI had invited Defkalion as presenters, a group that Rossi would rather not hear about anymore, and also Rossi’s compatriot, scientist Francesco Celani, whom on the other hand he did not mind.

Both Defkalion and Celani received much attention at the conference. Most people I talked to, however, doubted the contents of Defkalion’s presentation that mostly appeared to be a miscellany of various physical concepts drawn from a range of theories about cold fusion, plus general claims about results of measurements on Defkalion’s proprietary technology—all of it later published on the Defkalion website.[55] Hanno

Essén wrote to me:

"All the text is full of jargon, perhaps most intended to impress. It is very interesting if they actually get the results of tests that they describe, but that is all I get out of the report from Defkalion."

Celani's presentation gained greater interest and led to the first real impetus for research on cold fusion in many years. Celani showed an experiment with a very thin wire inside a glass tube filled with hydrogen gas. The thread was of the metal alloy *Constantan*, a mixture of mainly nickel and copper. Thus he was working in the same area as Rossi, Defkalion, Piantelli and Brillouin—nickel and hydrogen. The wire had been given a special coating, still Celani's secret, and when he increased the heat inside the glass tube it started, as in other cold-fusion experiments, to produce more power than was input. Much less power than Rossi's devices—only tens of watts, i.e. able to power a weak light bulb—but still more than explainable from a chemical reaction. What primarily gave Celani's experiment impetus somewhat later was that it was well-documented research available to others who wanted to try to repeat the results.

Rossi, however, was not interested in either Defkalion's or Celani's presentations. But Fioravanti was curious about Defkalion's presentation and evidently saw a reason to leak information about the test of Rossi's new reactor. Perhaps he wanted to show which of the inventors of a new energy source based on cold fusion he thought had come up with the best solution. Or he may have done it with Rossi's blessing—I never understood whether it actually could have been that way—even if Rossi a few days later wrote on his blog a little reproachfully that Cures 'had been identified as Domenico Fioravanti' and that it probably was him who had leaked the information, though it was confidential.

Rossi's connection to Fioravanti went much further back. In the late '70s, when Rossi had just started to produce oil from old tires, Fioravanti attended the Technical University of Turin and was going to conduct a study about electrostatic filters for air purification—exactly what Rossi had worked on before he started Petroldragon. Through his supervisor, Professor Cesare Boffa, he was introduced to Rossi, then considered an expert in the field, and during a visit he received a hefty stack of materials and drawings for study. In addition, Rossi showed him around the industrial site in Caponago outside Milan, where a pile of old tires was waiting beside the later famous plant for extracting oil from waste. More than thirty years later, Fioravanti discovered that Rossi had risen from the ashes of all the events surrounding Petroldragon and had become a controversial cold-fusion protagonist. After following the developments for six months, he contacted Rossi again in May 2011 via his blog *The Journal of Nuclear Physics*, but under the name Cures. Since he recalled their earlier meeting, Rossi easily remembered who it was and a little later Rossi also wrote Fioravanti's name in a response on his blog. Rossi ought, in other words, to have known that Cures was Fioravanti.

When Rossi later understood that Fioravanti was a colonel and military engineer, specialized in thermodynamics and missile tests, he recommended him to the unknown military customer who needed a neutral consultant inspector for testing the megawatt plant in October 2011. According to Rossi, Fioravanti had worked high up in NATO with contacts even in the Pentagon, and was therefore chosen for the mission. Meanwhile Fioravanti continued to write about the events surrounding Rossi under the name Cures on Cobraf.com, sometimes with comments about himself in the third person. He wrote, for example, about the photo that I took of him at the test of the megawatt plant:

"The type in the picture did not say a word to anyone, and I think, judging from the face, that

he was also pretty pissed off about the presence of the press and the unwanted disclosure of that he was military and his degree."

Around the same time he revealed what had happened during the test and how the military customer—of which I still had no confirmation—had acted:

"... It is very likely that serious negotiations are under way with the customer, which handled the test, (October) 28. I do not think the test was a condition for concluding a contract, but rather a verification that it worked properly and that the discussions could then begin in earnest. And such discussions are taken care of 'under water.' "

Since Fioravanti was appointed inspector he should know, I thought. He also, early on, had a well-reasoned view of what had always been Rossi's main challenge. Already in September 2011, he wrote:

"Rossi's problem is not to show that the E-Cat works. It works, and he is no longer interested to

prove it to the public. The real problem is to get out of the situation as a struggling small business owner with an economically potentially groundbreaking product, and to gain the economic and industrial 'critical mass' needed to manage the product properly, and make money on it. It's not as easy as you think."

His comments matched Jed Rothwell's comparison between Rossi and Edison, and my and others' opinion that Rossi needed an industrial partner with whom he dared to collaborate and who had the muscle to develop and market a commercial product. In the end, Rossi's activity was still mainly based on one man—himself. True, he had tried larger partnerships—first with Defkalion, with U.S. TEM Capital, associated with NASA, then with National Instruments. Each time, he had concluded that he could not trust them. Rossi knew what he wanted.

"When I see that a person is straightforward and uncomplicated, and who has no ulterior motives, and the person comes to me and says that 2 + 2 = 4, then I act like I do with you. But when I see that a person does not behave that way, and if I must say, listen, you are literally wasting my time, then I don't say anything else—I just say look, we're wasting time and it is useless to continue the discussion.

"There are on the other hand people who at all costs will try to negotiate because they still think that if you continue to pull a cart with square wheels, eventually something useful falls from the cart. I do not play that game. If a cart has square wheels, I don't pull."

A special business segment Rossi did not value much was venture capitalists. I had even heard a rumor that Carl Page, brother of Google co-founder Larry Page, had organized a meeting between Rossi and Elon Musk, super entrepreneur and founder of PayPal, Tesla Motors and SpaceX, but that Rossi had cancelled the meeting at short notice, reportedly irritating those involved. When I asked Rossi if it was true he didn't remember any such meeting nor did he know who Elon Musk was. However, he said:

"Some venture capitalist from California has contacted me but there is so much fraud in that industry—there are a lot of people talking about huge opportunities and availability, but then when you go into the concrete, you discover that there is a lot of fake. Then the concrete proposals are also so small that they don't interest us. Sometimes someone has wanted to invest half a million dollars to see what happens, but you know, I already spent half a million dollars in research. We do not need them."

If past attempts to find a partner had failed it was time for Rossi to see if a package with Hydrofusion, a group of Swedish investors and collaboration with industrial companies in Sweden could be put together. The investors, on the other hand, wanted to know if Rossi's technology worked. And I was invited as an observer.

So on the morning of September 6, 2012, I jumped on a plane to Bologna, for the first time in nearly a year. The test would start in the morning but I only had one day open and could not get there the night before. When I landed at eleven AM I was greeted by the usual summer warmth, a pleasure compared to the gray, cold Stockholm I had left. I took a taxi to Via dell'Elettricista—for the last time, I thought. Rossi had acquired a major industrial facility in the small town of Ferrara a few miles north of Bologna, designed to accommodate production. He was not, however, assured that it would be used much.

"Magnus is working hard to organize another production center in Sweden. There is nothing concrete yet but the plans are very serious and usually our plans eventually become reality. If the operation proceeds as planned, I would say that we realistically will have a production center in Sweden within a year," Rossi had told me at the beginning of the summer.

However, this depended largely on the day's test, to be done the same way as the test a few months earlier, on July 16. Six investor representatives were present—Erik Nerpin, Johannes Falk, Anders Olsson, the founder and principal owner of Cassandra Oil, Jan Alvén, a person with extensive experience in large Swedish industrial corporations, Anders Essén-Möller who a year earlier had lost billions of Swedish Kronor in just a few minutes in a fall of the shares of his medical equipment company Diamyd, and Jan Blomquist, investor in the Swedish mining company Kopparberg Mineral. From Hydrofusion four people attended—CEO Magnus Holm, web expert Stefan Helgesson, economist Hans-Peter Bermin and Professor and energy expert Björn Kjellström. Also along was the hired researcher from the Technical Research Institute of Sweden, SP, tasked to verify the measurements, plus Rossi and finally me.

"Over all, we were far too many," said Magnus Holm later.

When I arrived in the taxi several of the Swedes sat outside enjoying the sun and the heat in unbuttoned shirts. It would normally be at the limits of what was acceptable in a business context in Italy, even in industrial environments. But I knew how solar- and heat-thirsty Swedes could be after a short, cold summer that usually ended in early August, when Italians just started to go on holiday. The summer had been particularly cold in Sweden, with temperatures that only a few days climbed over 20 degrees Celsius. The atmosphere seemed relaxed but I had only just greeted Magnus Holm when I realized that something was not going as expected.

"The instruments show different," Holm said, abruptly.

He explained quickly and it just took me a few seconds to understand. The problem was simple but serious. The instruments Rossi was using to measure how much electrical energy was consumed to heat the device showed lower values than the instruments that the researcher from SP had brought. The difference was not trivial—Rossi's readings were between half and a third of the researcher's measurements. If the researcher's instruments were credible, the device was consuming two to three times more electrical energy than expected. It wasn't producing three times more energy than the input but was delivering no net energy. It did not work. I believed the researcher's instruments because I had immediately understood the source of the problem.

Rossi had a control unit that he used to gradually increase the input electric voltage. To regulate the voltage he twisted a small knob on the unit, technology identical to a conventional dimmer used to turn lights up and down. The problem with a dimmer is that it delivers chopped values—not a clean, smooth 'sine' curve typical from an AC outlet but a curve that is cut off abruptly and repeatedly, a hundred times a second. For this reason it is difficult to measure with simple measuring instruments of the type Rossi used. They simply showed wrong. How large the error was and whether they showed too little or too much was difficult to know in advance.

But now we knew how much input power was being delivered—the researcher's more advanced instruments measured such power properly and the values that his instruments displayed were also more logical; as the measurement process progressed and Rossi raised the temperature by increasing the input electric power, the thermal power that the device radiated was all the time almost exactly the same as the input electric power. The device was simply an electrical heating radiator. Of course this was much easier to believe than that the device would produce net energy from the start, as Rossi's values indicated; normally the strange reaction should start only at a certain temperature.

Besides the researcher from SP, Anders Olsson and Jan Alvén also participated in the measurements. They went back and forth with heat cameras and carefully recorded all measurements. But already, early on, when they found the error with Rossi's instruments, they seemed to have decided that the device did not work. They had had reason to be skeptical even before the measurements began. Rossi had promised to carry out a 'control' run—the same check the U.S. group and NASA had also requested: running a unit in parallel without fuel, to see if it produced less energy with the same measuring methods. But when the Swedes arrived at the industrial premises Rossi had not prepared the second identical reactor without fuel for the control run. Instead he had prepared a welded box that he thought could be used for the control run, but since it was not at all similar to the reactor it was hardly a reasonable proposal.

So already when I arrived at the industrial premises the Swedish investors had decided that if Rossi was not a rascal he had nothing that seemed to work. That Rossi refused to accept the issue with the instruments made things worse. He could perhaps have saved the situation by admitting that there must be something wrong and that it would be best to cancel the measurements and undertake the test on another day. Instead, he persevered and insisted that his instruments were correct and that the device worked as it should. I knew that Rossi had little electrical-engineering knowledge but I tried anyway to explain the problem to him. Rossi, on the other hand, called the person who had designed the control unit and who obviously supported him. I relaxed and hoped that the difference between the instruments would decrease; Rossi had intended to reach maximum electric voltage input of 220 volts, the typical European outlet voltage, and at that point the power from the outlet would practically be untouched by the dimmer and the wave form no longer chopped. This should make even his instrument display correctly. But eventually it was found that the control unit was being fed with industrial 'three phase' power, reaching 380 volts, so at 220-volt output the wave form would still be chopped and the issue with the instruments measuring differently would remain. No improvement was thus in sight.

Magnus Holm and the others in Hydrofusion found themselves in a tough situation and had to endure taunts from the investor group that they had let themselves be deceived by such a simple trick, that they had believed in collaborating with such an incompetent inventor and that they had proposed an investment of SEK65 million on such flimsy grounds.

I started to consider what the issue could mean regarding previous measurements I had made but eventually concluded that there was no apparent link. Both the controller and reactor were new; I had instead measured the older type of E-Cat with boiling water, and the control unit had no dimmer but a much slower control technology that should not have affected the accuracy of the measuring instruments. I also remembered that I had intended to acquire a more advanced instrument on one of my visits but that in the end I hadn't had the chance.

As the day went on, the situation became increasingly tense between the investors and Rossi. Suddenly the power supply was cut off when a component broke. The error was repaired quickly but the Swedes had already lost all interest in continuing. Around that time I had to leave, to catch my flight back to Sweden, but only slightly later the irritation had escalated into open conflict and altercation: when Rossi insisted that the test was successful, the investors more or less accused him of fraud and left. The whole situation was reminiscent of what had happened when the American investor group lost confidence in Rossi after the failed test with the older E-Cat in Bologna, ironically a year earlier to the day. I asked myself again if there was any pattern behind this, if Rossi consciously or unconsciously made sure it ended in discord and distrust.

I found it hard to believe that he had tried deliberately to lure the Swedes with a device he knew did not work but through a trick with the instruments seemed to work, and that the trick had been revealed unexpectedly with sophisticated measuring instruments. To win SEK65 million and then dodge, the trick had to be more advanced and better staged. Rossi simply did not understand the problem with the measuring instruments. In the end he even tried to convince the Swedes that his instruments measured correctly through a simple but meaningless test. He attached an ordinary 60-watt bulb to the control unit and turned up the voltage so that his instruments showed 220 volts, as in a wall outlet. Along with another of his instruments, it could then be calculated that the lamp consumed precisely 60 watts, as it should. In practice, this meant nothing because all his instruments showed wrong. The lamp consumed more than 60 watts and emitted a stronger light than normal, but this was hard to see. It was like having a car where the speedometer showed too low a speed, where you merely had to press harder on the accelerator to make the meter indicate a certain speed. The meter showed 60 miles per hour but the car was going much faster. Both the SP researcher and I shook our heads. And the Swedish investors seemed to believe that Rossi was a rascal or at least incompetent.

The same evening Rossi had booked a table at a restaurant in Bologna for the whole party but the only ones who showed up were Magnus Holm and his two colleagues in Hydrofusion. Rossi was disappointed. He had offered to redo the test the next day but the investors were not interested.

