

# **PUBLIC POLICY PLANNING FOR BROAD DEPLOYMENT OF COLD FUSION FOR ENERGY PRODUCTION IN THE U.S.**

## ***Task Report 1. The Changing Landscape of Cold Fusion***

Revision 3

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*“Every vision is a joke until the first man accomplishes it; once realized, it becomes commonplace” – Robert H. Goddard*

Prepared by:

Megan Leseberg, Graduate Research Assistant  
John Maxwell, Graduate Research Assistant  
Thomas W. Grimshaw, Ph.D., Principal Investigator and Research Fellow  
Center for International Energy and Environmental Policy  
The University of Texas at Austin  
Austin, TX 78712



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## Executive Summary

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*“Cold fusion is the most important discovery in the recorded history of technology. Only a few prehistoric discoveries such as fire and domesticated animals outweigh it. It will revolutionize many aspects of daily life, and many other technologies. It will force us to rethink our attitudes toward science and research, funding for research, and our ideas about where technology originates, who gets the credit, and who should get the profits. It will change history; it will change the face of the earth; and it will help open the whole solar system to exploration and colonization. It is hard to imagine a bigger subject...”<sup>1</sup>*

Cold fusion was announced in a press conference in 1989 as a promising new source of very low cost energy. For a variety of reasons, it was soundly rejected by mainstream science within a year. Cold fusion has, in fact, been widely referenced as a prime example of pseudoscience, weird science, bad science, and similar monikers.

Research on the claimed phenomenon did not cease after it was rejected. On the contrary, a dedicated, sometimes fractious, group of capable researchers and other interested parties (totaling approximately 200 to 300) has evolved and functions outside mainstream science. Since 1989, the landscape for cold fusion has developed into one of a pariah science with a mature sociology that closely mimics the processes of mainstream science. Within this context, continued experimentation and theory development have resulted in a growing body of evidence for the reality of low-temperature nuclear phenomena – and for the prospect that the dream of cold fusion becoming a major source of energy will be realized. The cold fusion landscape includes a continuing – mostly unsuccessful – struggle for legitimization in light of the growing evidence for its existence as a real phenomenon.

A number of events in the past year appears to be further altering the cold fusion landscape. These events include continuing research support under separate programs by the Andrea Rossi / Leonardo Corporation, Defklaion Green Technologies, Brillouin Energy, Blacklight Power, JET Energy / NANOR, LENUCO, Piantelli / nicHenergy, Sonofusion and U.S. NASA.

Andrea Rossi and his colleagues at the University of Bologna in Italy, appear to have shown generation of steam-producing heat by low-temperature nuclear reactions involving nickel and hydrogen – two common elements. The table-top device containing the reactor vessel has been termed the “energy catalyzer” (E-cat). Commercial arrangements have been made for manufacture and deployment of various configurations of the individual E-cats, each with a capacity of about 10 kilowatts. A one-megawatt device, consisting of about 300 E-cats, was tested at an industrial facility in Greece in October 2011.

It is widely recognized that at least for the short term, there would be widespread disruption in current systems of energy production, transport, and consumption if such a new, simple, cheap, and benign energy source were to emerge rapidly. As the Rossi and other events unfold in the coming weeks and months, a window of opportunity will apparently open for CIEEP to be at the leading edge for developing proactive public policies for dealing with the ancillary effects of cold fusion deployment.

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<sup>1</sup> Rothwell, Jed. *The Mail Archive*. 06/17/12. Accessed on 06/25/12, <http://www.mail-archive.com/vortex-1@eskimo.com/msg66710.html>.

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# **1 Introduction and Background**

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Cold fusion (CF) was announced at a press conference in 1989 but was rejected by mainstream science as pseudoscience within a year. Despite continued research and considerable experimental success by a number of capable scientists at many locations, CF has generally failed to gain broad acceptance in the years since. Because of its potential as a source of abundant, very-low-cost energy, the potential public welfare benefit of CF is readily evident.

After CF was rejected in 1989, interest continued in the phenomenon among a number of knowledgeable investigators, and research continued by reputable scientists in many countries. A “shadow” system emerged that mimics the sociological processes of mainstream science, including a peer-reviewed journal (published online), regular international conferences with an attendance of 100 to 200, a professional society, and a very active Google discussion group. As a result, a growing body of evidence has been established for the “reality” of cold fusion. For example, Storms documents 185 reports of excess heat, 55 reports of anomalous radiation, and 80 reports of elemental transmutation. In spite of the increased level of evidence and its enormous potential public welfare benefit, CF has remained – for a variety of reasons – a rejected and marginalized area of investigation. A relatively recent (July 2009) status review by Krivit and Marwan is included in Appendix A.

Nuclear reactions at low (near-earth-surface) temperatures may not involve nuclear fusion as was believed at the time of announcement – combination of hydrogen atoms to form helium with large releases of energy as takes place at very high temperature in the sun or a hydrogen bomb. In part, this terminology depends on the definition of fusion being used. Many researchers prefer to use the term “low energy nuclear reactions (LENR)” as a more accurate characterization of the phenomenon than CF.

CF is achieved in the laboratory using a variety of methods and materials. The primary “signature” of the reaction is “excess heat” – energy produced that cannot be accounted for as the result of chemical reactions. Early experiments utilized palladium electrodes and heavy water in electrochemical cells to produce the effect. Since then, CF has been achieved with other materials, including nickel and hydrogen in place of palladium and deuterium oxide, and approaches, such as a cell with deuterium gas with powdered palladium.

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A number of positive developments has improved the prospects of CF dramatically in the past few years. This changing landscape for this fascinating potential phenomenon may represent a major opportunity for the Center for International Energy and Environmental Policy (CIEEP). The purpose of this white paper is to describe this opportunity in terms of the significant favorable developments, provide suggestions on how best to respond, and develop recommendations for future action on a phased basis.

## **2 Recent Major Developments**

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After many years of marginalized research and gradual but steady increase of experimental evidence, several favorable events have occurred to advance the case for cold fusion. There are nine developments that have taken a center stage in the field of LENR/CF. The most common route that has been taken is the push to get commercially available units to market. This idea is expanded on in more detail in Section 4.

Individually, these events have substantially improved the prospects for CF. A way to view the technologies is through a criteria which would establish that the device is performing according to plan. Three simple attributes would be sufficient to judge the LENR/CF technologies: (1) Device can operate continuously for multiple weeks or months (2) High temperatures (around 600°C) would be reached continuously as well and (3) The LENR/CF device would be easily turned on and off and the reaction was resilient enough to last.<sup>2</sup> Collectively, they make a cogent case for CF as a major future source of energy for the public welfare benefit. A brief summary is provided for each event, including the main elements of importance for understanding the CF changing landscape – the basic methods employed, the context (location, lab, country, etc.), the people involved, the sources of information, the significance for CF prospects, and the contacts that may be made for additional information.

### **2.1 Rossi/ Leonardo Corporation**

Andrea Rossi is perhaps the most well-known person working in the LENR/CF field today. He has been working on getting his Energy Catalyzer (ECAT) device to market. The nickel-hydrogen reaction produces heat for industrial users with a 1 mW unit and domestic users with a 10 kW unit. Rossi has been very public in the demonstrations that he has made to the world, but he has yet to allow third-party testing without a patent which neither the United States or European Union have granted up to this point.

For more details on the Rossi / Leonardo Corporation, please see Appendix A.

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<sup>2</sup> Criteria for a Successful LENR Device. *Cold Fusion News*. 07/02/12. Accessed on 07/27/12, <http://coldfusion3.com/blog/criteria-for-a-successful-lenr-device>.

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## **2.2 Defkalion Green Technologies**

Formerly a member of the research group of Andrea Rossi, Defkalion Green Technologies is a Greek company which has claimed to have a working unit that is close to commercial release that will be called Hyperion. There has been a highly charged competition between Rossi and Defkalion to release the first unit. Like Rossi's, the Hyperion unit will be powered by a nickel-hydrogen reaction.

For more details on Defkalion Green Technologies, please see Appendix B.

## **2.3 Brillouin Energy**

The first company to make the claim that they have solved the mystery of the LENR/CF reactions, Brillouin Energy aims to be a licensor of the technology that they have developed. Brillouin's claim for their energy is a phonon-moderated hydrogen reaction which allows for the hydrogen atoms to become energized.

For more details on Brillouin Energy, please see Appendix C.

## **2.4 Blacklight Power**

One of the older companies currently working in the LENR/CF arena, Blacklight Power has been around since 1991 or just after the Fleischmann and Pons announcement. Randall Mills is the leading researcher pursuing energy from what is called the Catalyst Induced Hydrino Transition Cell which produces energy from the reaction of hydrogen.

For more details on Blacklight Power, please see Appendix D.

## **2.5 JET Energy**

Dr. Mitchell Swartz is the leading force behind the JET Energy Company which is located in Massachusetts and has been pursuing a LENR / CF device for many years. Along with Dr. Peter Hagelstein of MIT, Dr. Swartz has developed a device called the NANOR. This tubular structure has been claimed by the JET Energy to be successful in producing a long lasting excess heat reaction.

For more details on JET Energy, please see Appendix E.

## **2.6 LENUCO**

Similar to JET Energy, LENUCO is a research focused company located near a college campus. For LENUCO, the research leader is Dr. George Miley. Miley is pursuing a LENR device that can power spacecraft for deep space exploration. The driver for the energy is the Patterson cell which is a nickel-palladium system that works from a fluid interaction among the metal plated beads which form the structure of the system.

For more details on LENUCO, please see Appendix F.

## **2.7 Piantelli / nicHenergy**

Piantelli Francesco is one of the researchers who had originally partnered with Andrea Rossi in the initial research of LENR/CF devices. Piantelli has a company named nicHenergy which is based in Italy and is going after a nickel-hydrogen reaction which he hopes to bring to market as a domestic power source. Not many details have been released by Piantelli at this time.

For more details on Piantelli / nicHenergy, please see Appendix G.

## **2.8 Sonofusion**

Sonofusion is an alternative to the conventional metal-based LENR/CF reactions. Roger Stringham who is the main proponent behind the Sonofusion process has pushed this technology which uses acoustic energy within heavy water to produce excess heat products. The process known as cavitation has not appeared much in the field recently, but this is a technology worth keeping an eye on.

For more details on Sonofusion, please see Appendix H.

## **2.9 Continuing U.S. NASA Interest**

The United States' space agency, NASA has continued research on LENR/CF as a way to explore deep space. The farther from the sun a space probe goes, the less solar energy it can receive requiring another source of propulsion. Conventional fuels are very costly and make it difficult to launch as many spacecraft as NASA would like to. NASA has claimed to be pursuing a form of LENR/CF along the lines of the Widom-Larsen Theory which focus specifically on anomalous heat effects and propulsion applications.

For more details on Sonofusion, please see Appendix I.

## **2.10 *Francesco Celani***

For more details on Francesco Celani, please see Appendix J.

## **2.11 *University of Missouri – Kimmel Institute***

For more details on the University of Missouri’s Kimmel Institute, please see Appendix K.

## **2.12 *National Instruments***

For more details on National Instruments, please see Appendix L.

### 3 Assessment of Current Developments

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[Intro Words]

#### 3.1 Credibility of Claims

While the LENR/CF field has been widely criticized in the mainstream scientific community, there appears to be a critical mass of researchers who are pursuing similar researcher goals and are getting similar results around the world. There seems to be two main camps of researchers that are involved in the LENR/CF field.

The first set of companies involves firms that are seeking to bring a commercially available product to market. The main actors in this set are Rossi/Leonardo, DGT, Brillouin Energy, Blacklight Power and nicHenergy. These companies have made it their primary goal to produce a product that is safe, reliable and proven that can produce heat that can result in electricity production or just water heating.

The momentum has been building recently for the release of a commercially available product. The main competition of between Rossi/Leonardo and DGT has been fascinating to watch as two companies are battling to occupy the same space within the market. For many within the field, Rossi/Leonardo Corp. have had the smart money placed on them. The publisher of Pure Energy Systems, Sterling D. Allen, has Rossi's ECAT as his number 1 alternative energy technology as of July 6, 2012.<sup>3</sup> But, Rossi has incredible baggage attached to him. Rossi has made claims in the past that bring into question his credibility as a scientist and make some people question whether he is in fact just a snake-oil salesman playing off the hopes of those people who dream of a practically free and clean source of energy for the world. In the 1970's and 1980's, Rossi was involved in a company called Petrodragon which claimed to convert waste into oil.<sup>4</sup> In Italy, he was involved in several legal troubles and in fact was sent to prison for a time. Though there are examples of former criminals rising to redeem themselves, in the case of Rossi it seems that his outlandish claims and history of fraud make it likely that he may not have all of the cards he claims to be holding. In fact, the fact that there have not been independent evaluations of the

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<sup>3</sup> Top 5 Exotic Free Energy Technologies. *Pure Energy Systems: PesWiki*. Accessed on 07/06/12, [http://peswiki.com/index.php/Template:Top\\_5\\_Exotic](http://peswiki.com/index.php/Template:Top_5_Exotic).

<sup>4</sup> Krivit, Steven B. Rossi's Financial and Environmental Criminal History. *New Energy Times*. 03/10/12. Accessed on 07/05/12, <http://blog.newenergytimes.com/2012/03/10/rossis-financial-and-environmental-criminal-history/>.

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ECAT makes Rossi look like he is holding something back. On the other hand, the fact that his goal is commercial production and he wants to let the consumer decide for themselves is a strong argument in favor of letting the market decide who is right.

DGT which broke apart from Rossi/Leonardo Corp. in 2011 also claims to be close to commercially available production of its Hyperion LENR units. There is not near as much information on DGT as there is on Rossi. Rossi publishes his own journal, *Journal of Nuclear Physics*, which provides timely updates on the Rossi technologies and developments. DGT has professionally crafted public statements which give few details but has given pictures of the Hyperion unit as well as the future plans for the construction of a factory.<sup>5</sup> Just on a visual basis, the Hyperion unit looks more professionally engineered than Rossi's device which looks like it was constructed by a high-school science club. DGT also seems to have its business side more put together than Rossi. DGT has claimed to have been evaluated by various companies and governments, but similar to Rossi, there is no public evidence of an independent test of the device. Also, there may be outside influences on DGT since it is located in Greece which has had massive macroeconomic disruptions in the past year which could dissuade foreign investors from sinking capital into this company.

The main competition between Rossi and DGT seems to be the way that the market will decide which firm is the winner. This competition to produce a broadly distributed LENR/CF device will also answer the question if this phenomenon is real. Just one company will need to be successful in making the LENR/CF reaction controllable, repeatable and cheap enough for the world to take advantage of this technology.

Brillouin Energy seems to fit a LENR/CF market niche. Since they are focused on licensing their technology and not becoming a prime manufacturer of units, they may have an advantage of finding a low-cost manufacturer to produce their units and beat Rossi and DGT on price. But, there is a risk in sending this manufacturing to China or another low-cost manufacturing country in that the technology could be stolen easily and produced quickly by another manufacturer. The fixed costs are much lower if the company is just a licensor of technology rather than being a vertically integrated manufacturer. Apple outsourcing its manufacturing to Foxconn is a great example of the path that Brillouin could follow to success in bringing their attempt at LENR/CF

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<sup>5</sup> *Defkalion Green Technologies*. Accessed on 08/22/12, [http://www.defkalion-energy.com/files/2012-05\\_StatusPicturesFinal.pdf](http://www.defkalion-energy.com/files/2012-05_StatusPicturesFinal.pdf).

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to market. The fact that they claim to understand the reaction and can control it could call into question their credibility as that would be a scientific feat that should be disclosed to the world.

Blacklight Power and nicHenergy are two companies that are also putting out interesting ideas and technologies, but at this time there does not seem to be enough public information to put them in the upper tier of the LENR/CF companies. The top 3 consumer focused companies of Rossi/Leonardo Corp., DGT and Brillouin Energy are the companies to watch for their release to the public.

The second camps of companies in the field are more research-based than consumer focused. It seems that their goals are to firmly establish the science and then move toward deployment for a more scientific purpose rather than a profit-maximizing purpose. JET Energy, LENUCO and NASA are the three entities that occupy the research space in the LENR/CF field. Sonofusion occupies a space between the two types of entities, but there have not been any developments from this company in several years, so it will not be covered in much detail in this section.

JET Energy has a lot of academic muscle behind it with the MIT physicist Dr. Peter Hagelstein assisting in the research. Recent claims by Dr. Swartz have said that the NANOR has been running constantly for six months which would be an incredible achievement towards the establishment of a stable reaction. Getting an institution such as MIT to accept the research of LENR/CF would be valuable in training the next generation of experts in the field.

LENUCO which is directed by Dr. Miley is focused on integrating a LENR/CF propulsion device into spacecraft. This is also what NASA is pursuing in its search for an energy source for deep space exploration. This research is narrowly focused, but when word got out that NASA was participating in LENR/CF research, there was somewhat of an outcry that public dollars were going toward this sort of research. However, both LENUCO and NASA are committed toward a specific application of LENR/CF rather than a broad distribution of a consumer focused product.

The ability of the market to make quick judgments of the technology and give the signal of capital flows makes the consumer focused companies more likely to succeed in the long-run. However, there is past experience of research lead entities focused on one specific area leading to successful impacts in other areas of society such as the Internet.

### **3.2 Public Face Analysis**

When scouring the landscape of the LENR/CF it becomes apparent pretty quickly which companies have financial resources to put out a good public face for their products. Rossi has a crisp, user-friendly website which he updates frequently to provide news to people around the world. By far, it seems that he has the greatest capability to market his message and product in the best possible way. Defkalion Green Technologies also have a clean and user-friendly website which also signals that they have some financial resources behind their product. Blacklight Power has the next best website, though it is not on the same level as the professionally designed Rossi and DGT websites. Brillouin Energy and JET Energy have very amateur websites which look like they were created in the early days of the internet and indicate that there is not much concern in the short-term over the credibility of the marketing effort that is being made to the public. nicHenergy website is in Italian and contains no content, demonstrating that it is brand-new or there is not much in the way of financial efforts to dedicate to a web presence. LENUCO does not have a website that could be located with an easy search which is most likely a function of the fact that it is mainly an academic pursuit at this point and not a consumer focused entity, which also could probably be said for JET Energy.

### **3.3 Overall Assessment**

The three first tier companies that are pursuing the consumer focused approach by letting the market decide who is the winner of the technology battle is likely to be successful in reaching the optimal outcome for the deployment of a LENR/CF product. Between the three it is difficult to see who will come out with the best technology or whose claims are accurate, but it will be a very interesting time when these devices are beginning to hit the market.

## **4 Secondary Impacts**

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With an introduction of a technology like LENR/CF, the modern economy would be seriously affected. There would be many consequences both positive and negative that would take place with broad deployment of this field. Since it is most likely that a consumer driven company would be the first to bring about a working product, there will be disruptions to nearly every aspect of modern life. The constraint that expensive energy places upon economic growth would be wiped away. The effects from LENR/CF should be analyzed in a systematic way to explore all aspects of broad deployment of LENR/CF as an energy source.

Technology Assessment (TA) is tool that can evaluate this energy source which has the potential to provide abundant, low-cost, clean energy to the world. The public welfare benefit for this technology could provide the resource to boost the entire world out of poverty and enhance living standards for the whole world.

### **4.1 Direct Impacts**

The analysis of the direct impacts will examine the technologic aspects of the LENR/CF deployment.

Dispersed vs. Centralized energy generation

### **4.2 Indirect Impacts**

Investigating the secondary impacts of the will focus on the social aspects of the distribution of the LENR/CF devices.

## **Appendix A. Rossi / Leonardo Corp.**

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These appendices are the compilation of two researchers work. John Maxwell, graduate research assistant, made the initial attempt, documenting the basics of each company, as well as updates that occurred between the time period of January 1, 2012 and June 1, 2012. Megan Leseberg, graduate research assistant, made a second attempt, strengthening the initial draft, as well as updating any news, major findings, or changes that may have occurred since that time, specifically between the dates of July 2012 through January 2013.

### **A-1.1 Overview**

Andrea Rossi, an inventor, has been experimenting with producing energy from waste heat for many years. After the 1989 Fleischmann and Pons (F&P) announcement, Rossi began to investigate this effect himself and to try and replicate the outcomes that F&P experienced.<sup>6</sup>

Rossi, through the Leonardo Corporation, has claimed that he is very close to releasing a commercial-ready version of an LENR device that has been promoted as nothing short of a “clean-energy revolution”. Substantial supporting evidence to this claim is yet to be seen; the initial deadlines that Rossi set have not yet been achieved. However, a pending report – said to be released in late February or March – may be the evidence needed to solidify Rossi’s claims.

### **A-1.2 Key Players**

As the creator of the Energy Catalyzer, known as the ECAT, Andrea Rossi is considered the key person driving the LENR movement to its current developments. Rossi has a doctorate in Philosophy from Milan University, where he studied relativity. Having already been involved in the alternative energy generation field for over a decade when F&P released their results, he was instantly intrigued with their alleged findings. Since that time, Rossi has pursued a working LENR unit that can be validated by the consuming public.<sup>7</sup>

Sergio Focardi has been studying the interactions of nickel and hydrogen – two key ingredients to the LENR puzzle – since the early 1990s. Currently, he is Professor Emeritus at Bologna University. Focardi’s role in the Rossi/Leonardo Corp. began when Rossi approached him to act

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<sup>6</sup> Inventor Andrea Rossi. *ECAT: Cold Fusion Revolution*. Accessed on 06/10/12, <http://ecat.com/inventor-andrea-rossi>.

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as a third party contributor, an unrelated expert to test and validate the results of the ECAT. He has since stayed with Rossi as a contributor to the ECAT invention.

### **A-1.3 History, Development, Roots of Company**

After much research and development, in 2007 Rossi claimed to have begun seeing results. To support this claim, he initiated a dialogue with Focardi to prove that his invention did not work. If Focardi succeeded, Rossi would give him a financial prize upon conclusively disproving the initial results of his machine. In the case of this third party verification, Focardi could not disprove any of Rossi's work. As a result, his invention – the Energy Catalyzer (ECAT) – hit the world of alternative energy with a strong impact, as a working LENR unit.

Rossi submitted a patent in 2008 to the World Intellectual Property Office at the European Patent Office but was declined; the descriptions and scientific theory underlying the patent application were deemed to be deficient. However, in 2011, the government of Italy approved a patent for the ECAT<sup>8</sup>, a positive step for Rossi.

Rossi founded the company Leonardo Corporation to continue and promote the development of the ECAT. The company has recently been purchased by a trust of investors, according to an online source, though Rossi is still said to maintain the position of CEO.<sup>9</sup>

### **A-1.4 Claimed Mechanism for Energy**

The energy source for this type of reaction has been declared as a nickel-hydrogen reaction; “nickel is fused with Hydrogen and transmutes into copper”<sup>10</sup>, releasing energy in the process. As described by Pure Energy Systems<sup>11</sup>, the ECAT has nano- to micro-sized particles of nickel powder that are placed into a reactor. Within the reactor, there is pressurized hydrogen gas, as well as a proprietary catalyst. The reactor is then heated between 400°C and 500°C, at which point it is claimed that nuclear reactions, described above, begin to take place.

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<sup>7</sup> Inventor Andrea Rossi. *ECAT: Cold Fusion Revolution*. Accessed on 06/10/12, <http://ecat.com/inventor-andrea-rossi>.

<sup>8</sup> Energy Catalyzer Patent Approved! *ECAT Report*. 04/08/11. Accessed on 02/05/13, <http://ecatreport.com/andrearossi/energy-catalyzer-patent-approved>.

<sup>9</sup> Rossi: Leonardo Corp. Now Owned By a Trust of Investors. *E-Cat World*. 02/15/12. Accessed on 06/12/12, <http://www.e-catworld.com/2012/02/rossi-leonardo-corp-now-owned-by-a-trust-of-investors/>.

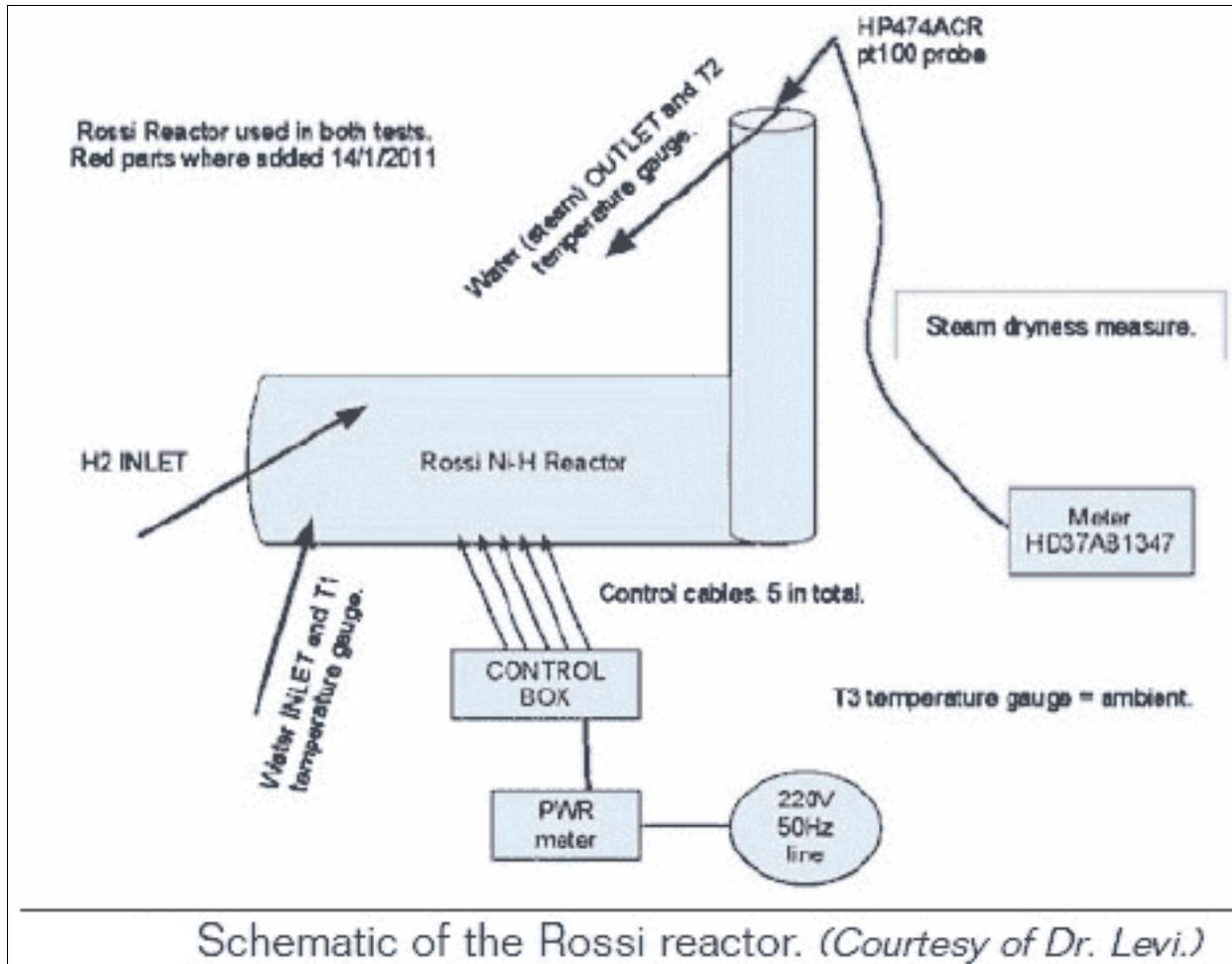
<sup>10</sup> ECAT Technology. *ECAT: Cold Fusion Revolution*. Accessed on 01/24/13, <http://ecat.com/ecat-technology>.

<sup>11</sup> Andrea A. Rossi Cold Fusion Generator (E-Cat). *Pure Energy Systems: PESWiki*. Accessed on 06/14/12, [http://peswiki.com/index.php/Directory:Andrea\\_A.\\_Rossi\\_Cold\\_Fusion\\_Generator\\_\(E-Cat\)#How\\_it\\_Works](http://peswiki.com/index.php/Directory:Andrea_A._Rossi_Cold_Fusion_Generator_(E-Cat)#How_it_Works).

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Energy generation by the ECAT has said to be up to 400 times the energy input.<sup>12</sup> Depending on the pressure within the reactor, this output energy can vary. Figure 1 is an illustration of the claimed reaction within the ECAT.