Basically, however, an unsuccessful test proved nothing. It just meant failure, without knowing why before thorough investigation. Magnus Holm and the other in Hydrofusion thought so, too, but were now in a tricky situation. In just two days a conference would be held in Zurich organized by Rossi's commercial partner companies in Germany and Switzerland. Rossi had, in the last year, concluded commercial agreements with companies in several regions and the conference was intended as an opportunity for these and other interested parties to meet, though Rossi and Hydrofusion had been less enthusiastic about the idea. One main item was that Rossi would officially present the report of the test in July—the one that Fioravanti had leaked and that I had received from Rossi and found errors in. And Hydrofusion would back him up. It was now clear that an additional error—the measuring instruments—was also involved on July 16 that basically rendered the whole report useless. Since the consequences of this had not yet been investigated properly, Hydrofusion finally decided not to participate in the conference. Rossi went, however, and coldly presented the report, though it was maybe based on inaccuracies, enraging the representatives for the Swedish investors.

"Magnus, who undoubtedly possesses theoretical training should have reprimanded Rossi, if nothing else to show that he was not involved in

Rossi's scam! I suggest that Mats publish our findings and lets everyone draw their own conclusions from our measurements," Anders Olsson wrote to me and to the others who had been in Bologna.

We did not, of course, publish anything just because others asked us to. We had not published anything about Rossi or cold fusion for over six months. During the year I had acquired a new chief editor and together we had decided not to publish further articles until independent testing had been done that could add substantial facts. Still, many readers asked what was going on and I could answer only that much seemed to be happening but that nothing could be verified. To publish articles on such flimsy grounds would lead only to pointless debates. Now we thought that we had to report, however, as a major Swedish investment has been planned and had been stopped after the failed test. We did so in a short article in which I also described the problem with the measurement error:

"The investor group had commissioned the Technical Research Institute of Sweden, SP, to monitor the measurement, and the researcher who attended measured an input electrical power that was two to three times higher than Rossi himself measured."

Meanwhile, Hydrofusion wrote a short Press statement that ended: *"Hydrofusion cannot at this stage support any claims made, written or other, about the amount of excess heat generated by the new high temperature ECAT prototype."*

Many forums and blogs that followed Rossi and cold fusion registered amazement, especially at Hydrofusion's message. I thought it was a responsible way to handle the situation. Magnus Holm noted that it had been a mistake to invite so many people to the test and that it should have been carried out only with his people and an SP representative. Only when they had made sure that everything was working should they have invited the investors.

We both thought that what was needed now was to step back and test the old E-Cat thoroughly. I did not think the new model had worked at all during the test and I wondered if it had ever worked or if it was just a measurement error. But Rossi had no plans to re-test the old E-Cat. Our contacts were, for a time after my article, minimal, but I realized eventually that he saw no reason to stop. On the contrary—he already had an important new opening to focus on.

54. Sveriges Tekniska Forskningsinstitut
55. The document has been removed but a copy can be found here: http://www.nyteknik.se/incoming/article

CHAPTER 19

Rossi finds a partner and increasing interest

If Rossi had by now been at odds with five companies or groups with whom he had discussed industrial and financial cooperation—Enel, Defkalion, TEM Capital, National Instruments and the Swedish investor group—the sixth time seemed different. The key: someone seemed willing to believe him.

"Perhaps the most important thing has been the absolute confidence that they have had in our work and this has become mutual. From the very beginning, they have approached this with extreme sincerity, maybe because the person who informed them was well prepared and made a very good presentation. With the activities they engage in, it was important for them," Rossi told me.

“Sure, the negotiations have gone up and down, because naturally we have had discussions. But we’ve gone through a lot of things together, with absolutely unexceptionable behavior on both sides, and you know, eventually a certain mutual trust also arises.

“And then of course it also involved a very large investment agreement. No small thing, not even for them, yet they signed in the end. But you should realize that it took a whole year—we signed on October 25.

The company was, according to Rossi, a large American corporation with global operations—he could not reveal its identity—and the person who put him in touch with the company was the American professor who had turned up uninvited to the Bologna test on October 6, 2011 and whom Rossi had let in. Rossi then introduced the professor to his U.S. licensees, Ampenergo, that handled the initial commercial negotiations. For a few months Rossi didn’t know much about progress. But when the negotiations had reached a certain point and it was time to deepen the discussions, Rossi was included.

“I would say that the turnaround came in February 2012 when we met for the first time at our office in Miami,” Rossi recalled. A key character, said Rossi, was the CEO of the company, who also was the person the professor had first approached.

“Fortunately, the CEO was after some time the most convinced of everyone.”

The agreement they signed in October 2012 contained a number of conditions and milestones. On the other hand, it included not only a commercial license of the kind Rossi had sold to a number of companies in different regions but also meant that his new partner also gained access to all the knowledge of the technology, including the industrial secrets, and had the right to develop and manufacture its own products built on the core technology. Furthermore, the rights covered North, Central and South America, China, Russia, Saudi

Arabia and the United Arab Emirates. The planned investments amounted, according to Rossi, to about a billion dollars initially.

When I spoke with Rossi about the collaboration at the end of December 2012 he said that he had already transferred the technology know-how. As far as I knew he had never reached that stage with any other industrial partner, not even Defkalion. I saw that now he was in earnest and was, for the first time, confident that Rossi had a feasible industrial plan. The collaboration appeared to have resulted from a stubborn and patient search under great pressure, both financially and mentally—a task that I thought few people could have handled. Rossi did not want to admit that it was a unique agreement but said that it was all about creating as many opportunities as possible.

“In the quantity, it was quite likely that among the many contacts there was one that was really good. But we do have many others that are going well, for example Magnus Holm, who now has a very interesting contact in his hand. Of course we continue to work with him," he said.

Though the agreement with the Swedish investors vanished in September 2012, and Hydrofusion, after the failed test, had taken a position that was uncomfortable for Rossi, he had still confidence in the Swedes. And he repeated his intention to build up a production center in Sweden. When Rossi told me this at the end of December 2012 I started to become sure that his technology really worked and that the strange phenomenon had now reached a point where it was ready for commercial use. My belief had emerged mainly from what I knew about Rossi and his technology but during the fall a couple of other events had also piqued my curiosity, though they were difficult to assess. The first started on a day in mid-October when an incoming Skype call appeared on the screen when I was at work. It was Alexandros Xanthoulis at Defkalion who searched me again.

"So, my friend," he said, leaning back and lighting a cigarette.

Xanthoulis told me that four independent groups had now performed a total of 21 documented tests of the Hyperion technology. One group represented the U.S. government and one the European Commission, plus another American organization he could not name. Reports from one or two of the tests would be published in a technical journal in late October. Xanthoulis had called me because he intended to send one of their reports to me within a few days, which sounded promising—I still hadn't seen any documented tests of Defkalion's technology. Xanthoulis also told me that he now was looking for investors again. In March 2012, when it had been discussed the last time, he had never received funding. He had instead sold his own assets to release more money, he told me, and he was still the sole owner of the company.

"I do not sell cheap," he said.

He said that he had a tough time financially but I gathered that he wanted to wait until the reports were published because it would make it easier to get well paid for his shares. And he repeated that he would only sell small shares of the company, or exclusivity for some industry for which the technology could be tailored, for example train or vessel operation. Xanthoulis stated that three or four such collaborations with very large organizations would launch in January 2013 and that 25 of the 100 largest companies in the world were on their list. The plan now was to find a dozen new owners and to bring in enough funding to arrive at finished products. He said that if I had any such contacts he was open to discussion with them.

“But no large shares,” he stressed, just as he did in March.

Soon after, he asked if I thought that the group of Swedes planning to invest in Hydrofusion might be interested. I replied that I could perhaps investigate that, but I realized that it was impossible for me, as a journalist. Additionally a bell rang in my head because the situation was similar to the one in March that year, when Defkalion had sent me a report that was anonymous and completely lacked data—basically meaningless, in other words.

Had Xanthoulis, then and now, hoped that we would publish something that would give Defkalion credibility and increase the company's value? This time, maybe he even saw the possibility that I could arrange contact with interested investors? The questions never got answers but I imagined that Xanthoulis' money could not last long. Admittedly he said that in Vancouver, to which Defkalion was moving, the company was welcomed warmly and received help with both laboratory premises and funding. He also told me that Defkalion had research contacts with 16 universities, including the University of Lund, Sweden, and also with a number of companies, among them "a Swedish truck manufacturer," i.e., either Volvo or Scania. The timetable for getting the Hyperion products finished had, on the other hand, once again been revised, possibly because of the move, and the goal was now spring 2013.

All in all, I was not impressed when Xanthoulis hung up but I was still curious about the report he said he would send. When it finally arrived it proved again to be a report with the author's name redacted. This time, however, it was done electronically in a .pdf document and because Defkalion had sent it to a few people and soon it was circulated. Immediately someone discovered that it was possible to select and copy the redacted name and paste it in plain text anywhere. Defkalion changed the document but by then it was too late. The author was Michael Nelson, the NASA propulsion-technology engineer—the same person who had organized the meeting when Rossi visited NASA in Huntsville in July 2011 and had also been present when the TEM Capital group visited Rossi in Bologna in September the same year. The report stated that the test at Defkalion had been made from September 6-8, 2012, exactly one year after Nelson's visit to Rossi in Bologna. It also happened to be the same days that the Swedish investors had visited Rossi.

Another document that Defkalion posted briefly on its website, out of carelessness or perhaps deliberately, stated that Michael Nelson had made the visit to Defkalion as understudy to Professor Michael Melich from the Naval Postgraduate School in Monterey, who had made his first visit to Defkalion almost a year before. The report was fairly extensive but contained no data, only a sort of checklist of what had been implemented and a summary of the results. The summary was interesting, though Nelson stressed that the results must be considered provisional until more accurate tests had been performed. He stated that Defkalion's device produced 1.5-3 times as much energy as the input electrical energy, and that the reaction seemed to produce more energy than was possible by chemical means—so it should involve some type of nuclear reaction .

So far it was in line with Rossi's technology but Nelson had also witnessed a control run without hydrogen—as everyone had asked Rossi to do. During the control run the device produced no net energy, another sign that the technology worked. Since the measurement values were missing we refrained from publishing the report. Though Xanthoulis had said that a technology journal would publish it in late October, the report never showed up anywhere. But on the whole, there were now more reports that strengthened the position that Defkalion really had something, though I still knew much less about Defkalion's technology than about Rossi's.

The next thing that happened in the fall was the start of the Martin Fleischmann Memorial Project, MFMP, which proved to be an entirely new element in research on cold fusion. The project was born at an international conference on LENR held in Korea, the week after the National Instruments' event NI Week: ICCF (International Conference on Cold Fusion), organized in 2012 for the 17th time. Despite its long history it had lately been visited by a relatively small group of researchers and observers who all knew each other and who stubbornly refused to give up interest in the area. In 2012, however, interest had increased significantly.

“Essentially my revisiting cold fusion was stimulated by Rossi’s publicity and I think that a number of the people at ICCF were there for the same reason,” said Bob Greenyer, a 40- year-old British engineer and serial entrepreneur over a crackling phone line shortly thereafter.

Greenyer said he had become very disappointed with the dark outlook envisaged for humanity, especially the spasmodic search for oil under the threat of *peak oil*—the culmination of the world’s total oil production, with dwindling oil supplies following.

“I had really been looking for anything that could get us out of the hole we seemed to be falling into,” said Greenyer.

On the second day of ICCF he had begun to discuss options with a Swiss entrepreneur, Nicolas Chauvin. Chauvin was 38 years old, an engineer who ran a company that envisioned creating LENR-powered cars—cars that would be refueled once a year at most. Greenyer, who had worked in the finance industry, found that the great uncertainty about cold fusion made the technology in practice ‘un-investible’ and that he wanted to change that.

The two immediately saw the opportunity to exploit the social dimension of the Internet and during the conference they drew up plans for the project along with like-minded people they quickly persuaded to join. The basic idea was to finally make the area acceptable by presenting a credible experiment to the public. First they would refine a precise and repeatable experiment that clearly showed net energy production unexplainable by a chemical reaction, thus necessarily involving a nuclear reaction. They would then build at least five setups of the experiment and donate them to some of the world’s most respected academic institutions. The institutions would conduct the experiment simultaneously, live broadcast, all data available via the Internet and media.

The social dimension consisted of two parts. The first was to fund the project via *crowdfunding*—collecting voluntary contributions via the Internet. The goal was half a million dollars. The second was live broadcasting and transparency which MFMP applied from the start. They blogged continuously and put up pictures and videos on their web site during the preliminary design work. When the first experiments finally started in late 2012 they showed all the data on a Web page in real time during the experiments. All the time they welcomed discussions and comments, not just to increase transparency but above all to capture knowledge from interested people following the project. As others had noted, they knew that cold fusion was an elusive phenomenon that required expertise from various disciplines since it seemed to span several scientific fields such as chemistry and physics. By pursuing the project openly on the

Internet, MFMP wanted to increase the chance of gaining access to all possible knowledge from as many angles as possible—the opposite of the present situation in which a few scientists worldwide had sat alone in their laboratories and persistently followed different tracks. In fact MFMP hoped in the longer term that the model of open research in real time could be applied to other areas. I agreed that the idea was exciting and could fundamentally change conditions for many types of scientific research.

MFMP's first experiment was the one that Professor Celani performed during NI Week, which he repeated during ICCF-17 in Korea, precisely while Greenyer and Chauvin began their discussions. Celani liked the idea and participated gladly. He sent pieces of the specially prepared wire of *constantan* to MFMP and advised on reactor construction and other important issues. He had also sent the wire to a dozen other scientists and institutions around the world, hoping that they could repeat his experiments.

“There’s always a risk that there is something wrong with my equipment and until the experiment is repeated by independent groups it is too early to cry about miracles,” Celani said to me in mid-October.

Celani seemed always to be in a good mood but he excused himself whenever he called me, as though he thought he was interfering. During his career he had often had a tough time, among other things because cold fusion had been so thwarted.

“It is very difficult, full of obstacles, and it is unclear why. There’s so much research that is not of any use or going bad and no one tries to hinder it. This one is potentially useful, yet it’s hindered. Strange. It makes no sense. During my 36 years in academia I have never seen such a fury. The research is cheap but whatever you do, it is immediately accused, fired upon. It makes no sense.”

MFMP, however, had difficulties getting its equipment working and the initial results were inconclusive. An acquaintance of Celani, Ubaldo Mastromatteo, who worked at the Swiss semiconductor giant ST Microelectronics, reported in December 2012 that he had managed to repeat the experiment but considerable uncertainty remained.

What finally convinced me was a new report on Rossi's latest reactor and a conversation with the scientist standing behind the report—the physicist Giuseppe Levi at Bologna University whom I had met at Rossi's first public test in January 2011. The 20-page report, well written in English, dropped into my mailbox in early January 2013. When I read it I realized that there was no reason to hesitate any longer. This time, measurements had been made for four consecutive days and much more stringently than all previous measurements on Rossi's technology, including the four I had been involved in. Though Levi had been careful in all his assumptions he concluded that the reactor had been operating stably and continuously and produced about six times more energy than the electrical energy input. A picture in the report, especially after I discussed it with Levi, made the strongest impression on me. It showed a reactor about to disintegrate when the reaction bolted out of control. Two strong bright yellow glows, like two tiny suns, seemed to shine right through both steel and ceramic. The reaction had become so hot that parts of the reactor were glowing. The electric cartridges did not account for the heat—they appeared like black shadows against the hot reaction.