Figure 1. A Visual Representation of the ECAT Constructed by Andrea Rossi<sup>13</sup>



The core is said to be the size of a pack of cigarettes, with the whole unit being approximately the size of a desktop computer. Rossi has approximated its maintenance to changing ink in a printer or pen. The cartridge will need to be replaced approximately every 180 days. Individuals will be able to refuel the ECAT; technicians will not be required, making it easily suitable for

<sup>12</sup> Andrea A. Rossi Cold Fusion Generator (E-Cat). *Pure Energy Systems: PESWiki*. Accessed on 06/14/12, [http://peswiki.com/index.php/Directory:Andrea\\_A.\\_Rossi\\_Cold\\_Fusion\\_Generator\\_\(E-Cat\)#How\\_it\\_Works](http://peswiki.com/index.php/Directory:Andrea_A._Rossi_Cold_Fusion_Generator_(E-Cat)#How_it_Works).

<sup>13</sup> Figure obtained from Andrea A. Rossi Cold Fusion Generator (E-Cat). *Pure Energy Systems: PESWiki*. Accessed on 06/14/12, [http://peswiki.com/index.php/Directory:Andrea\\_A.\\_Rossi\\_Cold\\_Fusion\\_Generator\\_\(E-Cat\)#How\\_it\\_Works](http://peswiki.com/index.php/Directory:Andrea_A._Rossi_Cold_Fusion_Generator_(E-Cat)#How_it_Works).

domestic use.<sup>14</sup> Also, safety will be improved because the external hydrogen canister has been replaced by an interior hydrogen system.<sup>15</sup> No radioactive materials are used.

### **A-1.5 Current Status**

After a public demonstration in October 2011, there has been a flurry of activity relating to Rossi and his ECAT. On his website, “Journal of Nuclear Physics”<sup>16</sup>, he has made numerous announcements and answers questions that are posted to him.

Rossi has claimed that there will be both an industrial and domestic plant built. The industrial plants, which will produce 1 MW of energy, will be around \$1,500/kW, totaling an estimated \$1.5 million per plant; see Figures 2 and 3, which give representations of the large ECAT units. The residential units, which will produce 10 kW of energy, will cost between \$100 and \$150 per kW. Rossi has stated that he wants everyone to be able to afford an ECAT, canceling the competition that exists in the LENR field.<sup>17</sup> Its favorable features are said to revolutionize energy production, with low operation and maintenance costs, minimal fuel transport cost (only two refuelings per year), zero carbon dioxide emissions, and essentially zero noise.<sup>18</sup>

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<sup>14</sup> Mills, Hank and Sterling D. Allan. Momentous Breakthroughs Announced During Anniversary E-Cat Interview. *Pure Energy Systems*. 01/15/12. Accessed on 06/15/12, [http://pesn.com/2012/01/14/9602012\\_Momentous\\_Breakthroughs\\_Announced\\_During\\_Anniversary\\_E-Cat\\_Interview/](http://pesn.com/2012/01/14/9602012_Momentous_Breakthroughs_Announced_During_Anniversary_E-Cat_Interview/).

<sup>15</sup> Mills, Hank and Sterling D. Allan. Momentous Breakthroughs Announced During Anniversary E-Cat Interview. *Pure Energy Systems*. 01/15/12. Accessed on 06/15/12, [http://pesn.com/2012/01/14/9602012\\_Momentous\\_Breakthroughs\\_Announced\\_During\\_Anniversary\\_E-Cat\\_Interview/](http://pesn.com/2012/01/14/9602012_Momentous_Breakthroughs_Announced_During_Anniversary_E-Cat_Interview/).

<sup>16</sup> Journal of Nuclear Physics, <http://www.journal-of-nuclear-physics.com>.

<sup>17</sup> Rossi: Already Started Production of Small E-Cats to Cost \$100-150 per kW. *E-Cat World*. 01/06/12. Accessed on 06/15/12, <http://www.e-catworld.com/2012/01/rossi-plans-for-small-10-kw-e-cats-to-cost-100-150/>.

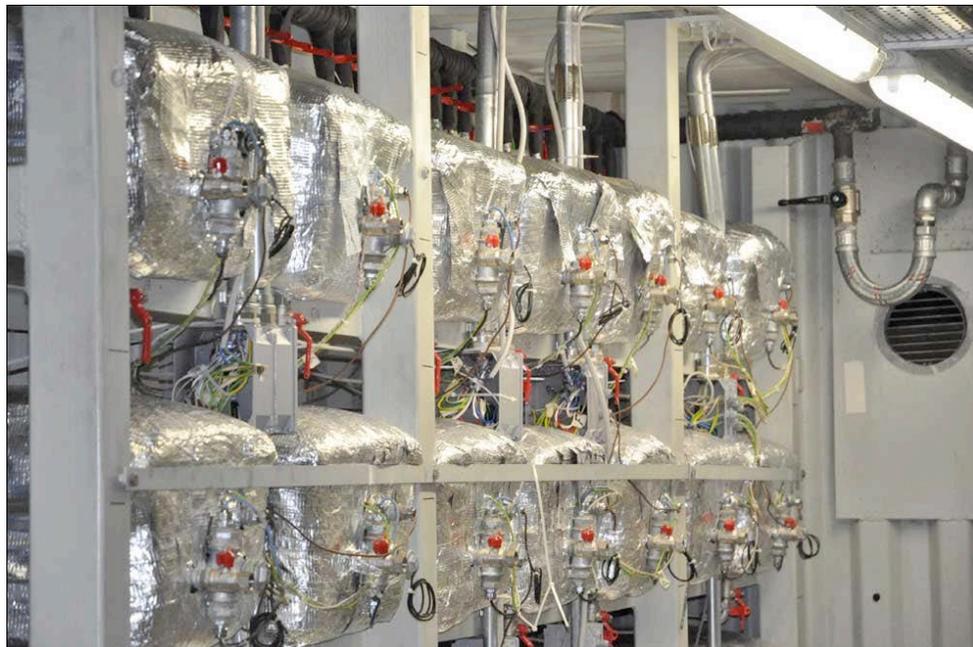
<sup>18</sup> ECAT Technology. *ECAT: Cold Fusion Revolution*. Accessed on 01/28/13, <http://ecat.com/ecat-technology>.

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Figure 2. A Graphical Representation of the Andrea Rossi 1 MW ECAT Unit<sup>19</sup>



Figure 3. Interior View of the First Generation ECAT 1 MW System<sup>20</sup>



There have been over 50,000 pre-orders of the ECAT, according to Rossi, as of January 2012. The initial order goal was 10,000 units, which they have thoroughly passed. He predicts that the

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<sup>19</sup> ECAT 1MW Pictures. *ECAT: Cold Fusion Revolution*. Accessed on 01/24/13, <http://ecat.com/ecat-products/ecat-1-mw/ecat-1mw-pictures>.

<sup>20</sup> ECAT 1MW Pictures. *ECAT: Cold Fusion Revolution*. Accessed on 01/24/13, <http://ecat.com/ecat-products/ecat-1-mw/ecat-1mw-pictures>.

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units will begin to be shipped 18 months from the end of January 2012, putting the first deliveries somewhere in the neighborhood of June 2013.<sup>21</sup> However, safety certification and intellectual property issues have emerged for the domestic ECAT; sound statistics supporting the safe and reliable operation of the unit must be produced to gain certification, and certification must be obtained before the units may be produced.<sup>22</sup> No timeframe for certification was given, although Rossi was confident the intellectual property issues would be resolved quickly, as they are an easier matter. Rossi has claimed to be making progress on the domestic ECAT's safety certification in the past<sup>23</sup>, ensuring it is safe to run in the home; therefore, one may infer that over eight months later, certification would be closer in reach. Securing Underwriters Laboratory's safety certification approval (of whom Rossi has been working with) is key to making sure that the domestic ECAT unit is fit for sale, as it is a signal to consumers that the product is safe and not a fraud.

Over the past year, there has been much talk and speculation of two factories that are allegedly in the works for the ECAT – one in the US and one in Europe. Pending software creation and necessary certifications, it is estimated production will start anytime between November 2012 and April 2013.<sup>24</sup> According to Rossi, as of May 2012, a 1 MW plant was delivered and is working at a military facility. The plant was said to have been produced in the US.<sup>25</sup> Rossi and his team are monitoring the unit in order to learn from the model at work. This will enable them to make any necessary modifications and apply them to the unit's design.

Rossi is, as always, working very rapidly at his ECAT technology. As of July 2012, he claimed to have developed a “solid-state ECAT” with enough energy to produce temperatures that reach 600°C. “Solid-state” is a term which refers to the process where the ECAT has no cooling fluid

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<sup>21</sup> Rossi: 50,000+ Pre-Orders for E-Cats Received: Predicts Worldwide Shipments Within 18 Months. *E-Cat World*. 01/23/12. Accessed on 06/15/12, <http://www.e-catworld.com/2012/01/rossi-50000-pre-orders-for-e-cats-received-predicts-shipments-within-18-months/>.

<sup>22</sup> Rossi: Domestic E-Cats Still Planned, Certification Problematic. *E-Cat World*. 01/04/13. Accessed on 01/17/13, <http://www.e-catworld.com/2013/01/rossi-domestic-e-cats-still-planned-certification-problematic/>.

<sup>23</sup> Rossi: ‘Substantial Progress’ Made on Certification. *E-Cat World*. 04/14/12. Accessed on 06/15/12, <http://www.e-catworld.com/2012/04/rossi-substantial-progress-made-on-certification/>.

<sup>24</sup> Rossi claims to be Planning Two Ecat Factories: one in Europe and one in the USA. Published 04/18/12. Accessed on 06/16/12, <http://energycatalyzer3.com/news/rossi-claims-to-be-planning-two-ecat-factories-one-in-europe-and-one-in-the-usa>.

<sup>25</sup> News update from Andrea Rossi and ECAT.com in May. *ECAT: Cold Fusion Revolution*. Accessed on 06/15/12, <http://ecat.com/news/news-update-from-andrea-rossi-and-ecat-com-in-may>.

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and no steam is being produced.<sup>26</sup> This temperature could be used to produce steam in supercritical plants, which currently employ fossil fuels for their energy sources. In addition, electricity could be produced by Stirling engines which are very efficient, as well as using the new ECAT technology for thermophotovoltaic technologies, which capture infrared radiation and convert heat into electricity.<sup>27</sup> The greatest potential breakthrough with the “solid-state” reactor is that Rossi seems to have demonstrated control over the reactions happening within the ECAT.<sup>28</sup>

In addition, this past August/September of 2012, Rossi released a new and different technology all together called the “Hot Cat” or “The Hot Honeycomb”, as it is also being called. This fusor technology is said to reach 1,200°C from a 10-lb unit that is stable and capable of producing 10 kW of power.<sup>29</sup> He is said to be releasing data to third-parties for testing and confirmation of his machine.<sup>30</sup> According to Rossi, the 1 MW plant of the Hot Cat is still on schedule to be completed in February. “He has said that after the Hot Cat is up and running for a while, that invited people will be able to visit and report about it – that may be a few months after it is installed and running.”<sup>31</sup>

Rossi has sought collaborations with multiple different companies throughout the past years. He has stated that National Instruments, a US-based controls company, and Leonardo Corp. had a relationship to support a platform for the ECAT device. This relationship has since ended<sup>32</sup>, but the significance of having a mainstream company acknowledge that they were participating in collaboration with Rossi gives his claims added weight. In addition to National Instruments,

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<sup>26</sup> Mills, Hank. The New Solid State E-Cat. *Pure Energy Systems*. 06/30/12. Accessed on 07/27/12, [http://pesn.com/2012/06/30/9602121\\_Solid\\_State\\_E-Cat/](http://pesn.com/2012/06/30/9602121_Solid_State_E-Cat/).

<sup>27</sup> Mills, Hank. Scorching Solid State E-Cat Temperatures Allow for Countless Applications. *Pure Energy Systems*. 07/03/12. Accessed on 07/27/12, [http://pesn.com/2012/07/03/9602125\\_Scorching\\_Solid\\_State\\_ECat\\_Temperatures\\_Allow\\_for\\_Countless\\_Applications/](http://pesn.com/2012/07/03/9602125_Scorching_Solid_State_ECat_Temperatures_Allow_for_Countless_Applications/).

<sup>28</sup> Mills, Hank. The New Solid State E-Cat. *Pure Energy Systems*. 06/30/12. Accessed on 07/27/12, [http://pesn.com/2012/06/30/9602121\\_Solid\\_State\\_E-Cat/](http://pesn.com/2012/06/30/9602121_Solid_State_E-Cat/).

<sup>29</sup> Rossi Update: The Hot Honeycomb. *Cold Fusion Now*. 08/30/12. Accessed on 09/24/12, <http://coldfusionnow.org/rossi-update-the-hot-honeycomb/>.

<sup>30</sup> Allan, Sterling D. Rossi Gives Third-Party Test Results from Hot Cat. *Pure Energy Systems*. Accessed on 09/24/12, [http://pesn.com/2012/09/09/9602178\\_Rossi\\_Reports\\_Third-Party\\_Test\\_Results\\_from\\_Hot\\_Cat/](http://pesn.com/2012/09/09/9602178_Rossi_Reports_Third-Party_Test_Results_from_Hot_Cat/).

<sup>31</sup> E-Cat Action Moves to 2013. *E-Cat World*. 12/14/12. Accessed on 01/21/13, <http://www.e-catworld.com/2012/12/e-cat-action-moves-to-2013/>.

<sup>32</sup> NI Corroborates Rossi Statements. *e-Cat Site*. 02/21/12. Accessed on 06/15/12, <http://e-catsite.com/2012/02/21/ni-corroborates-rossi-statements/>.

Rossi has reported that he has been meeting with German engineering firm Siemens AG to help with the production of steam turbines that could produce electricity with 30 percent efficiency.<sup>33</sup>

Though no details have been officially released, Rossi has recently revealed Leonardo Corp. has signed a contract with a company that is capable of necessary engineering and development, “giving the certainty of a solid future to our development”.<sup>34</sup> This partnership is said to with an American company, beginning in November 2012.<sup>35</sup> The plans include the following, “a 1MW thermal which uses the Hot Cat should be in place during 2013 in a plant for the production and distribution of energy...located in the U.S. or in a country in which the counterparty is a signatory to the activities, and will be the first non-military applications of this revolutionary technology.”<sup>36</sup>

Finally, a much anticipated, peer-reviewed, third party report covering the ECAT and its technology is said, by Rossi, to be in the review process and will be published in a “very high level scientific magazine” after February 2013.<sup>37</sup> This report is supposed to validate Rossi’s claims, as well as his technology.