"One spot began to grow. We tried to shut down the reactor but could not. Then we heard a loud bang from inside the reactor. It all took a few seconds," Levi told me, as snowflakes drifted down outside my window.

When they disassembled the reactor they found that the ceramic shield containing the reactor had melted, and it should withstand up to 2,700 degrees Celsius. The steel tube containing the fuel had a large hole in it and Levi saw on the edges of the hole that it had not melted—it must have been so hot that the steel boiled or burned up, indicating a temperature around 3,000 degrees. The reactor collapse had been achieved more or less deliberately, to find out what could happen. Basically it was not dangerous—no radioactivity was produced and it had nothing to do with the meltdown of a nuclear power plant. All that happened was that the reactor was destroyed. Similar situations were easy to avoid by not driving the reactor so hard, yet it indicated the potential of the reaction and how much remained to discover and develop. Again, this was what had attracted Levi. He had already received intense criticism for his past involvement in Rossi's first public test in January 2011 and he knew he would also be criticized this time. For safety, he signed the report with his name only and left the university out, because management still disagreed over how the contact with Rossi should be handled. And he had also been careful not to charge Rossi for the work.

“If I were wise I would start working at CERN where I would be guaranteed to get my name on at least one hundred scientific papers each year. But I’m not wise but instead make sure to end up in tangles, in search of new physics,” Levi said to me. “But if we are not here to write something new, what are we here for?” he added rhetorically.

The report also impressed Kullander and Essén—Levi had sent it to them for comment. The university administration had even threatened Levi with dismissal if he continued to experiment with Rossi’s technology. Levi’s proposal was therefore that the group around Kullander, Essén and the Svedberg Laboratory would assess the report and possibly endorse it officially, while proposing research collaboration between Uppsala and Bologna University. The Uppsala researchers thought it was interesting but decided that if they were to endorse the report they first wanted to participate in a repetition of the experiment. Now I found out that Bo Höistad and Björn Gålnander, who had been involved when Rossi did the failed measurement at the Svedberg Laboratory in April 2012, visited Rossi in Bologna a few months later —June 10-11. They then did measurements on the new hotter reactor Rossi had just developed but neither this time observed heat production.

“Rossi is upbeat and enthusiastic and gets carried away, and he said that it works maybe not so much, but it works. But Björn and I said that the measurements showed that there was no effect within limits of error,” Bo Höistad said. “But we were not at loggerheads about it in any way,” he added cheerfully.

Now that Levi’s report showed that the reactor seemed to work, the researchers in Uppsala were happy to give it another chance and eventually planned a week of measurements in March 2013. On Sunday, March 17 Lars Tegnér and Torbjörn Hartman flew to Bologna to attend the measurements that started in Rossi’s new premises in Ferrara on Monday. Rossi had arranged a room where Levi and the Swedes could work undisturbed with their own instruments, while he stayed away as much as possible. The plan was to run the reactor for at least 100 hours and for the Uppsala group to be represented at all times, the Swedes succeeding one another. The head of the Svedberg Laboratory, Björn Gålnander, joined the others in Ferrara on Wednesday together with Hanno Essén, Roland Pettersson and Bo Höistad, and the last representatives then went home on Sunday, 13 days later.

I soon learned from the group that the reactor had run stably for over 100 hours and the results looked positive and reliable. Now I waited for their official findings to finally report rigorous measurement by qualified researchers that Rossi's technology really worked. But their report was delayed. Everyone involved knew it would be controversial so they worked hard to make the conclusions as restrained as possible by focusing on the developed thermal energy that was abnormally large. They didn't speculate on what reaction could cause the energy release.

Publication was also delayed because the experiment was discussed intensively by the Svedberg Laboratory board, causing Björn Gålnander to choose eventually not to participate as a co-author.

Not until May 20 was the report published on the web site Arxiv.org, with the title *Indication of anomalous heat energy production in a reactor device* [56], by Levi, Essén, Hartman, Höistad, Pettersson, Tegnér and a former graduate student of Levi, Evelyn Foschi, who also participated in Levi's measurments in December 2012. Arxiv, run by Cornell University, was the site where Focardi and Rossi had sent their paper in spring 2010. Though Arxiv didn't customarily apply peer review but only performed a simple control that the content had a reasonable scientific level, Focardi's and Rossi's paper had been rejected, partly because the topic was so controversial. This time it almost ended identically, I discovered later.

The day after publication a person contacted the editors at Arxiv to point out that Steven Krivit, in connection with the article, had published links, known as trackbacks, which led to two of his own critical blog posts. The person called the links spam and said that Krivit had previously attempted to destroy other researchers' careers. The person referred to a description that Nobel laureate Brian Josephson had made of Krivit's actions in several cases [57]. An internal email conversation that was included accidentally in the response from Arxiv's editor revealed the administrators' view on the paper, Krivit and Josephson. An administrator named Paul wrote to his colleague Jake:

"Cold fusion dispute, we didn't want [the Swedish-Italian paper with number] 1305.3913. Obviously wrong, but written by authors with affiliation and past pub records and we can't claim they're lying or confused. The trackback 'spam' is weirdly more reliable than the article.

"No idea who [this person] is, but appealing to Brian Josephson as a source of sanity is not

likely to gain much traction. (...)

"Krivit was a friend of Fleischmann's (...) so he's weirdly trying to protect 'correct' cold fusion claims from 'fraudulent' ones."

Though at Arxiv the subject was apparently still controversial, the report was published. The authors stated that the energy production from Rossi's device was far beyond what was possible with a conventional chemical reaction, even if the calculations were made as conservatively as possible, i.e. assuming that all possible errors were maximal and to the detriment of the total energy calculation. They also noted that a careful analysis of how the temperature curve moved up and down during operation indicated that there was indeed a source of heat inside the device, in addition to the electrical resistances that kept the reaction going.

On Rossi's blog, *The Journal of Nuclear Physics*, congratulations poured in in a way that reminded me of when Rossi, 19 years old, had run 24 hours and set a record on a running track in Brescia. Elsewhere he received criticism but it was not as immediate as in the past, partly since the test this time was performed very carefully and possible sources of error minimized. My editors at *Ny Teknik* decided that we would only publish a short statement on the report and the measurements. They asked me to cite critical voices and I turned to the physicists Peter Ekström at Lund University and Göran Ericsson at Uppsala University, who had previously been skeptical. Ericsson declined on the grounds that the report's authors this time did not mention nuclear reactions and thus it was not in his area of expertise. But Ekström compiled a document criticizing the report [58] though upon closer examination many of his comments had already been investigated in the report, which Bo Höistad, spokesman for the group, also pointed out when he saw Ekström's document. For my editors the most important thing was that we reported criticism. Our readers would decide what was credible.

A week later Alessio Guglielmi, associate professor of computer science at the University of Bath, wrote a much-publicized open letter to the team where he mainly questioned the ethics of performing the measurements. First he noted that if the discovery was genuine it would alter the history of mankind. But because the published article did not contain information that enabled others to repeat the experiment—repeatability being a cornerstone of the scientific method—Guglielmi asked how the experiment advanced our knowledge and whether it was ethical for scientists to participate in it. What do we learn and who will benefit from the report? Guglielmi wondered.

Some people considered Guglielmi’s message contradictory. If there was a technology that, if genuine, could alter the history of mankind, wouldn’t this kind of measurement on that technology have the potential to advance our knowledge and also benefit mankind?

A month later it turned out that Ericsson still wanted to express his views. He and his colleague Stephan Pomp compiled a detailed critical report that they published on Arxiv [59]. Like Guglielmi, Ericsson and Pomp focused first on ethics rather than science. They began their report by questioning the authors' independence of Rossi; arguments in their report were based on the possibility that Rossi was an impostor. In addition, they presented a series of technical comments that were more or less well founded. On various online forums Ericsson's and Pomp's report was severely criticized, some critics even arguing that the low quality of the arguments was a proof that the original Swedish-Italian report was excellent.

Bo Höistad preferred that the dispute be handled internally at Uppsala University but he eventually replied strongly to Ericsson's and Pomp's criticism in an interview with the Italian online magazine International Business Times [60].

"It is very unfortunate that Ericsson and Pomp

resort to bad and mischievous comments. Accusing colleagues with a long and distinguished series of hundreds of scientific papers published in the most important international journals in physics, of being engaged in pseudo-science is simply a severe insult beyond any reasonable level of a decent academic behavior. Honestly, I am ashamed of having colleagues at the University of Uppsala that do not refrain from personal attacks of such a low level."

Eventually the debate silenced and again I had been mistaken when I thought that well-conducted and rigorous measurements would increase the interest to at least discuss and investigate the phenomenon. Now I began to believe that no test, no result and no measurement, however well implemented, would have significant public impact. Only when the technology was commercially developed, if it worked and was available in retail stores, could it arouse public interest, I thought. That was more or less what

Rossi had always maintained and I realized that I was now ready to prove him right.

This was in June, when the days grew longer and the nights ever lighter and shorter, coming to the shortest night of all, when in Sweden one can marvel at the midnight sky that barely becomes twilight before brightening again. On the night of June 22, 2013, Professor Focardi passed away in Bologna after a long illness, 80 years old. I had hoped he would live longer. Focardi had helped Rossi with scientific advice and had given him the decisive impetus to continue with his work. He did not live to see the outcome that the publication of the Swedish-Italian paper perhaps meant for the technology. He had been taken to hospital one month earlier and fell into a coma while processing of the paper dragged on. Levi did, however, show him a draft at his bedside while he was still conscious. Focardi had made a brilliant scientific career and accounted for important contributions in the research on LENR with nickel and hydrogen. But like Fleischmann and other skilled researchers in the field who had passed away recently, Focardi never received recognition for this in his lifetime.

§

Later in the summer I finally had the opportunity to make my own observations on Defkalion's technology and to meet Xanthoulis and chief engineer John Hadjichristos. In early July I was asked if I wanted to participate as an observer in a demonstration that Defkalion would make of its technology a few weeks later. The demonstration was to be conducted at Defkalion's development offices in Milan and webcast directly in association with the LENR conference ICCF-18, being held at the University of Missouri. Since I was on vacation on the coast of Italy I could easily take the train to Milan where sweltering heat with scorching asphalt and mercilessly sunlit facades waited—in the city only air conditioners could provide the relief that the northwesterly mistral wind and the shadow of the towering shore pines gave to those who made their way to the sea during the Italian summer.

I had received information that several other people, including a scientist from CERN, would be involved as independent observers at the demonstration and I therefore didn't prepare in any special way for the measurements. Just in case, I brought simple electrical measuring instruments. When I came to Defkalion's office on the afternoon of July 23 I was met by Xanthoulis. Though we had never met he seemed familiar after our telephone and Skype calls—slightly hoarse voice, short gray hair and short stubble, lightly furrowed face, bushy eyebrows, short and a little sparse eyelashes around his narrow, gently sloping and thoughtful eyes. Often with a cigarette in his hand.

He introduced me to Hadjichristos who showed me the measurement setup—basically similar to that which Rossi had used earlier, with water heated and boiled to steam, but slightly more professionally designed and with more advanced equipment. Hadjichristos, clean shaven with bushy, slightly graying hair and peering eyes behind rectangular glasses, showed me the measurement equipment eagerly and enthusiastically—the wiring and the reactor itself, a short steel cylinder slightly thicker than a wine bottle with sturdy steel flanges at both ends surrounded by an insulating ceramic block and enclosed in a metal cube with about one foot side. Inside the reactor there should, as in Rossi's reactor, be a few grams of fine nickel powder with additives, and later also hydrogen. The heat of the reaction would heat the water that was led through a tube connected to an ordinary faucet at one end, wrapped several turns around the reactor, with its outlet in a sink where hot water or steam could escape.

When the measurements were to begin and the webcast launched, I again acquired a role I had not predicted. Someone or some of the other observers —I never found out who—did not show up and one of those present did not want to appear on camera. Hadjichristos therefore asked

Alexandros Xanthoulis behind Defkalion's

Hyperion reactor at the demo in Milan, August 2013. Photo: Mats Lewan

if I might consider checking the measurements and I wondered if I were the only person in the world who agreed to take that role in the context of controversial technology, or possibly the only one who might be fooled publicly. But I agreed and we started. We started with a calibration of water flow to verify that the measuring instruments showed correct values, followed by a control run with argon gas instead of hydrogen. After this the real measurement with hydrogen in the reactor began and, if one relied on the measured values, everything worked, with an energy release in the same order as in Rossi's reactors.

I checked all the details of the experiment as best I could without preparation but even if I did find a value that did not fit—a value that lacked a critical influence—I realized that I could not in any way guarantee that everything was executed correctly. To do that required a much more accurate control of all the equipment and even additional observations that Defkalion seemingly did not agree to make—for example, let the steam out in the room for a while to observe steam flow. In my eagerness to explore everything I managed, however, to cause a mishap. By connecting a measuring instrument to the power supply of the setup in a wrong way, I triggered a so-called residual current device, cutting off the power in the whole building—all lighting, computers, instruments and also the webcast. The situation was embarrassing but luckily it happened between the control run and the active run and had no serious consequences either for the measurements or the equipment. In addition the interruption showed that the power supply came from the public grid.

It was valuable to have seen Defkalion's technology in operation but I was on the whole still unsure of the result. Since I was on vacation from *Ny Teknik* I waited to discuss the measurement with my editors and instead wrote a short report about my observations on my own blog[61], where a discussion quickly took off with nearly 500 comments. Among other things I wrote :

"My general impression is that it's a process that is similar to what I have seen at Rossi's demos. If you believe the values presented, it produces thermal power in the order of kilowatts from a very small amount of fuel."

John Hadjichristos at Defkalion's demo in Milan, August 2013.

Photo: Mats Lewan

I received much encouragement for my effort as an observer but as usual views diverged on what conclusions could be drawn. Even Franco Cappiello and Luca Gamberale, president and chief technology officer for Moses srl—the Italian company with which Defkalion run the development office in Milan as a joint venture—had unanswered questions after the survey and they decided to put all commercial activity on hold until Defkalion could carry out a measurement that dispelled their doubts.

Defkalion's reactor might have been working during the experiment. I didn't doubt it but the demonstration could not give me an equally convincing basis as the Swedish-Italian measurement on Rossi's reactor. Rossi stated during this period that his technology was now in the hands of his American industrial partner. In early July 2013 he claimed that the industry partner had successfully produced its own functioning reactor based on his instructions.

"For the first time an E-Cat not built by me, not controlled by me and not charged by me, not tested in my factory, but manufactured by third parties upon my instructions and know-how has worked properly. It is the first of millions, but the first is always special," as he put it on his blog in July 2013.

He also seemed satisfied with his situation. A few months later he wrote:

"I must say that in this period I am working very well because I have no more to think about patents, production or the daily business, but only about the R&D and the science of the reactors. (...) I feel like I'm 'playing in the majors'. I'm also working in an area at very high technological and strongly industrialized level, with access to any necessary instrumentation; when I need some instrument I have just to ask for it, and I receive it in matter of days, if not hours."

This was in contrast to how pressed he had been just a few years earlier when several industrial partnerships had been canceled and the megawatt plant was to be tested. Domenico Fioravanti, who then worked closely with Rossi on behalf of the unidentified military customer, described him in hindsight in a post on the web forum Cobraf.com:

"Rossi is not an obsessed and incompetent person. His expertise is high in several areas as a result of decades of work with technical applications and studies to achieve his goals. But the constant media pressure and the economic difficulties when the contract was canceled, combined with his resolute determination, made him work harder than was sustainable, and to commit several mistakes along the way. But as they say, he who makes no mistakes usually makes nothing at all. Finally, he reached his goal, but the path consisted of exhausting work filled with difficulties."

If one were conspiratorially inclined, this meant that Rossi was bluffing and was now sitting on a Pacific island with pockets full of money, collected from people who were still waiting for him to show and deliver a workable technology. It seemed unlikely. I could only infer that he really had an industrial partner who had thoroughly verified that the technology worked and now was developing commercial products.

One hint was that the few companies that had acquired local commercial licenses from Rossi to sell products based on his technology got an offer in late 2013 implying a termination of the license agreement and the refund of the license fee plus ten percent. A couple of licensees confirmed this and at least one had accepted the offer. Even the most kind-hearted scammer would never suggest such a refund, I thought.

At the end of 2013, furthermore, strong indications regarding the identity of Rossi's industrial partner appeared. Traces began on the social network LinkedIn where one Rossi employee had briefly posted a position at a company called Industrial Heat LLC, leading to the US investment company Cherokee Investment Partners in Raleigh, North Carolina[62]. Cherokee had nearly $2 billion under management, investing primarily in redeveloping brownfields—former industrial sites—especially through solar-powerplant projects. Cherokee CEO Thomas Darden was an experienced industrialist with renowned environmental commitment and with a wide personal network in various fields. In 2012, a new entity had been formed under Cherokee, with Darden as chairman. The entity—Industrial Heat LLC—seemed to have been created to develop and commercialize Rossi's technology.

According to the Chinese website Icebank.cn, Darden had visited China in the Fall of 2013 and had met, among others, with a Chinese representative for national planning of low-carbon energy production, as well as representatives from a couple of other bodies that answered directly to the Chinese Premier Li Keqiang. Icebank.cn reported that the discussions had regarded collaboration on a new and inexpensive nickel-based energy technology that did not emit greenhouse gases or other pollutants, did not produce radioactive waste and did not need to be powered by coal, oil or other fossil fuels[63]. Darden later made a careful comment in which he confirmed the meeting but did not reveal anything about connections to Rossi or his technology[64]. Indications, however, suggested strongly that he was the CEO whom Rossi had identified previously as the key figure for his industrial collaboration in the United States.

If China was involved at the level that Icebank.cn stated, Rossi's technology could get a significantly faster diffusion than otherwise expected. China was perhaps the one nation whose need for an alternative and environmentally-friendly energy source was most acute. China's coal consumption, already the largest in the world, was generating emissions so enormous that 750,000 people were estimated to die prematurely because of air pollution each year [65]. Despite this, expansion of coal-burning powerplants continued and when the first severe winter smog struck in early 2014 the contents of micro dust measured 671 micrograms per cubic meter, 26 times higher than the WHO limit of 25 micrograms per cubic meter regarded as safe[66]. An economy in growth and a population of over a billion people who needed food on the table and roofs over their heads, with a steadily rising standard of living, also meant that energy needs were constantly increasing.

Rossi's technology could hardly be handier for China. And with its high levels of engineering expertise, its strong governmental control and relatively limited regulatory restrictions, China could probably bring the technology into use more quickly than the U.S. and many other countries.

Hardly had this information spread before Industrial Heat confirmed the acquisition of Rossi's technology, in a press release on January 24, 2014.[67] According to the press release a primary goal for Industrial Heat was *"to make the technology widely available, because of its potential impact on air pollution and carbon dioxide emissions from burning fossil fuels and biomass."* The company referred in its press release to the Swedish-Italian test of Rossi's technology but also said that it had been evaluating the technology with its own personnel and an independent expert. Rossi confirmed that he was chief scientist at Industrial Heat.

We made a relatively brief report on the press release in *Ny Teknik*. Slightly more reports than had appeared previously also found their way into other news media, but, by and large, mainstream media and particularly scientific journals maintained their silence. On the other hand, a recent study had shown that the influence in the research community from scientific journals such as *Cell, Nature* and *Science* had decreased considerably in recent decades with the emergence of the Internet[68]. Maybe a change was underway that could create a new and more efficient environment for research in general, thanks to faster and more open communication within the scientific community, increasing the chance for new and unexpected discoveries.

Even in my own newsroom skepticism remained high, except for a few interested colleagues who occasionally asked me about the development. When we had news meetings and discussed various energy issues there was never any question about including LENR or cold fusion, not even as a potential opportunity. Book publishers I contacted to release this book declined or wanted at least to postpone publication pending more convincing proof that Rossi's technology really worked.

I reflected on the skepticism and suspicion I had met along the way. One example I remembered was the media watchdog radio show *Medierna* on Swedish national radio SR, which in November 2011 devoted a lengthy feature to criticizing my reporting without any real knowledge of the technology itself. If the technology was now functioning, they and other critics could in retrospect perhaps admit that I had nevertheless made a correct assessment but it was easy to forget how difficult it had been during the voyage. To venture into such a controversial area as cold fusion as a scientist, entrepreneur or journalist, risking that it turns out not to work, was the real challenge. Yet I would defend anyone who did it, against all odds. I believed that we needed to study phenomena and ideas with so much potential if there was the slightest belief that they could work. I also felt that it would be an even bigger mistake to completely miss such opportunities than investigating something that might not work.

§

On the afternoon of 29 January, 2014, while pondering these considerations, I suddenly received the news that Professor Sven Kullander had passed away the day before.

For a moment I felt as if time stopped. His passing was a great loss, even for those of us who were in the periphery of his life. Kullander was an enthusiastic and committed person and a great physicist, and to the end of his life he was active as chairman of the Royal Swedish Academy of Sciences Energy Committee. I admired him for his open mind and his courage in resisting established views if he felt it was necessary. I can never forget his surprising comment about Rossi's technology, the first time we met: "You have to embrace this." Despite occasional harsh criticism from colleagues, he never abandoned the position that you had to investigate the technology more thoroughly before you could determine if it worked or not. And he was eagerly curious about what phenomena could be lurking in its interior.

He was critical of several ideas that Rossi had proposed, but to my knowledge he never doubted Rossi as a person. This also reflected another aspect of the events during these years that was perhaps as important as the physics and the technology itself: Rossi, the man. I thought that the critics erred when taking Rossi's behavior as a reason to dismiss his technology, though his idiosyncratic character apparently made it easier for many to attack him. Fioravanti, who had worked closely with Rossi, made a similar assessment:

“It seems clear to me that Rossi has been widely underestimated by his opponents, both in terms of his professionalism and his personality. He has qualities that make him stand out from the crowd. He has (...) a fierce determination to achieve results. And he is smart, ambitious and unsinkable. The reverses of life have hardened him rather than smash him, as would have happened to most people. They made thorns grow on him. Krivit does not make him a bit.”

And in author Jed Rothwell’s apt description of Rossi’s behavior I saw a kind of summary of this whole story:

“Rossi often exaggerates about his business and other personal things, but as I have often said, when it comes to technical claims, he tells the

truth. Also, he does what he says he will do. He said he would make a 1 MW reactor and by golly he did. (...)

"If that 1 MW gadget was fake, it was the most expensive and elaborate fake in the history of fake energy devices. Most fake devices are small, cheap and thrown together. I've seen many of them.

"Despite his flamboyant personality and his irritating habits, Rossi is a force to be reckoned with. I think it is foolish to dismiss him, or make fun of him, or assume he is a fraud. I can see why people fall into this trap. As I have said, I think Rossi wants people to think he is a fraud. Many inventors have wanted this.

"I admit I could be wrong about all of this. But history shows you should not bet against irritating, exploitative, monomaniacal geniuses such as Edison or Jobs, and Rossi sure looks to me like one of them." [69]

56. http://arxiv.org/abs/1305.3913

57. http://www.tcm.phy.cam.ac.uk/~bdj10/art
58. http://nuclearphysics.nuclear.lu.se/lpe
59. http://arxiv.org/abs/1306.6364
60. http://it.ibtimes.com/articles/52396/20
fredda-gravi-critiche-test-
indipendenti-intervista-bo-hoistad.htm
61. http://matslew.wordpress.com/2013/07/24
on-defkalion-reactor-demo-in-milan/
62. http://www.e-
catworld.com/2014/01/examining-the-
rossi-industrial-heat-cherokee-
connection/
63. http://www.icebank.cn/news/detail_2.php
id=113
64. http://www.bizjournals.com/triangle/blo
raleighs-cherokee-trying-to-cut-
an.html
65. http://www.ft.com/cms/s/0/8f40e248-
28c7-11dc-af78-
000b5df10621.html#axzz2qt5lRYi0

66. http://www.dailymail.co.uk/news/article
2540955/Beijing-clouded-smog-way-sunrise-watch-giant-commercial-screens-Tiananmen-Square.html

67. http://www.prnewswire.com/news-releases/industrial-heat-has-acquired-andrea-rossis-e-cat-technology-241853361.html

68. http://phys.org/news/2012-11-reveals-declining-high-impact-factor.html

69. http://www.mail-archive.com/vortex-l@eskimo.com/msg78278.html

A new world

Like all revolutionary new ideas, the subject has had to pass through three stages, which may be summed up by these reactions: (1) 'It's crazy – don't waste my time.' (2) 'It's possible, but it's not worth doing.' (3) 'I always said it was a good idea.'

Arthur C. Clarke [70]

What will all vocal critics of Rossi and his technology say if it turns out that it works? I have mulled this question ever since I became involved in this story three years ago. As I write, in the winter of 2013-14, I believe that I could soon get an answer.

There is still no generally accepted evidence that the technology works, but I leaned in that direction early. Since the end of 2012 I have become almost convinced. Levi's measurement, later part of the Swedish-Italian report, was decisive, as was his account of how the reactor was destroyed by the extreme heat of reaction when it 'ran away.' Levi testified that his faith in Rossi increased since Rossi, during that period, agreed to everything Levi asked to measure. In addition, Rossi's descriptions seem credible and coherent, not least in terms of his industrial collaboration in the U.S. *Au fond*, my own observations and contacts with the people involved over the years, plus the Swedish-Italian report, finally strengthened my conviction. Critics are equally convinced that Rossi has not yet discovered or demonstrated anything of interest.

It's hard to understand the critics but I may have more information than they do on which to base my assessment. Among all impressions, the descriptions of when the reaction has run amok have been most important to me. I see them as a strong indication of something that can hardly be a mistake, error or deliberate scam. On the contrary, they appear to be nature's whims around a power that we have not yet learned to tame. It is not just about Rossi: equally important is the information on the various other groups that are closing in on the strange phenomenon.

Defkalion is still difficult to assess, but if their claims and observations can be trusted, as I was able finally to observe them at the demonstration in Milan in July 2013, they might have made the most progress. I still have doubts though. Celani's experiments and the attempts to replicate the effect, not least by the Martin Fleischmann Memorial Project, look promising. Piantelli seems to be having success with his methodical research, but I know little about this. However, I became aware that his collaboration with the American group at TEM Capital has ended for various reasons. Then we have Brillouin Energy, which I know least about. Like Defkalion, they may be developing a genuine commercial product. Another US company that is difficult to assess is Black Light Power, which has been developing a somewhat similar technology for several years and held a demonstration on January 28, 2014, with unclear results. BLP, however, has a completely different physical model than the others to explain the effect. In addition, companies are trying to 'fly under the radar,' including the Finnish firm Etiam, whose work became known when its patent application on a technology that appears to have much in common with Rossi's became public in May 2013.[71]

Moreover, the more than one hundred published scientific reports mentioned before show that the process has been observed, albeit with poor stability.[72] Though most cold-fusion critics ignore it, advocates—via many documented experiments with established methods and proven equipment—have demonstrated that the phenomenon is real, more solid support than is available to many far less controversial phenomena. Meanwhile, many critics have surprisingly hollow arguments. [73]

Over all, that body of evidence supports the strong argument that cold fusion or LENR actually exists. Given its potential as a new, clean, flexible and inexhaustible energy source, I cannot see any sensible arguments to halt research in this field. On the contrary, significant resources should be invested in discovering everything there is to learn about the phenomenon and to examine every possibility. Yet public awareness of what might be happening remains minimal, partly due to opposition to the idea of cold fusion and but also because of the distrust of Rossi.

Rossi's openness to criticism makes it easy for critics to attack him. But to decide in advance that his process is impossible seems unwise. The Swedish-Italian report shows credibly that it produces energy. No one argues that it's some form of *perpetuum mobile* that conjures up energy from nothing; its energy is bound in matter, released by some form of nuclear reaction (see appendix). No one yet understands how it could be based on known theory, or even exactly what it looks like. Though cold-fusion theorists believe that the phenomenon does not violate conventional theory, that shouldn't be a major issue. Established physical theories have been thrown over, historically, and today's theories are not immune to that fate. On the contrary, there's so much we still do not know and it does not take much to overturn an entire theory. Seemingly robust physical models can collapse at any moment when a piece of the puzzle does not fit.

One such piece of the puzzle is what the author Nassim Nicholas Taleb calls a *Black Swan*—the analogy is that black swans were long regarded as an example of something unthinkable, until they were observed in Australia in 1697. Another of Taleb's criteria for what he calls a black swan is that this odd piece of the puzzle has an immense impact on some area. No doubt a new, hitherto unthinkable form of nuclear reaction would have major consequences in the world.

In his book *The Black Swan—The Impact of the Highly Improbable*, Taleb points out that these unexpected events are what push all development forward. He reflects on how they tangle the financial market, since many tend to plan for uncertainty only in the context of the expected. By contrast, no one anticipates truly unexpected yet decisive events.

Within technology we're not as badly off: large, surprising leaps—breakthrough inventions—happen regularly at shorter and shorter intervals, though it's hard to know in advance which inventions will be crucial. Besides, in technology the process between leaps—engineers' ongoing work to refine and develop inventions until the next pops up—is as important as the leaps themselves.