### **A-1.5 Future Plans**

Many of the claims made by Rossi have yet to be substantiated. He did not achieve many of the deadlines he set for himself in 2012, such as the completion of ECAT factories by November 2012 and the beginning of sales for the domestic ECAT unit in December 2012.<sup>38</sup> However, factory production for the ECAT and domestic unit sales are no doubt still in Rossi’s future plans. Rossi said that the factories will be outfitted with robotic manufacturing technology to

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<sup>33</sup> Rossi: Siemens AG Helping with Leonardo Corp. With Efficient Electricity Generation from E-Cat. *E-Cat World*. 02/25/12. Accessed on 06/15/12, <http://www.e-catworld.com/2012/02/rossi-siemens-ag-helping-with-leonardo-corp-with-efficient-electricity-generation/>.

<sup>34</sup> Rossi on ‘Very Important’ Partner. *E-Cat World*. 11/29/12. Accessed on 01/17/13, <http://www.e-catworld.com/2012/11/rossi-on-very-important-partner/>.

<sup>35</sup> ‘Strong and Very Well Organized’ Team Behind the E-Cat. *E-Cat World*. 12/26/12. Accessed on 01/21/13, <http://www.e-catworld.com/2012/12/strong-and-very-well-organized-team-behind-the-e-cat/>.

<sup>36</sup> Prometeon SRL Issues Press Release on Leonardo’s US Contract. *E-Cat World*. 12/15/12. Accessed on 01/21/13, <http://www.e-catworld.com/2012/12/prometeon-srl-issues-press-release-on-leonardos-us-contract/>.

<sup>37</sup> Rossi: Peer Review by ‘High Level’ Magazine to take all of February. *E-Cat World*. 01/20/13. Accessed on 01/21/13, <http://www.e-catworld.com/2013/01/rossi-peer-review-by-high-level-magazine-to-take-all-of-february/>.

<sup>38</sup> Proposed ECat Schedule For 2012. *ECAT Report*. 02/01/12. Accessed on 06/15/12, <http://ecatreport.com/andrearossi/proposed-ecat-schedule-for-2012>.

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push down price and to keep up with potential demand.<sup>39</sup> The initial production run goal for the ECAT has been stated by Rossi to be one million units, in order to achieve the desired price point, as well as block competition.<sup>40</sup>

A new website, which appears to be selling the ECAT in Australia, looks to be the first market in which Rossi is leaning toward rolling out his product. The website<sup>41</sup> is offering the 1 MW and 10 kW units that Rossi has been pushing since the beginning of 2012.<sup>42</sup> The website currently shows an expected delivery in 2013. However, both US and European markets are also on Rossi's radar.

Pending safety certification, among other authorizations, as well as the third party report that will allegedly support Rossi's claims, seem to be the largest obstacles currently facing Rossi and the ECAT. These steps must be completed before the ECAT can be successfully produced and sold on a commercial level.

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<sup>39</sup> Clarification from Rossi About E-Cat Production—Robotized Factory Now Being Prepared. *E-Cat World*. 01/11/12. Accessed on 06/15/12, <http://www.e-catworld.com/2012/01/clarification-from-rossi-about-e-cat-production-robotized-factory-now-being-prepared/>.

<sup>40</sup> Rossi's Goal For 2012: 1 Million Units, Kill Competition. *E-Cat World*. 12/27/11. Accessed on 02/05/13, <http://www.e-catworld.com/2011/12/rossis-goal-for-2012-1-million-units-kill-competition/>.

<sup>41</sup> *E-cat Australia*, <http://www.e-cataustralia.com/>.

<sup>42</sup> Chirgwin, Richard. E-Cat pitching cold fusion to Australians. *The Register*. 07/16/12. Accessed on 07/27/12, [http://www.theregister.co.uk/2012/07/16/e\\_cat\\_opens\\_australian\\_web\\_shopfront/](http://www.theregister.co.uk/2012/07/16/e_cat_opens_australian_web_shopfront/).

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## **Appendix B. Defkalion Green Technologies**

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### **A-2.1 Overview**

Defkalion Green Technologies (DGT) is a Greek company that was initially part of Andrea Rossi's group, until they split in 2011. They have created an LENR technology with multiple models, known as Hyperion, which is claimed to generate energy through a nickel-hydrogen reaction.

In the past six months, DGT has relocated their headquarters to Canada, as well as committed to a joint venture with an Italian company, Mose Ltd. These changes could be viewed as evidence of continuing progress. However, their previous claims and deadlines for bringing a product to market were missed. Their website is currently under construction, making the verification of previously gathered information and figures impossible; it also limits access to up-to-date information from DGT directly.

### **A-2.2 Key Players**

Christos Stremmenos, who was previously employed at the University of Bologna, passed on knowledge of Andrea Rossi's technologies, leading to the formation of DGT. Stremmenos was originally appointed the Chief Technology Officer; however, he is no longer actively involved in the company.<sup>43</sup>

Alexandros Xanthoulis is a representative of the company. Very little is known about the other participants.

### **A-2.3 History, Development, Roots of Company**

DGT developed from a joint venture with Andrea Rossi, at which time in 2011, the two companies split from each other. DGT claims that they have Rossi's LENR plans but did not steal his technology. The company seems to claim that they are using a different set of plans than those Rossi provided them with. Rossi says that there is no way his technology was stolen, and the claims by DGT are utterly false. [source?]

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<sup>43</sup> Defkalion's Independent Testing Underway. *New Energy and Fuel*. 03/01/12. Accessed on 06/14/12, <http://newenergyandfuel.com/http://newenergyandfuel.com/2012/03/01/defkalions-independent-testing-underway/>.

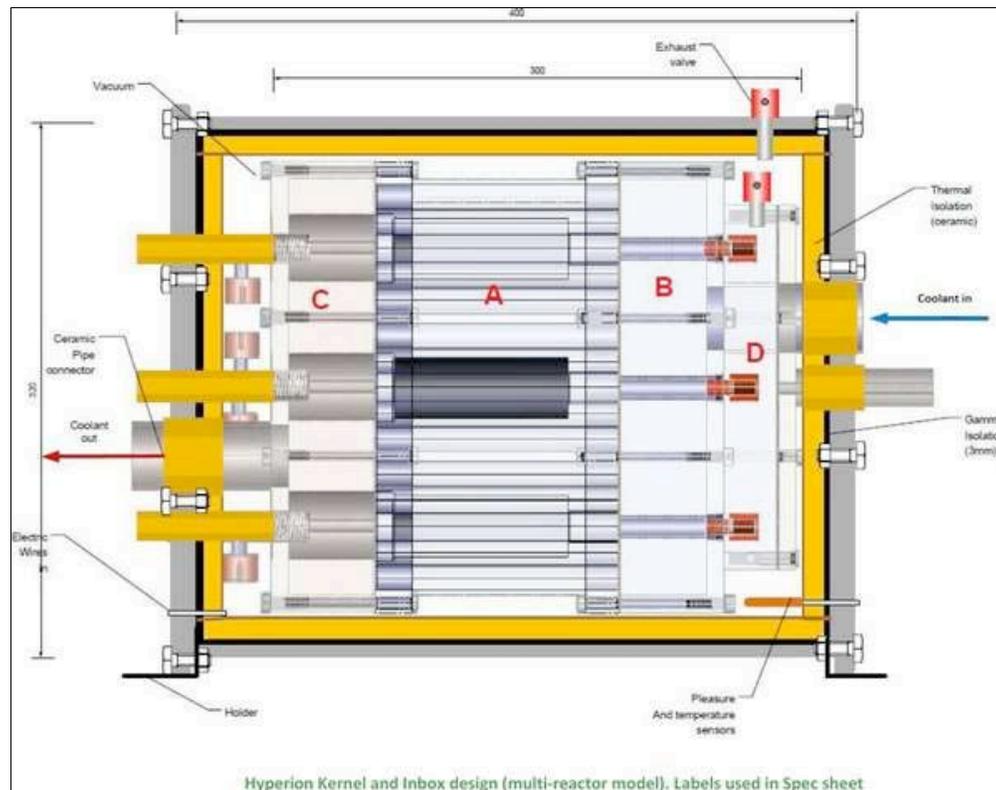
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As the DGT website<sup>44</sup> is currently being updated, no further details could be found.

### A-2.4 Claimed Mechanism for Energy

Similar to Rossi's ECAT, a nickel-hydrogen reaction is responsible for the energy generation with DGT's technology. Specifically, their experiments focus on exothermic reactions between hydrogen gas and nickel powder. DGT's LENR unit – Hyperion – operates from a process that begins by generating hydrogen from helium. An unknown trigger, either heat or electromagnets, causes a burst of heat activity. From observations of the system, the burst can be controlled by the operating system software, which keeps the reaction within a specified reaction zone.<sup>45</sup> Temperatures of 650°F are reached during the process, with energy output claims of far more than 20 times the input power necessary to begin the reaction.<sup>46</sup> See Figures 4 and 5 for schematics of the technology.

Figure 4. Defkalion Green Technology Hyperion Kernel Design [missing citation]

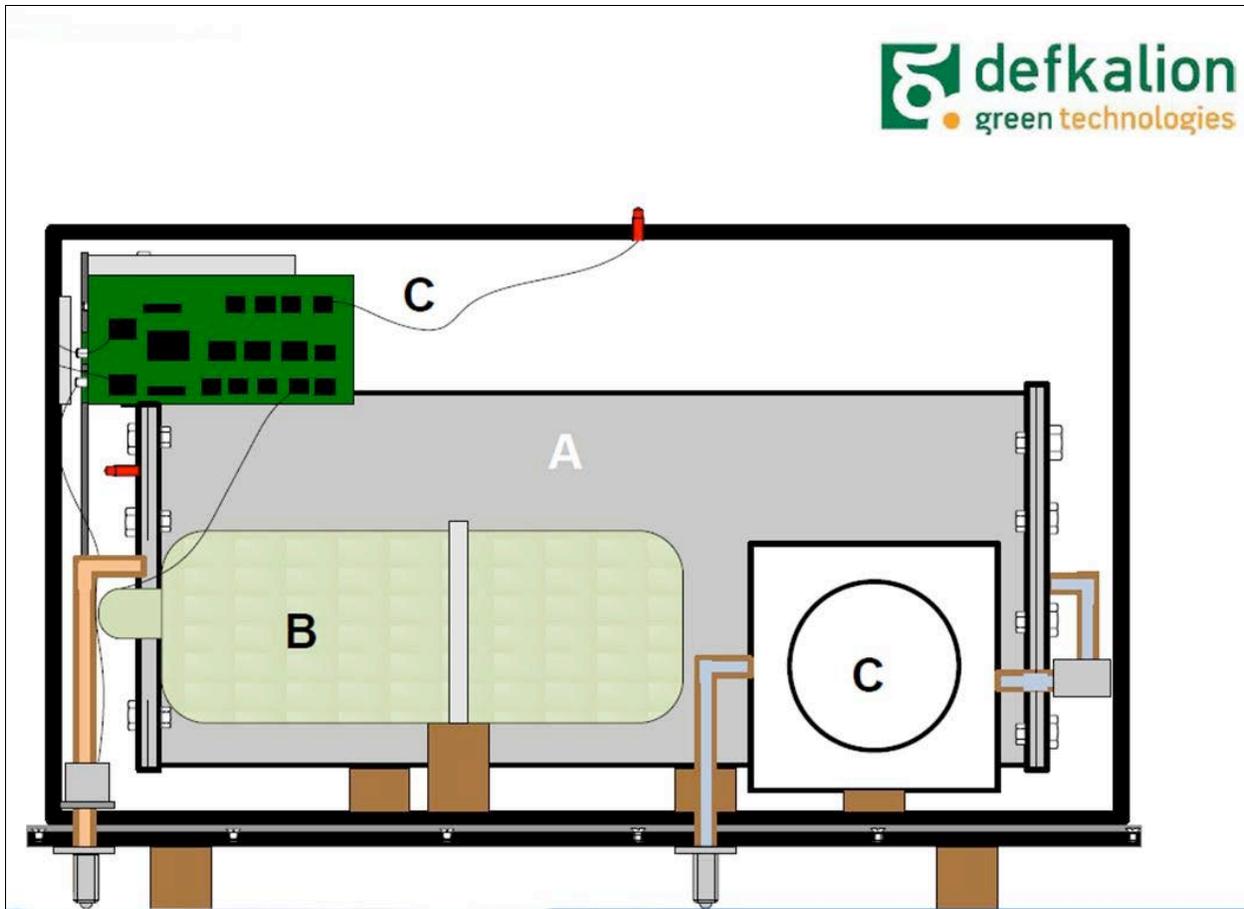


<sup>44</sup> Defkalion Green Technologies, <http://www.defkalion-energy.com/>.

<sup>45</sup> Defkalion: Hyperion Reaction Occurs in Bursts. *eCat News*. 02/08/12. Accessed on 06/12/12, <http://ecatnews.com/?p=2007>.

<sup>46</sup> Defkalion's Independent Testing Underway. *New Energy and Fuel*. 03/01/12. Accessed on 01/17/13, <http://newenergyandfuel.com/http://newenergyandfuel.com/2012/03/01/defkalions-independent-testing-underway/>.

Figure 5. General Plan for the Defkalion Hyperion [missing citation]



### A-2.5 Current Status

There are currently two models of the Hyperion<sup>47</sup>, which vary in size. The larger model (Series A and B) will be able to produce 10 to 45 kW of thermal power, requiring 310 W of input power to run. This model has a larger volume capacity of 20,280 cm<sup>3</sup> and weighs 32 kilograms.<sup>48</sup> The smaller model (Series C and D), on the other hand, has only one reactor per kernel and is capable of producing 5 to 11 kW output of steam power, with a requirement of 200 W of input power. These units are made out of steel and weigh 4.5 kilograms with a volume of 1,728 cm<sup>3</sup>.<sup>49</sup> No public displays have been performed, but the release of the above specifications in November 2011 shows progress. (These specifications could not be verified, as the site is currently under construction.)

<sup>47</sup> Accessed on 06/14/12, <http://coldfusionnow.wordpress.com/2011/11/30/2nd-commercial-cold-fusion-generator-planned-for-2012/>.