New inventions are based on fundamentals and skills already in place. The biologist and researcher Stuart Kaufmann calls this phenomenon *the adjacent possible*—a concept that the author Steven Johnson develops in the book *Where Good Ideas Come From, The Natural History of*

Innovation (2010):

"The adjacent possible is a kind of shadow future, hovering on the edges of the present state of things, a map of all the ways in which the present can reinvent itself."

You could say that the most unexpected and surprising inventions rely on adjacent possibilities that are furthest away, hardest to see and that few even believe are possible. Some of the most creative and inquisitive minds explore unknown territory and discover these opportunities—in this case Fleischmann, Pons and Rossi, among others, embarked on a journey of discovery.

That such a discovery is unexpected is no stranger than the resolution of a joke. In many respects it is the same. We laugh at the resolution of a funny story when we suddenly realize that it was obvious, had we interpreted the beginning differently. That we don't interpret the introduction this way depends on our brain, which is specialized to take in one piece of the puzzle at a time, and see how those pieces fit into any pattern we already know or think is meaningful. The brain is simply frugal and does not like to think in new ways. It does not store a new pattern until it has made clear that it really is a new pattern, not one already known.

Lateral thinking is a creative-thinking approach that the British physician and author Edward de Bono developed. Among other things it aims at circumventing the brain's thrift. One of the methods it espouses is to systematically investigate peripheral ideas that we, thinking rationally, dismiss as unthinkable and meaningless. These digressions can lead to unexpected discoveries that suddenly seem obvious once we discover them —much like the twisted ending of a joke. Yet such discoveries are elusive, because we often have to explore improbable and sometimes even forbidden ground. You can see it from another parable that Steven Johnson offers for 'adjacent possibilities:'

"Think of it as a house that magically expands

with each door you open. You begin in a room with four doors, each leading to a new room that you haven't visited yet. Those four rooms are the adjacent possible. But once you open one of those doors and stroll into that room, three new doors appear, each leading to a brand new room that you couldn't have reached from your original starting point."

Let's say that one room has a fifth door, hard to open because it has a challenging lock. Or that it's simply difficult to see, so that most people think it doesn't exist or that even if it exists there is no point trying to open it because it must lead nowhere. To wrestle with the door that may not even exist is a waste of time and a sure way to be accused of folly. But while most of us shake our heads and walk past, a few stay stubbornly and try to open the door because they believe that something amazing is on the other side. Suddenly, after long and diligent work, we get the door open and it turns out that there is a whole house on the other side, or maybe even a whole world, radiantly beautiful and different from the hitherto known. Once you see it, it's quite understandable and natural.

It was hard to imagine from inside that small room. Furthermore, we find that there are many ways to get there but that all the other roads were, if anything, even harder to discover than the first, from inside the room. The new could be discovered only because it lay within the 'adjacent possible.' But the door that led there was improbable and unacceptable to most people. The road was prohibited: exactly what cold fusion has been considered for more than 20 years, since Fleischmann's and Pons' results were rejected by a majority of the scientific community just a few months after their presentation. To find the key to what now looks to be a new energy source, the pioneers have had to traverse the forbidden and unthinkable idea of cold fusion.

That the idea was labeled as unthinkable a few decades ago thus appears to have been a fatal mistake; the lesson seems to be that we should oppose scientific prohibition more often, which is, on the other hand, highly sensitive. It's particularly threatening near a so-called *paradigm shift*—where pieces of the puzzle that don't fit established theories in a scientific area overturn everything and force us to design new theories and new explanatory models.

Science philosopher Thomas Kuhn coined the term 'paradigm shift' in 1962 and concluded that such difficult pieces of the puzzle are considered unsuccessful research—until, that is, they become so obvious and undeniable that they lead to a scientific crisis. Eventually a new paradigm is born with new models and theories. To illustrate how difficult it is for many researchers to embrace such a new theory system, Kuhn is said to have quoted the legendary physicist Max Planck, whose theories led precisely to a paradigm shift:

"A new scientific truth does not triumph by convincing opponents and making them see the

light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it.” [74]

As I have mentioned, Machiavelli observed that *“there is nothing more difficult to take in hand, more perilous to conduct, or more uncertain in its success, than to take the lead in the introduction of a new order of things. For the reformer has enemies in all those who profit by the old order, and only lukewarm defenders in all those who would profit by the new order.”* Then he added: *“This lukewarmness arises partly from fear of their adversaries, who have the laws on their side, and partly from the incredulity of mankind, who do not truly believe in anything new until they have had actual experience of it.”*

One individual who tried to understand the resistance to cold fusion was the science journalist Eugene Mallove, who published the magazine *Infinite Energy*, and a renowned research profile in the area, tragically murdered in May 2004. In his book *Fire from Ice: Searching for the Truth Behind the Cold Fusion Furor* from 1999, Mallove cites Leo Tolstoy:

"I know that most men, including those at ease with problems of the greatest complexity, can seldom accept even the simplest and most obvious truth if it be such as would oblige them to admit the falsity of conclusions they reached perhaps with great difficulty, conclusions which they have delighted in explaining to colleagues, which they have proudly taught to others, and which they have woven, thread by thread, into the fabric of their lives."

In this story I have also noted two main approaches to the new and unknown, also applicable to scientists virtually regardless of the facts presented: *genuine openness* to new phenomena and new mindsets and *apparent openness*, i.e. only for things that do not threaten widely-established views. Among the apparently open, disruptive news becomes particularly difficult for scientists and others with in-depth knowledge.

The discomfort, faced with the threat to being forced to abandon knowledge acquired with great effort, perhaps explains the massive resistance to the idea of cold fusion that Fleischmann and Pons attracted in the scientific community. But whether the discovery forces a paradigm shift in physics or not, the fact that the idea of cold fusion was labeled unthinkable and effectively banned for more than twenty years ago appears now to have been a serious mistake, if there were only the faintest hope that the phenomenon was real. As an indication, just consider one of the most immediate possible applications—clean water for everyone on earth.

WHO estimates that about 3.5 million people die every year from lack of clean water[75] and that 780 million people lack access to safe and clean water sources.[76] Purifying large amounts of water takes cheap, readily available energy. If the scientific community had let itself play with the idea of cold fusion, *though* it should be impossible, a new energy source *might* have been discovered much earlier. And saved millions of lives each year. So when considering what Rossi's critics will say and how they will save their faces, it's not just about those who have criticized him for the moment but all those who have resisted the idea of cold fusion since 1989.

Among the most outspoken critics, whom of course I respect, have been highly educated individuals such as Professor Ronald G. Ballinger, Professor Frank Close, Emeritus Professor Robert L. Park, Professor William Happer, physicist and editor David Lindley, Dr. Francis Slakey and the late Emeritus Professor John R. Huizenga. All have made statements more or less along the lines with what Dr Slakey, Science Policy Administrator of the American Physical Society, wrote in 1993—that cold fusion scientists are *"a cult of fervent half-wits (...) While every result and conclusion they publish meets with overwhelming scientific* *evidence to the contrary, they resolutely pursue their illusion of fusing hydrogen in a mason jar. (...) And a few scientists, captivated by [Fleischmann and Pons'] fantasy (...) pursue cold fusion with Branch Davidian intensity."* [77]

They and many others will get help in finding an excuse for their resistance if it turns out that the term cold fusion in itself can be discarded as defining the physics behind the new nuclear reaction. This is possible, even probable. It's still not clear from a theoretical perspective what kind of reaction it is and how it works but there's an indication that it is a complex process definable in various ways, without using the term fusion. Moreover, nobody knows really what cold fusion would be—it's mostly an idea about a phenomenon that no one has yet been able to explain in detail. If you can find a different name, critics will say something like this:

"I have always believed that it was possible to find a new kind of nuclear reaction—it was the

idea of cold fusion I regarded as impossible. And now we know that I was right."

Many also feel that Fleishmann's and Pons' big mistake was to use the term 'cold fusion,' because it created so much suspicion. Would I say, instead, that the crucial mistake seems to have been the opposite—to discredit the idea of cold fusion, though it seems unlikely, since it is precisely this idea that now seems to have borne fruit, though perhaps not in the form of something that physically could be called 'fusion' as we have come to understand it. This idea gave Rossi and others inspiration to continue stubbornly in their search for a new energy source. It aroused their curiosity, gave them hope and a goal. What can we learn? Not to dismiss promising and inspiring ideas because they seem unreasonable but to examine them without prejudice and with an open mind and see where they lead. It can't hurt anyone. Indeed, some ideas could lead to discoveries that change the world.

So I return to two classic arguments used extensively to dismiss Rossi's technology: *"If it seems too good to be true, it probably is"* and *"Extraordinary claims require extraordinary evidence"*—the latter a famous quote by astronomer and author Carl Sagan. Those using such arguments will probably say something like: *"Yes, the likelihood was really high that it was too good to be true,"* and *"I was just waiting for the extraordinary evidence, and finally it came."*

First, extraordinary claims require no extraordinary evidence. As with everything else for which inventors seek support, credible evidence is required, achieved with calibrated measurements, proven methods and standard instruments—as the Swedish-Italian group executed.

Then consider the 'too-good-to-be-true' argument. The British chemist and physicist Michael Faraday said that *'Nothing is too wonderful to be true, if it be consistent with the laws of nature.'* Most of the discoveries our current society are based on would have seemed too good to be true a thousand years ago. You could use the expression about scams such as Nigeria Letters, indicating a surprisingly large inheritance or similar improbability, but when a discovery comes along that could potentially change the world, indifference or dismissal seems to signify a lack of curiosity and disinterest in real change. Or perhaps even unwillingness to consider the possibility of a breakthrough. I may be wrong and the cold-fusion critics may be right. If I'm wrong I will at worst be embarrassed for having been naive or gullible, while the cost of discarding the idea of cold fusion or LENR, if the technology works, is high.

Because with an energy source delivering cold fusion's expected characteristics, changes over time may be huge, more extensive than many imagine: heating, cooling and clean water to the world, a possible solution to the climate crisis, clean and silent vehicles—boats, trains, planes, automobiles, spacecraft and personal air vehicles

—offering virtually unlimited range at low cost, sharply lower prices of raw materials, revolution in the agricultural sector, completely changed military conditions, the beginning of the end for the oil and nuclear industries and the transformation of all electric-power distribution. This is probably just scratching the surface.

We often fail to imagine new inventions' eventual uses. It's difficult to predict how they interact with other technologies, and what ideas pop up when product engineers and entrepreneurs worldwide address them and evaluate their strengths and weaknesses. Few imagined that the laser could eventually be used in eye surgery, digital memory, DVD players, communications, bar-code scanners, screen pointers and industrial cutting systems. Edison, who invented the phonograph, had little idea of its significance to recorded music. The first cars were considered horseless carriages, showing how we often think more in terms of things we have around us than on technology opportunities.

What is remarkable about the new energy source is its functional familiarity—a small, innocuous device that produces heat, a basic form of energy, a newborn cousin to fire, but cleaner, safer and a million times more efficient. Because it requires so little fuel—itself inexpensive—it is potentially very low cost. So it is relatively easy to imagine how it could be used, at least in the most obvious applications.

As a source of heat, merely replacing fire, it could provide significant benefits. According to the WHO, three billion people use open fires and leaky stoves for cooking and heating, daily. Over one million people die each year from the lung disease COPD, acquired from breathing polluted indoor air, while almost half of all deaths from pneumonia among children under five is also due to the poor air where fires burn indoors. Moreover, collecting firewood takes a lot of time from women and children, reducing their ability to perform other productive work and go to school.[78] A clean, new heat source, free of radioactivity and emissions, can potentially address this problem, equally applicable to any other heating method.

Two other applications are in air conditioning[79] and local electric-energy generation—cheap, compact and clean, carbon-free and relatively silent. A special opportunity with low-cost heating and electricity would be the possibility of creating unprecedented conditions in all climate zones for vertical farming—greenhouses in urban environments with artificial lighting and cultivation on multiple floors—which could potentially revolutionize the agricultural industry and improve the prospects of producing food for the world's growing population at a time when existing crops, such as corn, have exhibited rapidly rising prices due to their alternate use as a fuel source, while simultaneously causing starvation in areas where those costs have escalated.

Another obvious application is, again, clean water for the world's people. A new energy source based on a new nuclear reaction could provide an improved chance of survival to millions who die each year from the lack of clean water. With abundant cheap energy, one could desalinate seawater and clean dirty fresh water, for example by boiling and distilling water or by other technologies such as reverse osmosis. Water desalination costs huge amounts in hot, dry, wealthy countries, while it's too expensive to consider in poor countries. Lower energy prices could change the conditions for desalination. Combining the process with local electricity generation would further reduce the total cost.

Slingshot, developed by entrepreneur Dean Kamen, inventor of the self-balancing two wheeled *Segway*, achieves this. *Slingshot* desalinates water and can turn virtually anything wet into clean drinking water via a process based on vapor-compression distillation. It also supplies electrical power and is intended to work for long periods without maintenance. *Slingshot* is powered by a *Stirling* engine—an advanced version of the steam engine that needs only a heat source to spin. Heat is what the new energy source offers. Has Dean Kamen developed an idea about this yet?

Other new water-treatment and desalination technologies are under development. Nanoasis is working with a kind of extremely fine filter for reverse osmosis, where water but not salt passes through. Defense giant Lockheed Martin has recently developed a similar technology with a material called *Perforene*, based on graphene—the Nobel Prize-winning form of carbon that consists of only a single layer of atoms. Both Nanoasis and Lockheed Martin use filters with holes sized in nanometers.

Reverse osmosis consumes a lot of energy—the water must be forced through the filter, but in nanotechnology the resistance is lowered since the small holes are adapted to the size of water molecules. This lowers the required energy significantly but energy is still needed and a new, flexible energy source would open new opportunities. To provide the entire population with clean water and save millions of lives a year should, in any case, be within reach with abundant supplies of clean, cheap energy.

In general, a new, efficient energy source could potentially solve many major world problems. Or as Peter Diamandis and Steven Kotler put it, in their 2012 book *Abundance, The Future is Better Than You Think*, in which they argue successfully for the possibility of providing the entire population of the world with access to water, food, healthcare, education, energy and freedom within 25 years:

"Energy is arguably the most important lynchpin for abundance. With enough of it, we solve the issue of water scarcity, which also helps address a majority of our current health problems. Energy also brings light, which facilitates education, which in turn reduces poverty."

Yet Diamandis and Kotler don't give LENR or cold fusion a single word—another sign of the phenomenon's enduring bad reputation. I share their vision that despite all the dire predictions we face a historic opportunity to improve the lives of all people on earth, thanks to the exponential development of technology such as the Internet, artificial intelligence, robotics, nanotechnology, digital manufacturing and synthetic biology. I also agree that the sun is one of the most promising energy sources.

As many have noted, the total solar energy hitting the earth is thousands of times larger than the world's total energy consumption. The sun thus gives us more than we will ever reasonably need, if we develop our energy use sensibly, and is thus an obvious choice. All energy on Earth, except nuclear energy, comes originally from the sun; wind, oil, coal, gas, wood, waves, hydro power—all generated by the light and heat from the sun.

The problem is technical—to extract solar energy efficiently enough and to store and distribute it so that it can be used at night and in places with minimal solar radiation. The problem should be soluble—Swedish researchers made recent progress in raising solar-cell efficiency well above ten percent with a low-cost technology based on carbon nanotubes.[80] LENR can complement solar power—just as clean, continuously accessible, small, flexible, and inexpensive.

Besides potentially solving world problems, the technology offers two different possible effects. One is lower oil prices—some environmental economists assume that if a real and attractive alternative to oil appeared, the price of oil would fall immediately, even if the alternative may be many years away. That's because the oil producers would try to sell as much oil as possible before the impact of the alternative energy source will be felt. The paradoxical consequence would, in that case, be an immediate increase in oil consumption and thus also in carbon emissions.

The argument against such a development is that we may be close to or past the peak of the world's total oil production—also called *Peak Oil*. Further increasing oil production would require exploiting sources where oil extraction is expensive, inconsistent with falling prices, for example in the Arctic, where intense exploration is underway.

The second possible effect of functional LENR would be intense discussion of all R&D and attempts at harnessing 'normal' fusion as an energy source. Normal fusion—'hot' or thermonuclear—is the nuclear reaction occurring in the sun and stars, which many hope will become the inexhaustible source of energy that the world needs to escape fossil fuels and conventional nuclear power. Compared to nuclear power (fission of nuclei), fusion (of nuclei) has several advantages:

- It can't lead to meltdown—a fusion reactor will stop immediately if something goes wrong.

- The fuel—'heavy hydrogen,' or deuterium, present in large amounts in normal seawater—is not radioactive

- The waste is radioactive for a much shorter time than usual nuclear waste.

It sounds good. The problem is that temperatures of hundreds of millions of degrees, even hotter than the sun and stars, are required for it to work. The trick is to keep the superhot material—the plasma—suspended via strong magnetic fields inside the reactor chamber. Along with the challenge of dealing with the very powerful radiation from hot fusion, this makes the technology very expensive. Fusion research is devouring billions of dollars and euros, yet the energy extracted from the reaction has yet to surpass the energy needed to ignite it. Once the fusion has started it has extinguished in less than a second, or at best a few minutes.

In 2009 construction was started in Southern France on ITER, the world's largest experimental fusion reactor. It is an international venture that according to recent estimates should cost over €15 billion and is not expected to be completed until

2019. It will not be used for commercial power generation but only to sustain a fusion reaction that finally provides more energy than it needs, lasting up to nearly an hour. Defending this venture should be difficult if a new kind of nuclear reaction becomes a genuine alternative. The same fate would then also affect all other research into hot fusion for energy production.

All this—solving world problems and the impact on oil prices and fusion research—are direct consequences of a new, clean energy source. Long term, we can only guess. In general, a new, compact, flexible energy source should eventually find its way to wherever energy is needed. But much depends on future research and development.

At universities, researchers will reasonably pounce on an area that has been taboo and risky to investigate for over twenty years but should now appear as a huge, unopened bag of candy—a gigantic, unexplored treasure. This attracted the researchers in Bologna and Uppsala. What will evolve cannot be known but it could lead to discovering related phenomena involving different materials, even revealing new perspectives on the properties of matter. Such research should help companies working with applied research and development of LENR. Even for them, infinite possibilities beckon—optimizing the original technology, exploring alternative ways to control the reaction to obviate electrical power, miniaturizing the technology, for example in batteries and scaling it to higher power levels for large-scale energy production.

Development of applications for different industries will also reasonably be established. This is also what Defkalion claims to focus on, in collaboration with major industrial companies. The use of the technology should initially be limited by the fact that the energy release can't be regulated rapidly. Most obvious is energy supply to ship and train engines, where relatively continuous and smooth power development works well. Since the new fuel only needs to be refilled every six months—a few grams of nickel and a little hydrogen—ships and trains could be run continuously for months, even for years if they can be re-charged on the go, without emissions. Meanwhile, operating costs should be significantly reduced, lowering shipping costs and thus changing the economics of a wide range of industries.

Aircraft and spacecraft could be powered with the technology, whence Boeing's and NASA's early curiosity. For aircraft, emissions and fuel costs would be eliminated, leading to greatly reduced prices. Eliminating the weight of the fuel, while freeing the space now needed for fuel tanks, would increase passenger or cargo capacity. New energy-intensive engines could enable cost-effective vertical takeoff and landing aircraft, or VTOL.

In space applications, it's not only about propulsion but also about energy in space vehicles and fixed bases, reflecting NASA's interest. At once, longer expeditions, primarily to Mars, would become more feasible. Prototypes for alternative rocket engines that use heat energy from radioactive decay to expand gas already exist and to replace the radioactive heat source with a new and clean energy source should then not be a major problem.

Vehicle applications, such as in cars and trucks, though attractive, may take longer. The technology is not yet sufficiently flexible—you can't, for example, instantly increase and decrease power output, typically performed in internal-combustion engines with the throttle. But given the huge market potential for cheap, clean vehicle operation, over virtually unlimited mileage, significant resources should immediately be invested to solve the problem. The solution may lie in electric power, where the new energy source charges the batteries, though expensive, heavy and hazardous batteries, as currently used, are undesirable. A motor principle based on the direct use of the heat would be preferred, perhaps via technology based on Stirling engines, as in the water-treatment machine

Slingshot.

Once a technology to drive motors directly with the heat has been refined, the step would not be far from other areas where energy-consuming engines are used—pumps, cranes, fans and more. Long term, the technology could be miniaturized and used even in tiny engines, opening up all sorts of applications ranging from household appliances to medical technology, such as artificial hearts and muscles. All this may be dismissed as speculation, but hardly as impossibility.

What happens to the oil and power industries if any of this becomes reality? Based on the theories of carbon dioxide's contribution to global warming, the interest should be great to replace coal and oil with the new energy source. If so, how quickly can we adjust? The problem is that the single largest use of oil is road transport, consuming 46 percent of the total world oil consumption in 2007.[81] Shifting to a new energy technology for use in road vehicles would take time. Meanwhile, increased oil consumption via lower oil prices would remain a risk.

But when cars based on LENR arrive they should grab a large market share, because adoption would be a choice made by individuals and organizations. Even if oil prices fall, road vehicles using the new technology should cost less to operate than traditional ones. Being able to drive virtually unlimitedly mileage for six months without reloading the reactor would make the choice easy for buyers replacing a car. Reduced emissions would be a bonus and the conversion might be boosted via incentives already used for hybrid and electric vehicles in some countries.

Driverless vehicles, currently under intense development, could contribute to the rapid renewal of the world's vehicles since autonomous vehicles offer so many practical and environmental advantages and because human driving will eventually be considered too dangerous. Moreover, a shift towards driverless vehicles could reduce the number of cars in the world significantly, since driverless vehicles in automated systems could be used by many more people.

If oil can be rendered obsolete also in aviation, maritime and rail transport, and for heating, process industry and power generation, global oil consumption will soon be reduced to about a tenth—the part used in the petrochemical industry to produce plastics, synthetic fibers, synthetic rubber, dyes and more. This would be what would remain of the oil industry. But even if petrochemical products are needed, even that part of the world's oil consumption might not remain.

The author Jed Rothwell, who for many years has followed research in cold fusion, discusses this issue and, perhaps more thoroughly than any other writer, the possible consequences of such an energy source in his .pdf book *Cold Fusion and the Future*, released first in 2004.[82] Rothwell points out that oil can be produced synthetically, primarily from coal and water, though the process requires a lot of energy—as much as is released when burning the oil. Using clean, low-cost energy, this would be a minor problem. On the contrary, it would be more convenient, cheaper and safer to produce petrochemical products synthetically near the point of use, instead of pumping oil out of the ground and transporting it great distances, Rothwell thinks. Thus the last element of the oil industry would be threatened.

Rothwell does not stop at zero oil production. He envisages producing oil from carbon dioxide and water and pumping it into the bedrock as a kind of carbon trap, to reduce atmospheric greenhouse gases—i.e. a reverse operation of the existing oil industry. This could reduce carbon dioxide concentration in the atmosphere faster than just by reducing emissions.

Still, to reduce atmospheric CO2, Rothwell also imagines that through massive irrigation with desalinated water, a third of the Sahara and Gobi deserts could be re-vegetated, reversing the Man's desertification. It would initially require 1,560 cubic kilometers of water per year, feasible only with a clean, cheap energy source.

To boil that much water to desalinate it, starting from water at 20 degrees Celsius, would require 1.1 billion gigawatt-hours per year, equal to the continuous operation of about 100,000 nuclear power plants. At an energy cost of $0.3 cents per kWh—which Rossi anticipated in the early stages—desalination alone would cost $3,300 billion[83] per year, roughly what the economist and Nobel laureate Joseph Stiglitz has estimated that the Iraq war cost overall.[84] Project feasibility is uncertain. But it puts in perspective the possibility that a new and clean energy source at least may reduce the oil industry to zero.

The power industry may seem unthreatened by a new energy source. The logical approach is to scale the technology to plants generating hundreds of megawatts, as a heat source in existing power plants for electricity generation. Examining energy use in such a scenario shows that this is not a good idea. Electrical energy is produced mainly in power plants where heat from coal, oil, gas or nuclear reactions heats water to steam, driving turbines that drive large generators.

The problem is that the laws of thermodynamics limit the efficiency of the process. A larger portion of the heat energy—about two thirds—is excess heat that literally goes up in smoke. And to use waste heat, e.g. for heating, is difficult because the power plants are large and usually located far from densely populated areas for safety reasons. Significant energy is lost when the electricity is distributed long distances over the power grid—equivalent to about ten percent of the original energy. Useful electrical energy available to consumers is eventually only about a quarter of the heat energy that drives the turbines.

If the new technology can produce electricity locally for homes or neighborhoods, while taking advantage of excess heat for heating or air conditioning—a concept known as CHP or Combined Heat and Power—efficiency can be significantly increased. And if motors can run directly with thermal energy, not electricity, the efficiency would be even greater.

Electrical energy could be produced by steam-powered mini-turbines driving a generator, but consider the development of increasingly efficient thermoelectric generators—i.e. the technology Rossi studied in the 1990s that generates electricity directly from heat, without using steam, turbines or other moving parts. If the thermal generators attain sufficient efficiency, they could produce electricity from the new power source, and take advantage of excess heat.

Large power plants and extensive power grids could thus be seen as redundant, while representing an infrastructure with significant maintenance costs. It could take time before the new energy source could be scaled to produce electricity in power plants, and by having to rely on conventional power technologies, the power industry could find it difficult to compete on price. If the demand for distributed electricity gradually decreases with local energy production, as argued above, the maintenance costs would become increasingly burdensome and would ultimately reduce profitability. According to this reasoning, the power industry's days may be numbered, just as the oil industry's could be.

But peak household electricity consumption significantly exceeds average use. So equalization is needed, which a vast network offers, through—for example—'wheeling,' the transfer of surplus energy from one grid to another grid in need. But equalization could be more local, where a neighborhood or city shares common power and heat production. Another driving force is that society may be less vulnerable to breakdowns, accidents and sabotage if the grid is more local.

There is already a push towards *smart grids* that, among other things, will enable local electricity consumption and production at all points in the network. One reason is the need to connect local energy production, e.g. wind and solar power. So rather than making the power grids superfluous, a new energy source may drive the development of smart grids. By contrast, traditional nuclear power should phase out gradually if a new energy source starts to supply electricity, avoiding the major risks of nuclear power without having to produce more electricity from fossil fuels. It is difficult to use the excess heat in large nuclear power plants and nuclear plants are potential terror targets. Only the nuclear industry would mourn them.

Another aspect is generating power at remote sites, not only for households but also for technical facilities, just as many mobile networks' most distant base stations are powered by diesel generators that must be refueled regularly. For the telecommunications industry, this could mean significant cost reduction and new opportunities for mobile coverage in sparsely populated areas.

Defkalion appears to contemplate the great impact that the technology can have on the power industry and the plan seems to be to achieve collaboration.

"Everyone will produce the energy they need, both thermal and electrical. However, this process will not be immediate but will require a time that can range from 10 to 20 years. You'll have to allow time for the big players in energy distribution to develop their assets in synergy with the new technology without it being traumatic," said Luca Gamberale, chief technology officer for Defkalion's new European development office in Italy, a joint venture with the Italian company Mose srl, in an interview with the online magazine *Affaritaliani.it* in early 2013.[85]

Rothwell and others who think along these lines thus conclude that a new energy source built on a new nuclear reaction can provide the world with heating, cooling and clean water and save millions of lives. It could propel vehicles, revolutionize aviation and aerospace, sharply reduce carbon emissions and lead to the decline of the oil and nuclear industries, and a shift towards smart grids in the power industry. Such technology in vessels could also significantly reduce the cost of shipping and hence for all goods transported by sea—a majority of all freight globally. In addition, lower prices could come for all sorts of raw materials, especially energy-intensive ones, leading to lower costs for manufacturing and other industrial activities in numerous areas, including the agricultural sector.

Further ahead, many completely new applications could become possible with energy that is clean, cheap and compact—i.e. has high energy density. An example: personal flight vehicles, such as *quadrocopters*—helicopters with four rotors that have become both a popular toy for consumers and a tool for researchers and industrial uses—for example, camera-equipped pipeline inspection and agricultural surveys. A particular advantage with quadrocopters is that they can be operated precisely, without pilot training, via an electronic system controlling its four rotors. Scientists worldwide have shown how groups with several quadrocopters can follow each other in formation, playing ball and even playing musical instruments.

A larger model carrying a few people could be controlled automatically via satellite-based navigation, coordinated with nearby quadrocopters. The key would be clean, inexpensive operation—fuel for several months flying would weigh only grams. New opportunities would also be opened for smaller quadrocopters that with conventional, rechargeable batteries have only ten-minute flight time. The new nuclear reaction, scaled to battery size, could power small aircraft, potentially airborne for months, usable for much more extensive tasks, ranging from long-range reconnaissance missions to telecommunications.

One such development is from Matternet, a company that wants to build a network of autonomous quadrocopters in Africa as an alternative to road infrastructure for key transport, such as medicine. Inspiration comes from the Internet's transport of information where data is divided into small packets. Matternet wants to do the same for material. Instead of going to a medical center on foot for a day or more, a patient can consult a doctor via video. With a few keystrokes on a cell phone the doctor could order shipments of medicine—via Matternet, it could arrive in hours or minutes. With conventional batteries the quadrocopters need intermediate battery replacement at charging stations every ten kilometers. If the power supply used LENR, they would have practically unlimited reach. Does Matternet understand this possibility?