<sup>48</sup> Accessed on 06/12/12, <http://defkalion-energy.com/files/HyperionSpecsSheetNovember2011.pdf>.

<sup>49</sup> Accessed on 06/12/12, <http://defkalion-energy.com/files/HyperionSpecsSheetNovember2011.pdf>.

In February 2012, DGT held a test with high-level representatives of the Greek government. The focus of these tests was to show that, “there was excess heat energy released from a ‘Low Energy Nuclear Reaction’ and not from a chemical source”.<sup>50</sup> The tests were neither confirmed nor denied by the government. Results were reportedly positive, according to some sources.<sup>51</sup> Third-party tests were also added by other organizations, which DGT announced in a press release.<sup>52</sup>

Sources indicated that DGT was supposed to bring the Hyperion to market in July.<sup>53</sup> However, the company did not follow through with this claim, and no new information or updates have been released regarding a new proposed market date. Here are some of the claims that accompanied the July announcement:

- The LENR device can be turned on and off with the flick of a switch.
- The cold fusion device can generate temperatures of up to 350°C (662°F).
- Defkalion could use a better liquid to make steam from.
- The Hyperion is currently running at temperatures of 250°C (482°F), which would be adequate for home heating purposes and to operate a low pressure steam engine.
- Each LENR unit will generate around 5 kilowatts of heat so the device would generate about 25 kilowatts of heat.
- Each Hyperion will cost about 30 Euros (\$39.99) a year to operate.
- Defkalion has the legal certification to market the cold fusion devices in the European Union.
- Defkalion will not sell or market LENR devices in the USA because it lacks certification to do so. The US doesn’t recognize EU certification. (Note this may mean they plan to sell the rights to manufacture or market in the USA to somebody else). Note this also probably means that the device cannot be marketed in Canada.
- The LENR devices will be monitored long distance via internet or wireless to ensure proper operations.
- The company has 27 scientists working on its project.
- Defkalion plans to manufacture 300,000 Hyperions in its first year of operation.

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<sup>50</sup> Lewan, Mats. The Greek government in test of Defkalion’s technology. *NyTeknik*. 02/28/12. Accessed on 06/15/12, [http://www.nyteknik.se/nyheter/energi\\_miljo/energi/article3419346.ece](http://www.nyteknik.se/nyheter/energi_miljo/energi/article3419346.ece).

<sup>51</sup> Defkalion: Super Secret Government Agents Like Hyperion. *eCat News*. 02/28/12. Accessed on 06/15/12, <http://ecatnews.com/?p=2101>.

<sup>52</sup> Accessed on 06/15/12, [http://www.defkalion-energy.com/files/2012-01-23\\_Independent\\_Testing\\_on\\_Hyperion\\_Reactors.pdf](http://www.defkalion-energy.com/files/2012-01-23_Independent_Testing_on_Hyperion_Reactors.pdf).

<sup>53</sup> Defkalion Could Start Marketing LENR Device in July. *Energy Catalyzer*. Accessed on 06/15/12, <http://energycatalyzer3.com/news/defkalion-could-start-marketing-lenr-device-in-july>.

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- Defkalion's LENR device has generated temperatures of up to 1,500°C (2,732°F) in testing. This could open the door for other industrial applications such as smelting, melting, or welding, if it is perfected.
- Defkalion has received visitors from NASA.

DGT did release an independent report which includes data about the Hyperion LENR device. This data allegedly supports their claims, "showing that Defkalion is not a scam. Instead it is a real company with a real technology that actually works".<sup>54</sup> However, the report could not be reviewed, as previously stated, the DGT site is currently under construction; therefore, these claims could not be verified.

As of Summer 2012, DGT moved their headquarters, and likely its operations, to Vancouver, Canada<sup>55</sup>, in order for their progress to take place in a more economically secure environment. According to the little information available on their website, they also currently have offices in Italy, Greece, and Cyprus.

Additionally, they have also just entered into a joint venture with an Italian company, Mose Ltd, known as Defkalion Europe. This joint venture will be based out of Milan and will sell a new industrial version of DGT's Hyperion – R5.<sup>56</sup> According to DGT's announcement, the venture is able to "produce a stable reaction using a plasma discharge mechanism, and can safely produce temperatures of 600°C"<sup>57</sup>. Additionally, they have stated they are now ready to enter into the market; however they say "this process will not be immediate but will take several years".<sup>58</sup>

### **A-2.6 Future Plans**

As of June 2012, DGT's future plans involved releasing a full working prototype by July 2012, such as the one seen in Figure 6 below. The license fee for factory operation was said to be 40.5 million Euros, with a maximum production quantity of 300,000 units annually, and there would

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<sup>54</sup> Defkalion Finally Releases Data on LENR Device. *Energy Catalyzer*. 11/01/12. Accessed on 01/21/13, <http://energycatalyzer3.com/news/defkalion-finally-releases-data-on-lenr-device>.

<sup>55</sup> Defkalion enters New Joint Venture Plans Italian R&D Center. *Energy Catalyzer*. 01/17/13. Accessed on 01/21/12, <http://energycatalyzer3.com/news/defkalion-enters-new-joint-venture-plans-italian-rd-center>.

<sup>56</sup> Defkalion enters New Joint Venture Plans Italian R&D Center. *Energy Catalyzer*. 01/17/13. Accessed on 01/21/12, <http://energycatalyzer3.com/news/defkalion-enters-new-joint-venture-plans-italian-rd-center>.

<sup>57</sup> Report: Defkalion GT and MOSE s.r.l. Forming Joint Venture. *E-Cat World*. 01/16/13. Accessed on 01/21/13, <http://www.e-catworld.com/2013/01/report-defkalion-gt-and-moses-ltd-forming-joint-venture/>.

<sup>58</sup> Report: Defkalion GT and MOSE s.r.l. Forming Joint Venture. *E-Cat World*. 01/16/13. Accessed on 01/21/13, <http://www.e-catworld.com/2013/01/report-defkalion-gt-and-moses-ltd-forming-joint-venture/>.

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be a restriction of one license per country.<sup>59</sup> However, as mentioned above, these goals were not met. No other information has been released, alluding to new possible deadlines, etc.

*Figure 6. Visual of an Actual DGT Hyperion Unit [missing citation]*



However, the latest news of the formation of a joint venture for the production of an industrial Hyperion model does show continued progress. Along with that announcement, DGT did make the claim that they are ready to enter the market; therefore, it could be inferred that their future plans involve completing this process and finally bringing a concrete, functioning unit into production.

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<sup>59</sup> Defkalion Green Technologies Communicates With Interested Parties. *E-Cat World*. 04/13/12. Accessed on 06/15/12, <http://www.e-catworld.com/2012/04/defkalion-green-technologies-communicates-with-interested-parties/>.

## **Appendix C. Francesco Celani**

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### **A-3.1 Overview**

Francesco Celani is a researcher at the forefront of the LENR field. He has studied both Palladium-Deuterium (Pd-D) and Titanium- Deuterium (Ti-D) systems. After nine years of work, Celani reconfirmed the production of an anomalous heat measurement; the observation of the anomalous effects occurred when there were non-equilibrium conditions on the samples.<sup>60</sup>

Celani performed a successful demonstration of his nickel-hydrogen-based LENR reactor this past August at NI Week in Austin, Texas. This was a very significant milestone, both for Celani and the LENR field as a whole.

### **A-3.2 Key Players**

Francesco Celani is an Italian scientist with a degree in Experimental Physics from the University “La Sapienza” in Rome. He is one of the leading researchers in the CF/LENR field. Throughout his career, he has done much research and experimentation at the nuclear level.<sup>61</sup>

### **A-3.3 History, Development, Roots of Company**

Celani began to experiment with CF soon after F&P’s announcement in 1989. His drive to the field was to invalidate F&P’s claims of finding neutron emissions.<sup>62</sup> He does not have an official company; however, he has collaborated with numerous Japanese scientists including: Makoto Okamoto, Akito Takahashi, Kazuaki Matsui, Naoto Asami, Hideo Ikegami, Tadahiko Mizuno, Jirota Kasagi, Hideo Kozima , and his wife Missa Nakamura.<sup>63</sup> He has claimed to receive funding from private entrepreneurs, but the donors have requested to remain anonymous.<sup>64</sup>

Celani has mainly been concerned with studying Pd-D<sub>2</sub>O electrolytic systems, as well as systems which operate within gaseous environments. His Pd-D<sub>2</sub> gas system has been said to operate at a

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<sup>60</sup> Celani, Francesco. Cold Fusion Effect on My Life. Accessed on 09/21/12, <http://web.pdx.edu/~pdx00210/FTEssay/Essays/Celani.htm>.

<sup>61</sup> Biography: CV Francesco Celani. 03/22/12. Accessed on 02/05/13, [http://www.iccf17.org/popup/bio\\_5.htm](http://www.iccf17.org/popup/bio_5.htm).

<sup>62</sup> Celani, Francesco. Cold Fusion Effect on My Life. Accessed on 09/21/12, <http://web.pdx.edu/~pdx00210/FTEssay/Essays/Celani.htm>.

<sup>63</sup> Celani, Francesco. Cold Fusion Effect on My Life. Accessed on 09/21/12, <http://web.pdx.edu/~pdx00210/FTEssay/Essays/Celani.htm>.

<sup>64</sup> New Interview with Francesco Celani. *E-Cat World*. 09/04/12. Accessed on 02/04/13, <http://www.e-catworld.com/2012/09/new-interview-with-francesco-celani/>.

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temperature of roughly 550°C, utilizing thin, long wires. Celani's Ni-H<sub>2</sub> system has reportedly operated at temperatures up to 900°C.<sup>65</sup>

### **A-3.4 Claimed Mechanism for Energy**

Celani is currently exploring the reactions of nickel-hydrogen cells. This is similar to the research that another prominent CF/LENR researcher, Andrea Rossi, is exploring. Celani differs from Rossi though, in that Celani uses a nickel-copper alloy, which is referred to as Constantan. His system operates in a gaseous environment.<sup>66</sup>

### **A-3.5 Current Status**

During NI Week this past year in Austin, Texas, Celani performed a demonstration of his nickel-hydrogen-based LENR reactor. The reactor was said to run continuously for over 55 hours, with a peak of excess heat at 22 W and with stable excess heat of 14 W.<sup>67</sup> (Alternate sources reported a generation of 21 W with indirect heating of the Constantan wire and 25 W with direct heating.<sup>68</sup>) Both sources gave a continuous input power of 48 W. This was a very significant step for Celani, showing substantial evidence of his claims.

Celani has recently announced that a successful third party replication has been made of his LENR system, using nano-Constantan wires. "The experiments were carried out in complete autonomy, by researchers (experts) affiliated to a major international industry."<sup>69</sup> According to Celani's statement, the reactor used in this demonstration was "completely different from the one we [Celani] developed and used"; "as a result, the probability of a systematic error in measurements has become highly unlikely".<sup>70</sup>

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<sup>65</sup> Biography: CV Francesco Celani (CERN 22 March 2012). Accessed on 09/22/12, [http://www.iccf17.org/popup/bio\\_5.htm](http://www.iccf17.org/popup/bio_5.htm).

<sup>66</sup> Celani Presents his Nickel-Hydrogen Device at ICCF-17. *Ecatinfo.com*. 08/20/12. Accessed on 09/24/12, <http://ecatinfo.com/e-cat/celani-presents-his-nickel-hydrogen-device-at-iccf-17>.

<sup>67</sup> Celani Demonstrates Excess Heat from Nickel Hydrogen Reactor at NIWeek. *E-Cat World*. 08/08/12. Accessed on 01/24/13, <http://www.e-catworld.com/2012/08/celani-demonstrates-excess-heat-from-nickel-hydrogen-reactor-at-niweek/>.

<sup>68</sup> Celani, Francesco, et al. Cu-Ni-Mn wires, with improved sub-micrometric surfaces, used as LENR device by new transparent, dissipation-type calorimeter. *Slide Share*. ICCF17, 10-18 August 2012, Daejeon-South Korea. Accessed on 02/04/13, <http://www.slideshare.net/ssuser70/celani-iccf17-trasp3>.

<sup>69</sup> Celani Announces 3<sup>rd</sup> Party Replication. *E-Cat World*. 12/05/12. Accessed on 02/04/13, <http://www.e-catworld.com/2012/12/celani-announces-3rd-party-replication/>.

<sup>70</sup> Celani Announces 3<sup>rd</sup> Party Replication. *E-Cat World*. 12/05/12. Accessed on 02/04/13, <http://www.e-catworld.com/2012/12/celani-announces-3rd-party-replication/>.

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Celani has also made numerous presentations in the past year. In 2012, he presented his system at NI Week Austin, TX, ICCF-17 in Daejeon, South Korea and the World Sustainable Energy Conference in Geneva, Switzerland. His system has been evaluated by National Instruments, and he is currently working with them to perfect his reaction.[\[verify\]](#) <sup>71,71,72</sup>

### **A-3.6 Future Plans**

Celani plans to continue developing and perfecting his technology. He has plans to launch his Constantan alloy and provide the underlying material to produce the LENR reactions at a larger scale. He will continue to perfect the wiring of the system and to get the gaseous environment to yield to a self-sustaining reaction that will be self-reinforcing through positive feedback of the nickel reaction. “More, and systematic work, is necessary to elucidate the several open questions, first of all the stability over time of the anomalous heat generation and its reproducibility-safety.”<sup>73</sup>

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<sup>71</sup> NIWEEK 2012 – Cold Fusion – LENR – eCAT – Anomalous Heat Effect Demonstrated. *YouTube*. Published on 08/09/12. Accessed on 09/23/12, <http://www.youtube.com/watch?v=Xe5rcEvsek0> .

<sup>72</sup> Celani, Francesco. Progress, in the Condensed Matter Nuclear Science, on excess energy production: towards practical applications? *World Sustainable Energy Conference 2012 – International Sustainable Energy Organization*. January 10-12, 2012. Accessed on 09/21/12, <http://newenergytimes.com/v2/news/2012/2012Celani-WSEC.pdf>.

<sup>73</sup> Celani, Francesco, et al. Cu-Ni-Mn wires, with improved sub-micrometric surfaces, used as LENR device by new transparent, dissipation-type calorimeter. *Slide Share*. ICCF17, 10-18 August 2012, Daejeon-South Korea. Accessed on 02/04/13, <http://www.slideshare.net/ssusereef70/celani-iccf17-trasp3>.