The same opportunities would be valid for other small aircraft such as *Nano Hummingbird*—a hummingbird-sized concept developed as a reconnaissance tool by AeroVironment for the U.S. Department of Defense, and for versions of controversial drones or UAVs, unmanned aerial vehicles used by, among others, the U.S. military in unmanned military attacks.

This may initiate new military operations. Rothwell suggests armies of 'robot chickens'—small, autonomous flying robots equipped with artificial intelligence and unlimited flight time. Such flying armies could handle everything from reconnaissance to devastating sabotage and massive attacks, making traditional weaponry meaningless. Slightly closer is the threat of small, inexpensive, long-range drones that could be used by criminal groups or in terrorism. With limited means they could scout and attack virtually anywhere in the world.

Another conceivable application is swarms of smaller flying objects, 'mechanical insects,' for military use. Such development is being conducted by the U.S. government-backed consortium Micro Autonomous Systems and Technology, MAST. In spring 2013 a research group at Harvard University implemented the first controlled flight of a biologically-inspired robotic insect weighing only 80 milligrams, with a one-inch wingspan.[86] Though the feat was remarkable, the flight was restricted because the 'insect' required power via a thin wire. One missing ingredient, to achieve a free-flying insect robot and eventually swarms, is an compact and sustainable energy source.

These visions and many others, equally spectacular, may prove correct. They may also seem false, though possible in principle. In any case they may seem daunting to many and it may be worth putting them in a perspective of future technology development.

Above all, a new energy source based on cold fusion or LENR may not necessarily be as unique as it may seem, since big leaps in technology historically come more and more often. Entrepreneur and author Ray Kurzweil has observed this. He argues that the almost improbable development within semiconductor technology described by *Moore's Law*—the number of transistors on integrated circuits doubling every two years—is part of a constantly accelerating, exponential growth that all development has seemed to follow since the origin of life.[87]

Exponential growth is not intuitive. Despite data showing that development is accelerating continuously, it's more natural to think that it is progressing at a steady pace. If things are progressing steadily, an energy discovery of this dimension would be unique. And to those looking at life around them, development seems to progress at a constant speed—acceleration is not noticed, viewed over a few years. But with a longer perspective, exponential development is deceptive, if we believe that everything is moving forward at a steady pace.

One way to illustrate this is the legend of the inventor of chess. As a reward from his ruler he had asked for one grain of rice on the first square of the chess board, two on the next, then four, eight, sixteen, and so on—exponential growth, doubling at every step, just as in Moore's Law. The ruler thought that this was a modest claim but to his dismay realized that the total was more rice than existed in the whole country. In the first half of the chessboard there would be over four billion grains, or about 100 tons of rice. But the dramatic effect of exponential growth is its force when it really takes off; on the second half of the chess board, growth would be so great that the rice would become a mountain higher than Mount Everest. Then consider the next step, when the chessboard is finished. Since each square contains a grain of rice more than all the preceding squares together, the next square would contain another equally huge mountain, plus one grain.

Since 1965, when Intel's Gordon Moore formulated his observation, we have not reached even half the chessboard in the case of semiconductor development. Reflecting on the dramatic increase in computer capacity since then, imagine what awaits. Many have predicted that Moore's law will fail, though it has described semiconductor development for fifty years and looks set for at least another ten years. Others believe that it is based on a kind of self-fulfilling process via the following reasoning: since the industry expects this development, everyone must try to follow the curve. The risk is falling behind, thus everyone together ensures that the exponential curve is followed.

Several arguments refute these claims, e.g. that corresponding relationships are demonstrably valid for many other technologies, some applying long before Moore made his discovery. Kurzweil also developed a simple model based on the idea that each developmental step uses the past progress. Whatever is developed somewhere in a system, e.g. nucleated cells, sexual reproduction, spoken language, the wheel, the knife, the internet, accelerates development in the whole system. He calls it *The Law of Accelerating Returns*. Mathematically, it is easy to show how this leads to exponential growth. The conclusion is simple—technical progress continues inexorably to accelerate and crucial developmental leaps come closer and closer.

Doubling the over-all pace seems to happen every ten years, so the 2000s would result in a development about one thousand times greater than during the 1900s, and the following century a million times more. A major contribution to accelerating development should gradually come from the billions of people who, according to Diamandis' and Kotler's vision, will have their basic needs met within a few decades. They would then for the first time have the time and resources to contribute to over-all development, not least with new ideas from different horizons. Maybe they will get this opportunity via a new energy source. Considering the accelerating nature of the development, the new energy source is not necessarily a historically unique discovery. On the contrary, other discoveries of equal merit might reasonably be expected in a nearer future.

Another writer who reflects on technology development is Kevin Kelly, in his book *What Technology Wants*. Kelly discusses how we best can manage, embrace and shape technological inventions—our own creations. In a sense it can be compared to raising our own children. He uses the term *convival* in the meaning 'possible to live with'—a measure of how we can shape technology so that it works well with ourselves and with nature. He uses six characteristics to measure the quality of technology: efficiency, decentralization, flexibility, cooperation, redundancy and transparency. A new energy source based on cold fusion has good prospects vs. those criteria but the yardstick also offers us an idea of what we should pay attention to.

To spread it to as many users as possible worldwide, much like computers and cell phones, would increase decentralization. Flexibility and transparency would be improved if the secrets can be revealed and the technology freely modified and improved, via 'open source.' And the need for redundancy indicates a continued commitment to and integration with other sustainable energy sources like solar and wind.

In addition to his six criteria, Kelly takes inspiration from nature through a checklist of thirteen benchmarks that nature's own development constantly seems to seek. Kelly believes that our role is to facilitate the pursuit of nature, even in technology, and his benchmarks guide us as ways to measure whether a particular technology in its current form moves us in the right direction for better coexistence: efficiency, opportunity, emergence, complexity, diversity, specialization, ubiquity, freedom, mutualism, beauty, sentience, structure and evolvability. The list is useful for all kinds of technology. Sometimes it can help us imagine how we could develop a technology that seems to have retreated, though we should go ahead and refine it.

One example is industrialized farming, which often may seem to have lost the qualities that once existed in small-scale agriculture. Instead of reverting to less efficient methods—which would conflict with nature's way of evolving— Kelly's guidelines provide us an idea of what properties should be improved, for example, a drive towards increased diversity, which industrial agriculture tends to lack. As an analogy, we see that we should specialize the new energy source for many applications and spread it to different kinds of use worldwide. To provide increased sentience we should integrate it with IT and AI that according to Kurzweil could be expected to provide consciousness in machines within a few decades. To increase beauty we should make it as elegant as possible.

Without denying the importance of beauty in technology, IT-AI integration is perhaps the most important. However groundbreaking and revolutionary any technology might appear, powerful IT developments, possibly with nanotechnology and genetic engineering, are the areas that more than any others will change our lives in the coming decades, with dramatic consequences.

Many people think the IT revolution and the Internet as complete and more or less in place—an Internet that facilitates search, management and exchange of information, efficient trade and increases opportunities for social contacts and networking. Others who follow technology believe instead that IT development has just started, and that it will offer so much more.

In his analysis of exponential development Kurzweil concludes, startlingly yet believably, that IT will in just a few decades encompass all human knowledge and skills, including intelligent problem-solving and the brain's emotional and moral capabilities. He estimates that around 2050 computing power equivalent to all human brains on Earth will sell for $1,000. This is not mere blue-sky thinking. Kurzweil has shown great accuracy in previous predictions about technology, basing his analysis on the exponential development that seems to have been going on for billions of years without decelerating. The conclusion is startling but, on the other hand, one could ask why the curve would decelerate now, of all times in the history of the universe.

Those who believe that Kurzweil's analysis is not only reasonable but also probable, expect that the digital revolution will bring drastic consequences in industry after industry and will lead eventually to most human labor being replaced by automatic and intelligent systems and robots. Kevin Kelly is among those who argue insightfully about this development in his article *Better Than Human: Why Robots Will—And Must—Take Our Jobs*. [88] He and others describe a sharp change to which society will have to adapt, and should be added to the change brought by a new energy source. Awareness of this reality outside technology circles is limited. Politicians and economists, for example, with limited insights into technology, may be poorly prepared. But though robots and machines might take our jobs, it's not certain that man will be left in the lurch when the exponential development of technology takes off.

On the contrary, Kelly believes that robots, by assuming our jobs, will help us expand our dreams, find meaningful new tasks and become more human. Kurzweil believes that mankind will have to let computers help us keep up with the development, done in part, perhaps, by gradually integrating biological life and biological intelligence with the technology we have created.

The instant when machine intelligence will exceed biological is often called *the technological singularity*. It would end one era and launch another that is hard to describe because we can't know what choices a higher intelligence would make. One or more 'super intelligences' could come to dictate world development, and Professor Nick Bostrom, director of *The Future of Humanity Institute* at Oxford University, also considers super intelligences among what he calls existential risks—those that threaten the entire future of humanity. He emphasizes the importance of solving the problem of how we can ensure that a super intelligence will share our fundamental values, before we manage to build it—before the singularity.

Currently, no such solution exists. All ideas on how to create machines that are blocked so that they will not harm human life—*Asimov's Three Laws of Robotics* is perhaps the best known—fail, based on the rational assumption that super intelligences could eliminate any such barriers. A sustainable solution must instead be based on the existence of an inherent reason for super intelligences not to hurt humans. One such could be the observation that one of the most fundamental strengths of nature and the universe is diversity, and that any sentient being must realize this and be motivated to defend other living and intelligent beings, including humans, to increase its chances of survival. Another hope is that an intelligent machine created by humans, who in turn are a product of nature, must reflect the values that have emerged gradually with mankind, including respect for other intelligent beings.

The discussion is important, but no matter the solution, technology development, both before and after the singularity, is partly based on continually increasing efficiency, smaller dimensions and denser information. From this perspective a new energy source seems both a natural and necessary part of technological development and can contribute not only to information but also to energy becoming accessible to everyone around the world on equal terms.

Yet many worry about what a virtually unlimited supply of energy would mean for Earth. It’s a reasonable concern, but the pursuit of efficiency should reduce the risks. Besides, nothing realistically can stop our exponential growth or development, however described. It seems to be an inherent power of nature. We should follow nature’s pursuit of efficiency and balance of energy consumption as best we can. We cannot stop the exponential development but we can probably influence its direction and goals, and instead of economic growth aim for a better balance with natural resources.

Basically, this matches Kelly's message and though it may seem a daunting challenge I am optimistic. I have always believed in both nature's and humanity's innate ability to find the right way forward. Used correctly, the new energy source and its successors can be developed into a sophisticated, resource-efficient force that fits the quest Kelly has identified in nature.

But if an energy source built on a new nuclear reaction has really been discovered, though generally considered impossible, what we must do first is to put it to use and allow its surprising qualities to spread, which can happen faster than many believe.

Or as an Italian friend of mine puts it:

Al bello ci si abitua subito (Good things are instantly taken for granted).

70. Arthur C. Clarke. Report on Planet Three and Other Speculations. Harper & Row, NewYork, 1972, s. 70

71. http://www.google.com/patents/WO2013076 cl=en

72. http://lenr-canr.org/acrobat/RothwellJtallyofcol.pd

73. http://pages.csam.montclair.edu/~kowals

74. Max Planck, Scientific Autobiography and Other Papers. Philosophical Library, New York, 1949.

75. Pr"ss-■st"n A, Bos R, Gore F, Bartram J. Safer water, better health: costs, benefits and sustainability of interventions to protect and promote health. World Health Organization, Geneva, 2008.

76. WHO: Progress on Drinking Water and Sanitation: 2012 Update

77. Slakey, F., When the lights of reason go out - Francis Slakey ponders the faces of fantasy and New Age scientists. New Scientist, 1993. 139(1890): p. 49.

78. http://www.who.int/mediacentre/factshee
79. The technology to create cool from heat was invented back in the 1800s and refined in the 1920s by the Swedes von Platen and Munters in their famous refrigerator with no moving parts. Other similar technologies have later been developed.
80. http://www.nyteknik.se/nyheter/energi_m
81. World Oil Outlook, 2010, Organization of the Petroleum Exporting Countries.
82. LENR-CANR.org
83. 3,3 x 10^12
84. The Three Trillion Dollar War, Linda J. Bilmes, Joseph E. Stiglitz, W. W. Norton & Company, 2008.
85. http://affaritaliani.libero.it/green/fi energia-Defkalion-Europe1012013.html?refresh_ce
86. http://news.harvard.edu/gazette/story/2 insects-make-first-controlled-flight/

87. The Singularity Is Near: When Humans Transcend Biology, Ray Kurzweil, Viking Press, 2005.
88. http://www.wired.com/gadgetlab/2012/12/robots-will-take-our-jobs/all/

Appendix: E-Cat theory, or how to become a nuclear physicist in half an hour.

Exactly how the reaction of the new energy source works is, as I write, not clear. It is evident only that it should be a nuclear reaction of a new, hitherto unknown nature. To better understand what this means, consider a nuclear reaction. It is not very complicated—simply a reaction in which atomic nuclei are involved.

The atomic nucleus is a small body in the center of the atom, itself the building block for all visible matter in the universe. The nucleus consists mainly of two kinds of nuclear particles, protons and neutrons. They are similar in size and weight but the protons are positively charged, like '+' on a battery, while the neutrons have no charge. The number of protons in a nucleus may vary from one to about 100 and determines what kind of atom it is or, more specifically, which of the ~100 elements in the universe the nucleus is a piece of.

Elements are all around—hydrogen, oxygen, nitrogen, carbon, silicon, copper, chlorine, iron, gold, silver and uranium. Water, however, is not an element but a molecule comprising an oxygen atom and two hydrogen atoms. Nor is air, a mixture of different kinds of molecules, mainly oxygen molecules with two oxygen atoms and nitrogen molecules with two nitrogen atoms.

Around the proton-neutron nucleus spin electrons, forming a cloud of charge far outside the nucleus. Electrons are smaller than protons and neutrons but with a negative charge, like '-' on a battery. The charge equals the proton's, but reversed, and since atoms usually have the same number of electrons and protons, atoms have no charge as a whole—fortunate, else everything around us would be very electric. This is the atom at large. So what do atoms encounter in everyday life? Before we consider nuclear reactions, we must look at more common phenomena—chemical reactions.

Everywhere on earth and within ourselves atoms are constantly involved in chemical reactions that sustain life and society, for example, when the body burns food we eat or when gasoline burns inside a car engine. A chemical reaction means that atoms either bind to each other by sharing electrons in different ways, or separate and allow the electrons to return to their own atoms.