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## **Appendix D. Brillouin Energy**

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### **A-4.1 Overview**

Brillouin Energy (BE), based out of Berkley, California, is developing an LENR technology by converting hydrogen into helium with the use of water and a metal, mainly nickel. BE claims to completely understand how the CF/LENR process works. The proof that they know the science best is that their data show a steady curve of energy output, which is in contrast to the data obtained during other CF/LENR demonstrations. [verify]

BE is working on two boiler models to target essentially every market – industry, commercial, and residential. Though they have still not received patent recognition in the US, China has awarded them a patent, and outside funding agreements/collaborations show promise for continued development.

### **A-4.2 Key Players**

Robert Godes is the Founder, President, and Chief Technology Officer (CTO) of BE. Godes is an “innovative technical designer, electrical engineer, and creative solution inventor with over 25 years experience in identifying and developing technology products for diverse organizations.”<sup>74</sup> He has studied mechanics, quantum mechanics, and several areas of physics, electronics, control systems, programming, and chemistry. “His talent in integrating mechanical design, physics, and chemistry provides extraordinary insight into the various problems and failures of existing research in this field.”<sup>75</sup>

Robert George is the CEO of BE. George is a “multi-disciplined executive with extensive experience in product design and commercialization, running successful companies in the public and private sector, providing creative solutions for product development, marketing and international licensing and joint ventures.”<sup>76</sup> In addition to BE, George is also currently Managing Director at Grosvenor Financial Partners, LLC. He has had a very successful career, producing very positive results for a number of companies.

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<sup>74</sup> Our Team. *Brillouin Energy Corporation*. 2012. Accessed on 01/30/13, [http://www.brillouinenergy.com/?page=our\\_team](http://www.brillouinenergy.com/?page=our_team).

<sup>75</sup> Our Team. *Brillouin Energy Corporation*. 2012. Accessed on 01/30/13, [http://www.brillouinenergy.com/?page=our\\_team](http://www.brillouinenergy.com/?page=our_team).

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Jim Aldridge, who has extensive experience in developing renewable energy solutions, is the Engineering Manager and Project Leader, and David Firshein is the CFO. Additionally, Michael McKubre, who is a longtime CF researcher, has reviewed and validated the BE experimental claims. He has since joined the BE Board of Advisors, which is currently made up of six individuals.

#### **A-4.3 History, Development, Roots of Company**

The technology behind BE was developed by Godes, originally named Quantum Fusion. He actively researched LENR from 1992 through 2002, during which he created a productive test reactor. Due to his success, Godes created Profusion Energy Inc. Under this company, he requested patent protection in 2005 from a leading US patent firm. This patent, as well as the patents filed on behalf of BE, have been rejected by the United States Patent and Trademark Office (USPTO), as the US Examiner will not approve any patent which has cold fusion claims.<sup>77</sup>

Lack of outside funding caused the foreclosure of Profusion Energy. However, in 2009, Godes established Brillouin Energy. He retained the services of MCM Group, Inc., Grosvenor Financial Partners, LLC, and TTC in exchange for founders stock.<sup>78</sup> With BE, Godes has assembled a very capable team to continue his efforts to bring his LENR technology to a commercial state.

#### **A-4.4 Claimed Mechanism for Energy**

Controlled Electron Capture Reactions (CECR) are the claimed mechanism for energy generation; this process is said to be slightly different than traditional CF/LENR processes, as it uses Q-pulses, which are high current pulses through the lattice of the CECR reactor. Essentially, the technology converts hydrogen in water into helium gas within a piece of nickel (or other metal with the correct internal geometry)<sup>79</sup>, releasing large amounts of energy as heat during the process. Godes says that "...hydrogen protons are converted into neutrons. These newly produced neutrons are soon captured by hydrogen ions or other atoms in a metallic (e.g. nickel) lattice near where the hydrogen ions were converted to neutrons. The captured neutrons generate

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<sup>76</sup> Our Team. *Brillouin Energy Corporation*. 2012. Accessed on 01/30/13, [http://www.brillouinenergy.com/?page=our\\_team](http://www.brillouinenergy.com/?page=our_team).

<sup>77</sup> French, David J. New kid on the block? Brillouin Energy Corp. *Cold Fusion Now*. 04/23/12. Accessed on 06/08/12, <http://coldfusionnow.org/new-kid-on-the-block/>.

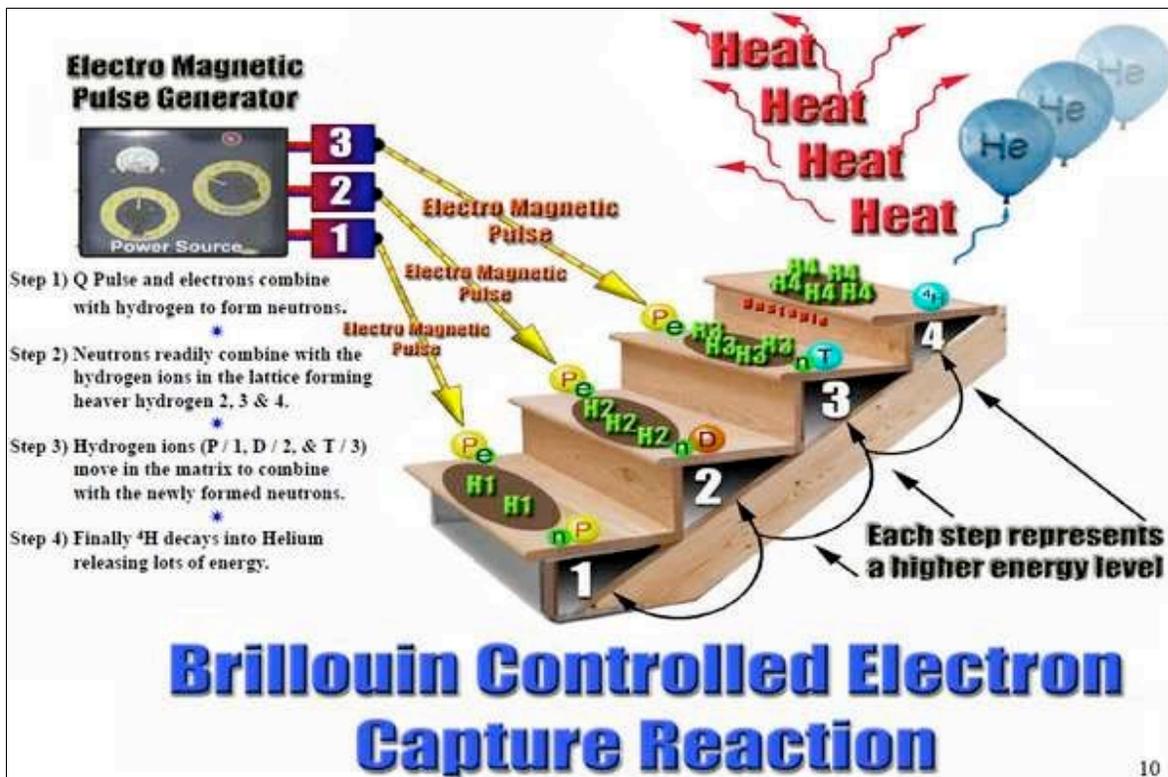
<sup>78</sup> Corporate History. *Brillouin Energy Corporation*. 2012. Accessed on 01/30/13, <http://www.brillouinenergy.com/?page=history>.

<sup>79</sup> Non-Technical Overview. *Brillouin Energy Corporation*. 2012. Accessed on 01/30/13, [http://www.brillouinenergy.com/?page=tech\\_summary](http://www.brillouinenergy.com/?page=tech_summary).

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heat because the new atoms that are one neutron heavier shed excess binding energy as heat to the lattice, resulting in a dramatically clean, low-cost, hi-quality heat output.”<sup>80</sup> The reaction has a “Q-wave”, which pushes the deuterium through the lattice and causes the reactions to take place within the system, producing heat and helium.<sup>81</sup> The process moves from an endothermic reaction, which is the creation of cold neutrons from electromigration, to an exothermic reaction, as the cold neutrons accumulate on the hydrogen nuclei. Figure 7 illustrates this reaction and the claimed process which results from the reaction (energy released as pure heat).<sup>82</sup>

Figure 7. Visual of the CECR Process<sup>83</sup>



BE claims independent validation from Los Alamos Laboratory, as well as SRI International. The company also claims to be able to manage the reaction far more effectively than other

<sup>80</sup> Allan, Sterling D. Brillouin: “Understanding How LENR Works Will Enable Us to Be First”. *Pure Energy Systems*. Last updated 07/14/12. Accessed on 01/18/13, [http://pesn.com/2012/04/19/9602078\\_Brillouin--Understanding\\_How\\_LEN\\_R\\_Works\\_Will\\_Enable\\_Us\\_to\\_Be\\_First/](http://pesn.com/2012/04/19/9602078_Brillouin--Understanding_How_LEN_R_Works_Will_Enable_Us_to_Be_First/).

<sup>81</sup> Carat, Ruby. Brillouin Energy Quantum Fusion Animations. *Cold Fusion Now*. 03/21/12. Accessed on 06/10/12, <http://coldfusionnow.org/brillouin-energy-quantum-fusion-animations/>.

<sup>82</sup> Westenhaus, Brian. New LENR Machine is the Best Yet. *OilPrice.com*. 04/23/12. Accessed on 06/14/12, <http://oilprice.com/Energy/Energy-General/New-LENR-Machine-is-the-Best-Yet.html>.

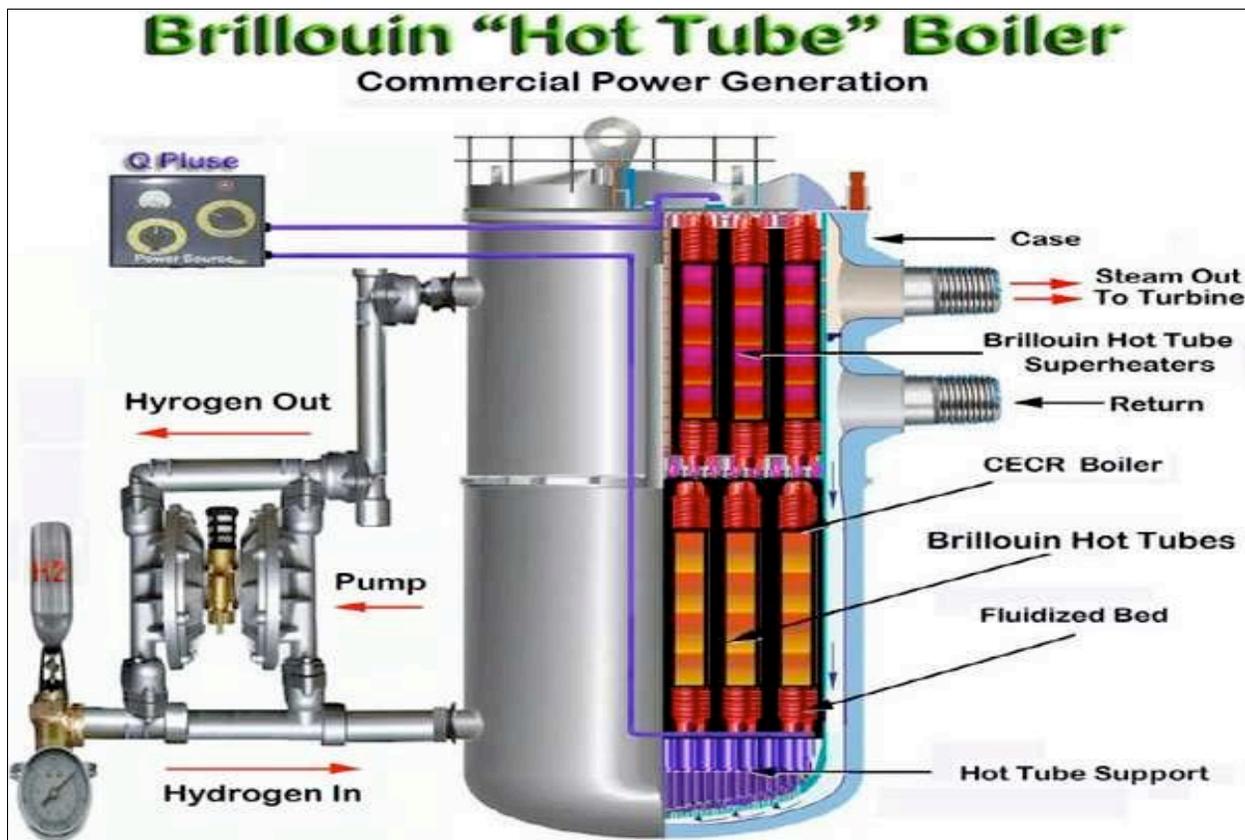
<sup>83</sup> Allan, Sterling D. Brillouin: “Understanding How LENR Works Will Enable Us to Be First”. *Pure Energy Systems*. Last updated 07/14/12. Accessed on 01/18/13, [http://pesn.com/2012/04/19/9602078\\_Brillouin--Understanding\\_How\\_LEN\\_R\\_Works\\_Will\\_Enable\\_Us\\_to\\_Be\\_First/](http://pesn.com/2012/04/19/9602078_Brillouin--Understanding_How_LEN_R_Works_Will_Enable_Us_to_Be_First/).

parties in the field. BE says that they can turn the reaction on and off and run it in a steady state.<sup>29</sup> [verify]

#### A-4.5 Current Status

BE is currently developing two types of products. The first is the Brillouin New Hydrogen Boiler (NHB), also known as the “Hot Tube”. The other product is the Brillouin Boiler (BB). The NHB is a dry boiler system which will be able to produce heat from 400°C to 500°C, which are temperatures capable of running power plant turbines.<sup>84</sup> Figure 8 is a graphic of how the boiler technology works. The BB is a wet boiler, which uses distilled water and electrolytes. It can produce temperatures from 100°C to 150°C. This type of technology could be marketed as a low-cost water heating source, which would be sold to commercial and residential customers.

Figure 8. Illustration of How the Brillouin Hot Tube Boiler Works<sup>85</sup>



<sup>84</sup> Allan, Sterling D. Brillouin: “Understanding How LENR Works Will Enable Us to Be First”. *Pure Energy Systems*. Last updated 07/14/12. Accessed on 01/18/13, [http://pesn.com/2012/04/19/9602078\\_Brillouin--Understanding\\_How\\_LEN\\_R\\_Works\\_Will\\_Enable\\_Us\\_to\\_Be\\_First/](http://pesn.com/2012/04/19/9602078_Brillouin--Understanding_How_LEN_R_Works_Will_Enable_Us_to_Be_First/).

<sup>85</sup> Allan, Sterling D. Brillouin: “Understanding How LENR Works Will Enable Us to Be First”. *Pure Energy Systems*. Last updated 07/14/12. Accessed on 01/18/13, [http://pesn.com/2012/04/19/9602078\\_Brillouin--Understanding\\_How\\_LEN\\_R\\_Works\\_Will\\_Enable\\_Us\\_to\\_Be\\_First/](http://pesn.com/2012/04/19/9602078_Brillouin--Understanding_How_LEN_R_Works_Will_Enable_Us_to_Be_First/).

Despite the initial rejection from the USPTO, BE has initiated a second US “Continuation” application; with “proof of utility”, this technology may yet receive a US patent. The application is still pending at this time.<sup>86</sup>

In the meantime, BE has been granted a patent from China for their hot water boiler technology.<sup>87</sup> This could impact the USPTO’s long-standing position against any CF/LENR technology.

BE has also received “second stage” funding of \$20 million from Sunrise Securities, located in New York, pending a conditional agreement.<sup>88</sup> Additionally, according to the BE website, they have already entered into their first international licensing agreement, covering three nations, and are involved in “ongoing negotiations for other potential international partners”.<sup>89</sup>

#### **A-4.6 Future Plans**

BE does not plan on becoming a manufacturer themselves; rather, they would like to become a technology licensing firm to third-party production companies. A \$2 million investment is being sought to continue BE’s work.<sup>90</sup> BE has claimed that they are working with a number of entities such as the Naval Research Lab and “major corporations”.<sup>91</sup>

BE has a potential market in the US if and when it reaches a commercial level – the replacement of retiring coal boilers with BE boilers. This suggests that centralized generation is the goal for BE, rather than domestic units.<sup>92</sup>

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<sup>86</sup> French, David J. New kid on the block? Brillouin Energy Corp. *Cold Fusion Now*. 04/23/12. Accessed on 01/23/13, <http://coldfusionnow.org/new-kid-on-the-block/>.

<sup>87</sup> China Grants Patent to Brillouin Energy. *Next Big Future*. 09/06/12. Accessed on 01/23/13, <http://nextbigfuture.com/2012/09/china-grants-patent-to-brillouin-energy.html>.

<sup>88</sup> Brillouin Energy has conditional Funding for \$20 million. *Next Big Future*. 09/06/12. Accessed on 01/23/13, <http://nextbigfuture.com/2012/09/brillouin-energy-has-conditional.html>.

<sup>89</sup> Our Business Model. *Brillouin Energy Corporation*. 2012. Accessed on 01/30/13, [http://www.brillouinenergy.com/?page=business\\_model](http://www.brillouinenergy.com/?page=business_model).

<sup>90</sup> US Company could begin Licensing LENR Boiler Technology within a Year. *Cold Fusion News*. 03/31/12. Accessed on 06/14/12, <http://coldfusion3.com/blog/us-company-could-begin-licensing-lenr-boiler-technology-within-a-year>.

<sup>91</sup> Interview With Robert George and Robert Godes of Brillouin Energy—Announce Successful Cold Fusion Reactor. *E-Cat World*. 03/29/12. Accessed on 06/14/12, <http://www.e-catworld.com/2012/03/interview-with-robert-george-and-robert-godes-of-brillouin-energy-announce-successful-cold-fusion-reactor/>.

<sup>92</sup> Carat, Ruby. Brillouin Energy interview on Ca\$H Flow: We can re-power coal plants with LENR. *Cold Fusion Now*. 03/28/12. Accessed on 06/11/12, <http://coldfusionnow.org/brillouin-energy-interview-on-cah-flow-we-can-re-power-coal-plants-with-lenr/>.

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## **Appendix E. Blacklight Power**

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### **A-5.1 Overview**

Blacklight Power (BLP) is a New Jersey-based company that has been in existence since 1991. It is headed by Randall Mills. The main point of focus for BLP is to use a process of catalysis to generate energy from the hydrogen atom.<sup>93</sup>

Mills has claimed to have achieved “critical milestones”, projecting to have a completed 100 W unit by the end of 2012 and an operational 1.5 kW residential unit by 2013. The initial 100 W unit deadline appears to have passed without a product – no evidence of a completed unit could be found; the 1.5 kW unit remains to be seen.

### **A-5.2 Key Players**

Randall Mills, founder and principle stockholder of BLP, has also been the Chairman of the Board, President, and CEO since 1991. Mills has extensive experience in the energy technology field, receiving patents or filing patent applications in: 1) Millsian computational chemical design technology based on Classical Physics; 2) magnetic resonance imaging; 3) Mossbauer cancer therapy; 4) Luminide class of drug delivery molecules; 5) genomic sequencing method; and 6) artificial intelligence.<sup>94</sup> He rejects quantum mechanics as is it currently understood and views his “hydrino theory” as completely deterministic. He self-published his entire physics theory with the title of *The Grand Unified Theory of Classical Physics*.

BLP’s Board of Directors includes six additional individuals.

### **A-5.3 History, Development, Roots of Company**

Mills, in an effort to prove his theory during the early 1990s, originally created a company known as HydroCatalysis Power, where he experimented with heat-producing electrolysis cells.<sup>95</sup> He later shifted his focus to electrical discharges in gases, simultaneously renaming the company

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<sup>93</sup> Accessed on 06/17/12, <http://www.marketwatch.com/story/electricity-generated-from-water-blacklight-power-announces-validation-of-its-scientific-breakthrough-in-energy-production-2012-05-22>.

<sup>94</sup> Management. *Blacklight Power*. Accessed on 01/30/13, <http://www.blacklightpower.com/business/management/>.

<sup>95</sup> Guizzo, Erico. Loser: Hot or Not? *IEEE: Spectrum*. January 2009. Accessed on 01/30/13, <http://spectrum.ieee.org/energy/nuclear/loser-hot-or-not/2>.

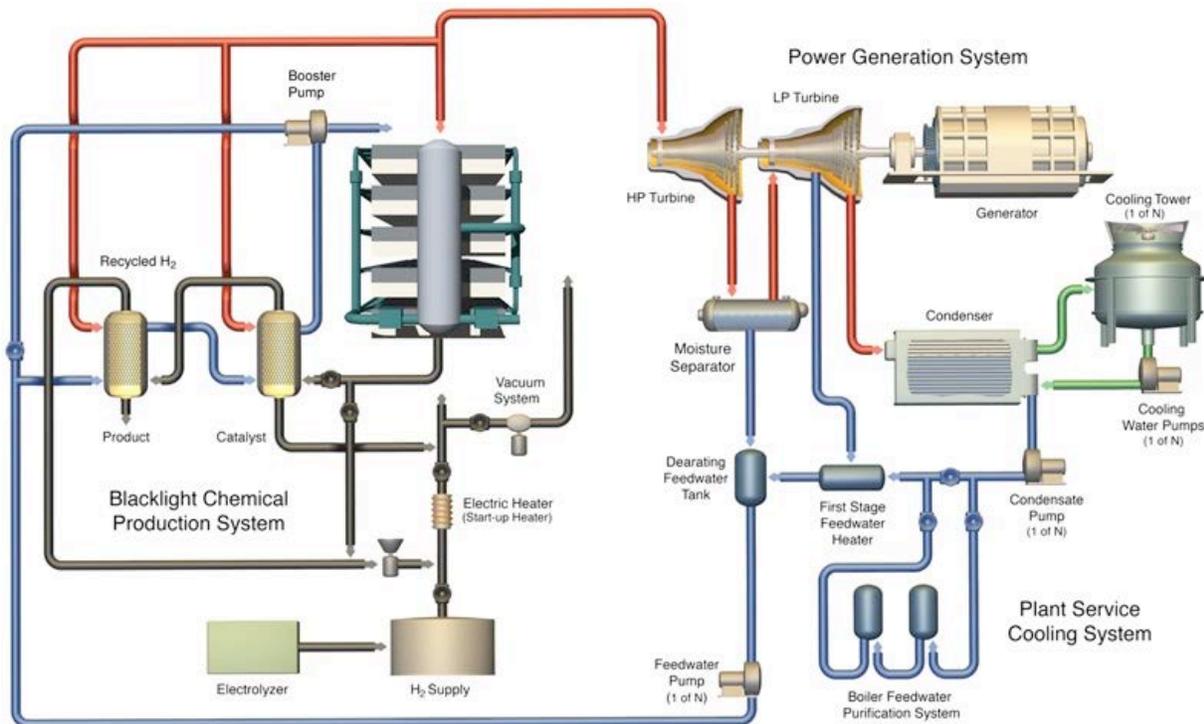
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Blacklight Power – “a reference to the emissions of ultraviolet light he observed”.<sup>96</sup> Since, however, he has shifted his focus yet again, to a solid-fuel design, which is discussed in more detail in subsequent sections.

### A-5.4 Mechanism for Energy

A Catalyst Induced Hydrino Transition Cell (CIHT) is the mechanism for energy with this technology. The CIHT generates electricity directly from water vapor by using a cathode, anode, and an electrolyte that aids in creating hydrinos. Figure 9 shows the process by which the CIHT claims to work.

Figure 9. Blacklight Power’s CIHT Mechanism Process<sup>97</sup>



The hydrinos are said to be a more stable form of hydrogen that release 200 times more energy than directly burning hydrogen. The mechanism can be broken down into the following four steps:<sup>98</sup>

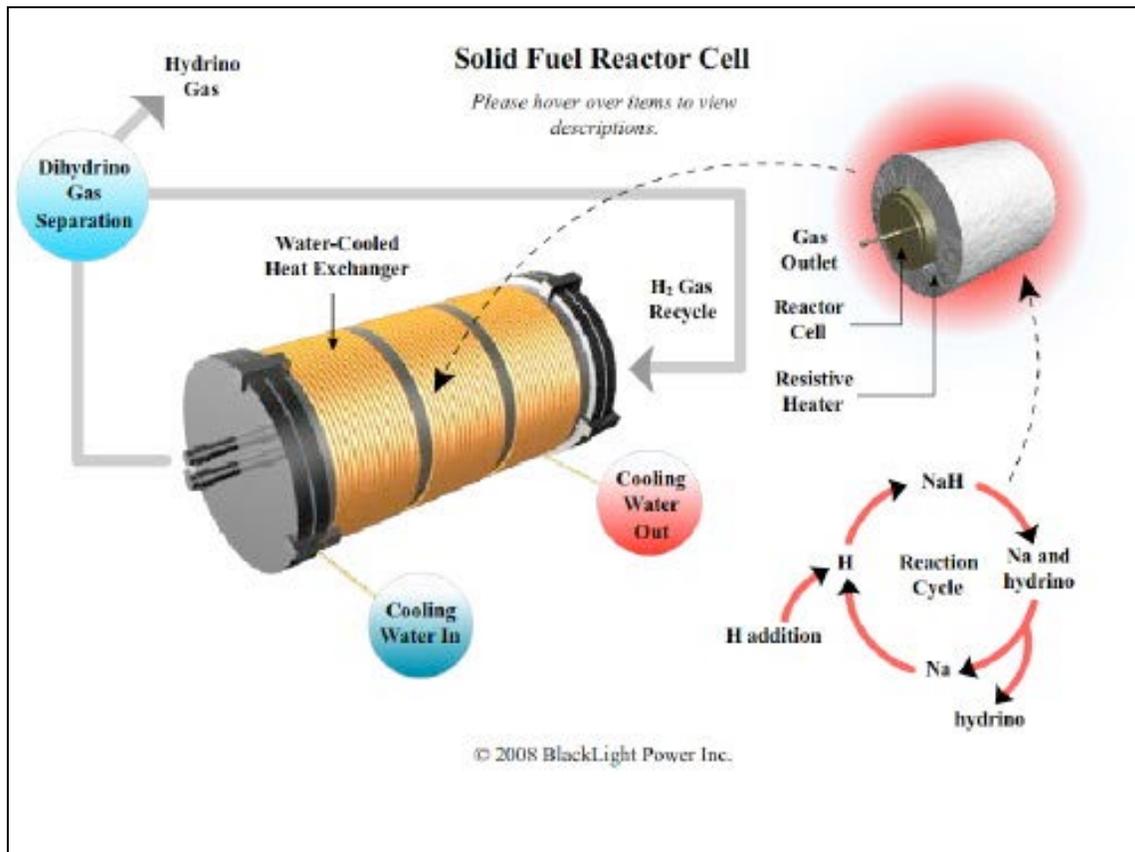
<sup>96</sup> Guizzo, Erico. Loser: Hot or Not? *IEEE: Spectrum*. January 2009. Accessed on 01/30/13, <http://spectrum.ieee.org/energy/nuclear/loser-hot-or-not/2>.

<sup>97</sup> Blacklight Power. 2012. Accessed on 01/30/13, <http://www.blacklightpower.com/wp-content/uploads/images/plantprocess2.png>.

<sup>98</sup> CIHT Cell: Catalyst Induced Hydrino Transition Cell. *Blacklight Power*. Accessed on 06/18/12, <http://www.blacklightpower.com/technology/ciht-cell/>.

1. The process is similar to an alkaline fuel cell, but the electric current is passed through the cell and an inert atmosphere, where trace water vapor surrounds the cathode, anode, and electrolyte.
2. The electric current produces hydrogen and oxygen from the electrolysis of the water vapor, and the cell is discharged for a longer time than it was charged.
3. Water is formed at the anode, as the hydroxide (OH) and hydrogen (H) molecules react. Hydrinos form during this discharge period, as the water is the catalyst for the reaction.
4. Once the hydrinos have been formed, energy is given off and reactions occur at both electrodes where there is a cycle of hydrino formation from the electricity, oxygen, and water. The power is produced even though there is no longer any electricity being applied to the cell. Figure 10 gives the technologic breakdown of how the solid reactor cell works.

Figure 10. Illustration of How the CIHT is Claimed to Work [missing citation]



The current prototype consists of a steel cylinder containing one kilogram of an industrial chemical, Raney nickel, which is a powdery porous nickel-aluminum alloy that traps hydrogen gas.<sup>99</sup> Claims have been made that the system is able to produce energy for 0.1 cents per kWh.