Some reactions require energy, called 'endothermic.' One example: plants' amazing photosynthesis, through which plants absorb carbon dioxide and water, which they convert into sugar and oxygen, using light energy. Other reactions release energy and are called 'exothermic,' such as the hydrocarbons in gasoline that burns in the internal-combustion engine in reactions with oxygen, wherein carbon dioxide and water is formed.

Electrons thus travel a little here and a little there, but nothing happens to the nucleus in chemical reactions. So the same elements remain before and after the reaction—when hydrogen burns, hydrogen atoms bind to oxygen atoms to form water molecules, but in the water molecule both hydrogen atoms and oxygen atoms remain as such.

Nuclear reactions are quite different and much rarer on earth. A nuclear reaction means that it's not the electrons but the atomic and nuclei particles that participate. Since the number of protons in the nucleus then changes easily, different elements exist before and after a nuclear reaction.

We focus on nuclear reactions from which we can extract energy, the exothermic. The main advantage of using nuclear reactions for energy extraction is that they can release a lot of energy for each atom involved—much more than chemical reactions, about one million times more. This means that little fuel is required in nuclear reactions, about a million times less to produce the same amount of energy. This is why the sun is so hot and burns for billions of years (the sun is powered by nuclear reactions) why atomic bombs slam so violently and why nuclear plants can produce so much energy from relatively little fuel.

At this point it's worth noting that all this energy comes from transforming minute amounts of matter completely into energy. After having released the energy, atoms both in chemical and nuclear reactions weigh a little less. It's hardly detectable—the decrease in mass is extremely small since the amount of energy that matter contains is huge. It was defined by Albert Einstein in 1905 in his classic formula $E=mc^2$, where E is energy, m is mass and c is the speed of light. Putting numbers into the equation you will find that one gram of matter, if transformed into energy, will yield about 25 gigawatt-hours, roughly corresponding to one day's production from a nuclear power plant or to the energy from burning 568,000 US gallons of automotive gasoline. The first atomic bombs also released about this amount of energy. They contained about six kilos of plutonium, but in the end only about one gram of matter was consumed at the explosion.

So even in nuclear reactions that already require little fuel, only a fraction of the matter in the fuel is consumed, but nuclear reactions are still a million times more effective than chemical reactions. This gives perspective of matter's potential source of energy, if we can find useful ways to harness the energy at will in controlled situations.

In essence, there have so far been two ways to get plenty of energy from nuclear reactions. One is to split large atomic nuclei—what happens in conventional nuclear power plants and atomic bombs—called fission. The other is to fuse small nuclei—which occurs in the sun and stars and hydrogen bombs: fusion. Both these nuclear-physics tricks work because nuclei are happiest when medium sized, roughly the size of iron atoms, with nuclei consisting of 26 protons and around 30 neutrons.

When large nuclei split and become smaller, they relax a little and then get rid of energy. The same thing happens when small atomic nuclei merge into larger—they feel more comfortable and release energy. One might say that the nuclei particles in these medium-sized nuclei are more tightly bound and when this happens energy is released, like something that falls into a hole and acquires kinetic energy we can extract. Similarly, we want to harness the energy released when nuclei are bound tighter.

One of our tricks is to extract energy through fission, a technology born in December 1942 when the Italian physicist and Nobel laureate Enrico Fermi started the first functioning nuclear reactor, *Chicago Pile-1*, under the football stadium at the University of Chicago. The trick with fission is to shoot neutrons against big nuclei hard enough so that they split. The excess energy is released as various kinds of radiation that becomes heat.

Fermi and the American Robert Oppenheimer later led the work of the world's first atomic bomb in the Manhattan Project. Fermi doubted near the end of his life whether humanity could handle the large forces in nuclear reactions.

"History of science and technology has consistently taught us that scientific advances in basic understanding have sooner or later led to technical and industrial applications that have revolutionized our way of life. It seems to me improbable that this effort to get at the structure of matter should be an exception to this rule. What is less certain, and what we all fervently hope, is that man will soon grow sufficiently adult to make good use of the powers that he acquires over nature." [89]

To continuously generate energy by fusion, as in the sun—not only in hydrogen bombs—has proved far more difficult to master than fission. As in the sun, you want to start with hydrogen nuclei, and in fusion reactors a variant called heavy-hydrogen is preferred. Hydrogen is the universe's simplest element with only one proton as nucleus. In heavy hydrogen there is also a neutron, which makes the atom about twice as heavy, hence the name. Yet it is still hydrogen because there's only one proton.

Heavy hydrogen—deuterium—is found naturally in sea water. In one water molecule out of approximately 3,200, one of the two hydrogen atoms is deuterium. It sounds little but suffices for fusion as an energy source to serve humanity for the foreseeable future.

Fusing two deuterium nuclei creates a few different possible reactions. Among other things, the nucleus of an even heavier version of hydrogen—tritium, with one proton and two neutrons—is formed, and also atomic nuclei of the element helium, with two protons and two neutrons. Immense energy and many free neutrons are released simultaneously.

Fusion is attractive because the fuel, unlike in conventional nuclear plants, is not radioactive and is abundant in the ocean. Waste after the process is much easier to handle than usual nuclear waste. Another significant advantage is that the fusion reactors can't suffer a meltdown but instead stop by themselves when something goes wrong.

The difficulty of achieving fusion, however, is that all nuclei are positively charged because they contain protons and therefore repel each other, like opposing magnets. Overcoming the repulsion—the 'Coulomb barrier'—requires boosting the nuclei's speed by raising the temperature. Atom nuclei move faster as temperature rises.

But the opposing force is so strong that temperatures of tens of millions of degrees are required, as in the sun and stars, to attain high enough speed. To accomplish this on earth is not easy. The main track is to build a kind of annular reactor, much like a tire tube, though much larger. Such reactors are called *Tokamak* and within them the superhot material—the plasma—hovers, held by powerful magnetic fields such that it should not touch the walls. In addition, people and equipment must be protected from the strong radiation produced, though how radiation affects construction materials during extended operation is not yet fully known.

Fusion research, as seen in Chapter 20, is very expensive. Despite huge spending it has not yet managed to produce a reaction that produces more energy than it requires. Perhaps investing in the ITER experimental reactor in France has begun to be discussed or has been terminated, as a consequence of a new kind of nuclear reaction that seems to offer a viable and attractive energy source, offering huge advantages.

Admittedly Rossi and many others were originally inspired by the idea of so-called cold fusion but it is not certain that the new nuclear reaction will be defined in this way. Yet it is easy to understand what was so attractive with cold fusion—you would get all the benefits of conventional fusion and also avoid almost all the disadvantages.

By letting the nuclei cross the *Coulomb barrier* at only a few hundred degrees or less, despite the opposing force between them, the reaction would immediately be easy to use and much cheaper. Abundant deuterium would be used, not radioactive fuel. But according to known physics, cold fusion should, just as hot fusion, cause radiation that must be guarded against. But in the experiments already undertaken significant radiation has rarely been detected. The hope has been that cold fusion would also have the fortunate property to be almost radiation-free.

It is thus easy to understand the fuss when electro-chemists Martin Fleischmann and Stanley Pons presented their findings at a news conference on March 23, 1989, stating that it was cold fusion. In Chapter 2 we saw that they based their conclusions in part on the fact that the thermal energy they had observed must come from a nuclear reaction, because there was insufficient fuel for the energy output to be explained by a chemical reaction (as we have seen, nuclear reactions release about a million times more energy for the same amount of fuel, compared with chemical reactions).

In their setup, two electrically conductive rods were immersed in heavy water—i.e. water with deuterium in the molecules—and one rod was made of palladium. They then switched on a current through the water through the rods. What then happens is electrolysis, which in this case means that the water is decomposed into its two components, oxygen and hydrogen; at one rod oxygen is formed and bubbles to the surface, and at the other rod hydrogen is bubbling.

The experiment itself—electrolysis of water—is a classic implemented regularly in schools worldwide as an example of an endothermic reaction, i.e. a reaction that requires the supply of energy, in this case electrical energy. Fleischmann and Pons let it bubble for weeks and then it suddenly became warmer than it should—significantly more thermal energy was released than the input electrical energy. Energy does not come from nowhere, because that would make it a *perpetuum mobile*, and few believe in that. To be precise, such a *perpetuum mobile* breaks the first law of thermodynamics—that energy can neither be created nor destroyed—and we don't want to change that.

Fleischmann and Pons had instead an idea of where the energy came from. The atoms of deuterium, which bubbled at the rod of palladium, were sucked in by the palladium atoms that happen to tie hydrogen well. They became so dense inside the metal rod that some managed to fuse in a nuclear reaction—their nuclei were so close that they overcame the Coulomb barrier and achieved ... fusion!

Many disbelieved the explanation. John R. Huizenga, who passed away on January 25, 2014, just before this book was published, was emeritus professor of chemistry and physics at Rochester University in the U.S. and President of the U.S. Department of Energy panel for evaluating research into cold fusion in 1989. In 1993 he wrote his book *"Cold Fusion: The Scientific Fiasco of the Century,"* in which he formulated three miracles required for cold fusion to work:

The first was to force the Coulomb barrier at room temperature. The second was the lack of strong neutron radiation. All deuterium nuclei must merge perfectly into helium without side reactions that normally occur at fusion, including a bunch of residual free neutrons. The third was the lack of strong gamma radiation known to be emitted when helium nuclei are formed during 'normal' fusion. But since no such radiation has been observed in cold-fusion experiments, one must assume that the corresponding energy is somehow transferred as heat to the solid material around it, also seemingly a miracle.

An attempted explanation of the third miracle is based on the fact that cold fusion happens in a solid, where the atoms are organized in a lattice, while traditional fusion occurs between atomic nuclei colliding freely like balls in a vacuum. One can imagine that the excess energy in cold fusion is taken up by the lattice. The problem? Nuclear reactions occur over distances thousands of times smaller than the distances between the atoms in the lattice and a million times faster than what normally happens in the lattice—a puzzle that doesn't seem to fit.

So few believed that Fleischmann and Pons had achieved fusion of some sort. Whatever reaction it might be, one thing was clear—it was not normal thermonuclear fusion because it should have led to powerful radiation that would have made the experiment directly lethal.

If it worked, however, the benefits were impressive. Large amounts of energy were released, just as with normal fusion, but at mundane temperatures with much less input energy, without radiation or radioactive waste. Exactly what it was all about, however, remained unclear. Only now, when the physics behind what appears to be a new energy source may be explored, can we hope for an explanation.

Rossi and others, working with nickel and hydrogen, have a different approach than Fleischmann and Pons, though their experiment was a starting point and source of inspiration. Instead of a palladium rod Rossi uses a fine nickel powder. Instead of decomposing heavy water to release deuterium he uses ordinary hydrogen gas in a canister, possibly enriched with deuterium.

He puts the nickel inside a container, a reactor—in its early design, potato sized and made of steel. Inside are also a few other substances —*'catalysts'*—that help the reaction without being consumed. In the early versions, a few grams of hydrogen were introduced from a canister that was then disconnected, but the hydrogen gas can now be applied from a material inside the reactor that can store hydrogen.

In all, this appears to be both Rossi's and Defkalion's design—nickel powder and catalysts inside a small reactor chamber filled with hydrogen gas. Also Piantelli, Celani and Brillouin Energy work mainly with nickel and hydrogen. Rossi starts and controls the process by applying heat to the reactor with an electrical heating cartridge. Defkalion, beyond the cartridge heater, uses electrical discharges from a kind of modified spark plug. The reaction taking off inside the reactor then produces a lot of thermal energy and probably some relatively weak radiation that is also converted to heat. How the reaction works no one knows for certain.

As in the Fleischmann and Pons experiment, in Rossi's device initial phenomena brought to mind fusion, including the discovery of copper in the nickel powder used as fuel. In this case, it could be the nucleus of nickel that had reacted with the nucleus of hydrogen, consisting of a single proton, which then formed a new nucleus, copper, because copper has one proton more than nickel—a fusion reaction that in itself would release energy if it occurred. But analysis of the used nickel shows that the copper was simply a contamination powder from another source.

The explanation that Rossi himself seems inclined to assume is based on the theory that Hidetsugu Ikegami started to sketch in the late 1990s and gained support for through his experiments with Roland Pettersson. Ikegami bombarded liquid lithium with nuclei of deuterium, consisting of one proton and one neutron. His theory was that the deuterium nuclei, after being accelerated in a strong electric field, could penetrate the lithium atoms and thus came very close to the nuclei of lithium.

Normally this is insufficient for fusion—the nuclei repel each other because of the Coulomb barrier but it still happens occasionally at very low probability, so small that in practice it is irrelevant. What Ikegami thought, however, was that when lithium was liquid, everything became so viscous that the deuterium nucleus stayed close to the lithium nucleus for so long that the probability of fusion increased dramatically, a hundred billion times or more.

A large amount of deuterium nuclei would be included in a sort of short-lived fusion with lithium nuclei. If the lithium nucleus took up a proton, we would have the element beryllium that has one proton more than lithium, while the neutron in the deuterium nucleus would go away on its own. A calculation also shows that hefty amounts of energy should be released.

The kind of beryllium that would be formed is unstable and would immediately divide, producing two helium nuclei. The end result would be what cold fusion mostly has been about—deuterium nuclei to form helium plus energy, though it took the help of a lithium atom.

Some suggest that complete fusion of nuclei never occurs. But it is perhaps possible that Ikegami's hypothesis on the effect of the viscosity of liquid lithium is correct and that it dramatically increases the likelihood of some other nuclear phenomenon while the nuclei are very close. It can also have its counterpart in other experiments in LENR.

It is still hard to describe the phenomenon precisely. Only comprehensive research can give a good answer. What seems certain is that it releases a large amount of heat and that it is a nuclear reaction of a new and hitherto unknown nature—a nuclear reaction with a long list of amazing benefits and seemingly few disadvantages. Now you know what a nuclear reaction is and also that it is probably time to abandon the currently known variants of nuclear reactions for energy production—fission and fusion—and move forward.

89. Fermi Remembered, James W. Cronin, University Of Chicago Press, 2004.

Acknowledgments

I thank my English editor, John Joss, who helped me with invaluable editing of my translation of the book into English and with proposed amendments also introduced in the Swedish original. Despite a skeptical starting point, John has always believed in the importance of the publication of this story, which has meant a lot to me.

I also thank, posthumously, Professor Sven Kullander for reviewing and commenting on the appendix.

Thanks also to Lars-Anders Karlberg for final examination and valuable feedback on the Swedish original, Jed Rothwell for perusal and comments on large parts of the second chapter, Jörgen Appelgren for editing the book's photographs, Jonas Askergren for the graphics of the E-Cat, and Marco Renieri for the book cover.

Big thanks to my wife for her patience and

understanding during the writing of the book, and of course to my kids, who are the future and to whom this book is dedicated.