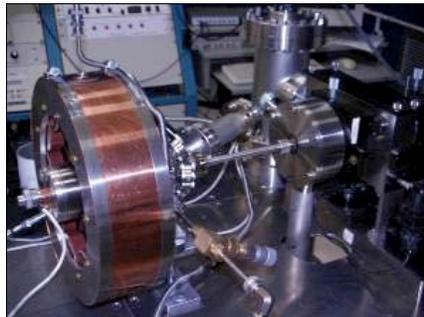
### **A-5.5 Current Status**

In 2012, Dr. Mills stated that the CIHT technology has achieved “critical milestones in scaling its new technology”, with an electrical gain that is 10 times that of the input electrical energy. BLP plans to complete a 100 W unit by the end of 2012, and a 1.5 kW pilot project for residential use is expected to be operational by 2013.<sup>100</sup> The 1.5 kW unit is said to be the initial commercial application of BLP technology. As of January 2013, however, no evidence could be found to verify the completion of the 100 W unit by the proposed deadline.

### **A-5.6 Future Plans**

As stated above, the CIHT will be developed into an electricity producing model by 2013; this 1.5 kW pilot unit will be designed for the residential market.<sup>101</sup> Average electric usage in a US home is 1.5 kW, but the peak usage is closer to 15 to 20 kW. It would be necessary for the family or individual to purchase enough units to handle peak load or install a battery bank and inverter system.<sup>102</sup> The stability of the hydrino technology should make the unit more stable than previous attempts by BLP. Figure 11 gives a visual of what the actual CIHT looks like.

*Figure 11. Picture of an actual CIHT [missing citation]*



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<sup>43</sup> Guizzo, Erico. Loser: Hot or Not? *IEEE Spectrum*. January 2009. Accessed on 06/18/12, <http://spectrum.ieee.org/energy/nuclear/loser-hot-or-not/2>.

<sup>100</sup> They're Baaack – Blacklight Power. *Next Big Future*. 05/22/12. Accessed on 06/20/12, <http://nextbigfuture.com/2012/05/their-back-blacklight-power.html>.

<sup>101</sup> BlackLight Power Announces Scientific Validation of Process Converting Water Vapor to Electricity. *E-Cat World*. 05/22/12. Accessed on 06/18/12, <http://www.e-catworld.com/2012/05/blacklight-power-announces-scientific-validation-of-process-converting-water-vapor-to-electricity/>.

<sup>102</sup> Allan, Sterling D. Electricity generated from water: BlackLight Power announces validation of its scientific breakthrough. *Pure Energy Systems*. 05/22/12. Accessed on 06/17/12, [http://pesn.com/2012/05/22/9602098\\_Electricity\\_generated\\_from\\_water--BlackLight\\_Power\\_announces\\_validation/](http://pesn.com/2012/05/22/9602098_Electricity_generated_from_water--BlackLight_Power_announces_validation/).

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## **Appendix F. JET Energy / NANOR**

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### **A-6.1 Overview**

JET Energy, a company based in Massachusetts, was founded by Mitchell Swartz. JET's technology is based on the development of quantum optical electronic components, using lattice assisted nuclear reactions (LANR).<sup>103</sup>

Swartz and his partner, Peter Hagelstein, have successfully demonstrated the ability of their technology – NANOR – to generate excess heat during a CF short course at MIT in 2012. No new information or news could be found regarding the progress JET Energy may have made over the past year; although Swartz and Hagelstein did appear to have held a second short course at MIT this past January.

### **A-6.2 Key Players**

Mitchell Swartz graduated with degrees in electrical engineering, a doctorate in science from MIT, and a doctor of medicine from Harvard. Swartz has researched CF for many years. He publishes his own website, “Cold Fusion Times”<sup>104</sup>, which he describes as “the journal of the scientific aspects of loading isotopic fuels into materials and the science and engineering of lattice-assisted nuclear reactions.”<sup>105</sup>

Peter Hagelstein is an Associate Professor of Electrical Engineering at MIT. He works with Swartz on the development of the NANOR system. Hagelstein recently conducted a short course on cold fusion at MIT, “Cold Fusion 101: Introduction to Excess Power in Fleischmann-Pons Experiments”, which gave a theoretical and experimental overview of the CF/LENR field.<sup>106</sup>

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<sup>103</sup> JET Energy's Goal is: Clean Energy Production. *JET Energy, Inc.* Accessed on 01/30/13, <http://world.std.com/~mica/jet.html>.

<sup>104</sup> *Cold Fusion Times*, <http://world.std.com/~mica/cft.html>.

<sup>105</sup> Mitchell Swartz. *New Energy Times*. Accessed on 02/01/13, <http://newenergytimes.com/v2/sr/Swartz/Mitchell-Swartz-Cold-Fusion-Researcher.shtml>.

<sup>106</sup> Frazier, Christy L. Cold Fusion Demonstrations During MIT Short Course. *Infinite Energy*. March/April 2012. Accessed on 02/01/13, <http://www.infinite-energy.com/iemagazine/issue102/mitdemo.html>.

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### **A-6.3 History, Development, Roots of Company**

From what little information that could be found about JET Energy's history, it can be inferred that the company has been around since at least 2003. In 2003, there was a successful demonstration by JET Energy at a CF conference in Cambridge, Massachusetts.

### **A-6.4 Claimed Mechanism for Energy**

The process known as CF or lattice assisted nuclear reaction (LANR) is a quantum electronic component, also called NANOR. This technology is based on a ZrO<sub>2</sub>-Pd reaction structure. The tubular structure houses the NANOR and control devices to measure the reaction as energy flows into the system and heat flows out.<sup>107</sup> The heat generated from an aqueous system, using JET Energy's PHUSOR cathodes, is produced in the nanomaterial environment, as the fusion products formed are helium-4 from deuterons.<sup>108</sup> Due to the NANOR's construction and materials, JET claims that this device offers superior evidence of existence and better control of the CF/LANR reactions.

### **A-6.5 Current Status**

The NANOR device that JET Energy has created was run for five days in the spring of 2012 during the short-course taught by Hagelstein at MIT (discussed above). Unlike previous demonstrations, such as the 2003 MIT CF/LANR demonstration, this demonstration had three independent ways of monitoring excess heat for improved accuracy.<sup>109</sup> Figure 12 gives the test results of the NANOR experiment. Many improvements can be seen with this new model. The energy gain from this model – which was reproducible and controllable – was 14.1, compared to roughly 2.7 in 2003. Additionally, this sixth version of the NANOR terminal is much smaller and self-contained; whereas in 2003, JET Energy demonstrated a NANOR at ICCF-10 which needed two tabletops to hold the system. This new model is also “pre-loaded so that the LANR activation is separated from loading”.<sup>110</sup>

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<sup>107</sup> Swartz, Mitchell R. and Peter L. Hagelstein. Demonstration of Excess Heat from the JET Energy NANOR at MIT. *The International Society for Condensed Matter Nuclear Science*. 2012. Accessed on 06/14/12, <http://www.iscmns.org/work10/HagelsteinPdemonstra.pdf>.

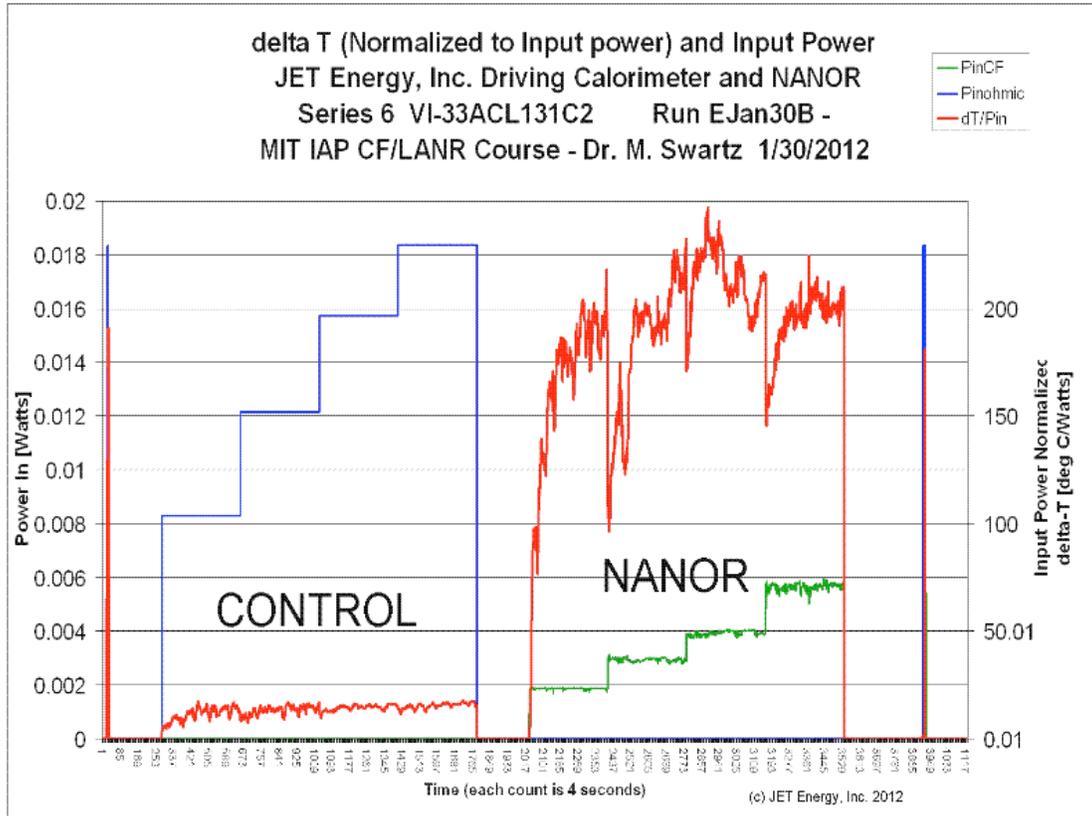
<sup>108</sup> Frazier, Christy L. Cold Fusion Demonstration During MIT Short Course. *Infinite Energy*. March/April 2012. Accessed on 06/15/12, <http://www.infinite-energy.com/iemagazine/issue102/mitdemo.html>.

<sup>109</sup> Frazier, Christy L. Cold Fusion Demonstrations During MIT Short Course. *Infinite Energy*. March/April 2012. Accessed on 02/01/13, <http://www.infinite-energy.com/iemagazine/issue102/mitdemo.html>.

<sup>110</sup> Swartz, Mitchell R. and Peter L. Hagelstein. Demonstration of Excess Heat from the JET Energy NANOR at MIT. *JET Energy*. 2012. Accessed on 02/01/13, <http://www.iscmns.org/work10/HagelsteinPdemonstra.pdf>.

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Figure 12. Graph of results of the NANOR tests that were run in January 2012<sup>111</sup>



Hagelstein and Swartz have just put on their second short course at MIT this year, held from January 22 to January 30, 2013.<sup>112</sup> It could not be determined whether an actual demonstration was conducted; “many examples of excess heat generated by CF/LANR systems were shown, using aqueous nickel and palladium systems.”<sup>113</sup>

Additionally, Hagelstein and Swartz recently demonstrated their NANOR system to Massachusetts State Senator Bruce Tarr. Tarr is one of the few politicians in the US who is publicly supporting CF/LENR research, actively pursuing additional information. In addition to Hagelstein and Swartz, Tarr has also met with Andrea Rossi to discuss his work in the field.<sup>114</sup>

<sup>111</sup> Swartz, Mitchell R. and Peter L. Hagelstein. Demonstration of Excess Heat from the JET Energy NANOR at MIT. *JET Energy*. 2012. Accessed on 02/01/13, <http://www.iscmns.org/work10/HagelsteinPdemonstra.pdf>.

<sup>112</sup> IAP 2013. Cold Fusion 101: Introduction to Excess Power in Fleischmann-Pons Experiment. *Massachusetts Institute of Technology*. 2012. Accessed on 02/01/13, <http://student.mit.edu/searchiap/iap-BD6D0CF8E170B284E0400312852F4A61.html>.

<sup>113</sup> *Cold Fusion Times*. 01/28/13. Accessed on 02/01/13, <http://world.std.com/~mica/cft.html>.

<sup>114</sup> MIT’s Hagelstein Demos JET Energy Cold Fusion to Mass. State Senator Tarr. *E-Cat World*. 04/20/12. Accessed on 02/01/13, <http://www.e-catworld.com/2012/04/mits-hagelstein-demos-jet-energy-cold-fusion-to-mass-state-senator-tarr/>.

### ***A-6.6 Future Plans***

Specific future plans for JET Energy were not found, but it may be assumed Swartz and Hagelstein will continue to develop the NANOR to achieve commercial availability.

## **Appendix G. LENUCO**

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### **A-7.1 Overview**

LENUCO is a small company based in the research park at the University of Illinois.<sup>115</sup> They are working on developing new technologies to expand space exploration opportunities with the use of CF/LENR processes, as well as working toward a goal of commercial production in the future. LENUCO appears to still be in the preliminary design, conceptualization phase with these aspirations.

### **A-7.2 Key Players**

George H. Miley is the head researcher for the company. He is a Professor Emeritus at the University of Illinois Urbana-Champaign. He has been on the frontier of CF research since 1989 and has acquired several patents in nuclear science and plasma research.

### **A-7.3 History, Development, Roots of Company**

Miley can trace his theory back to F&P, but the main ancestor to LENUCO is the Patterson Cell. The Patterson Cell was created by Jim Patterson and was based on a different type of technology than F&P. Patterson used a system that employed nickel and nickel-palladium coated plastic beads within an electrolytic system. These beads formed a system where the fluid ran through the metal beads and produced fusion products.<sup>116</sup> Figure 14 is an illustration of a Patterson Cell. One main point that Miley took away from the Patterson cell is that the nickel and palladium films used in the reactions should not be perfect because the areas of imperfection are where the reactions occur.<sup>117</sup>

LENUCO – the academic-based research outfit – has focused on utilizing LENR as a replacement for radioisotope thermoelectric generators (RTGs) in deep-space travel.<sup>118</sup> However, they also have said to have commercial production goals as well.

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<sup>115</sup> Miley Says LENUCO Can be a Huge Success. *Ecatinfo.com*. 04/17/12. Accessed on 06/14/12, <http://ecatinfo.com/e-cat/miley-says-lenuco-can-be-a-huge-success>.

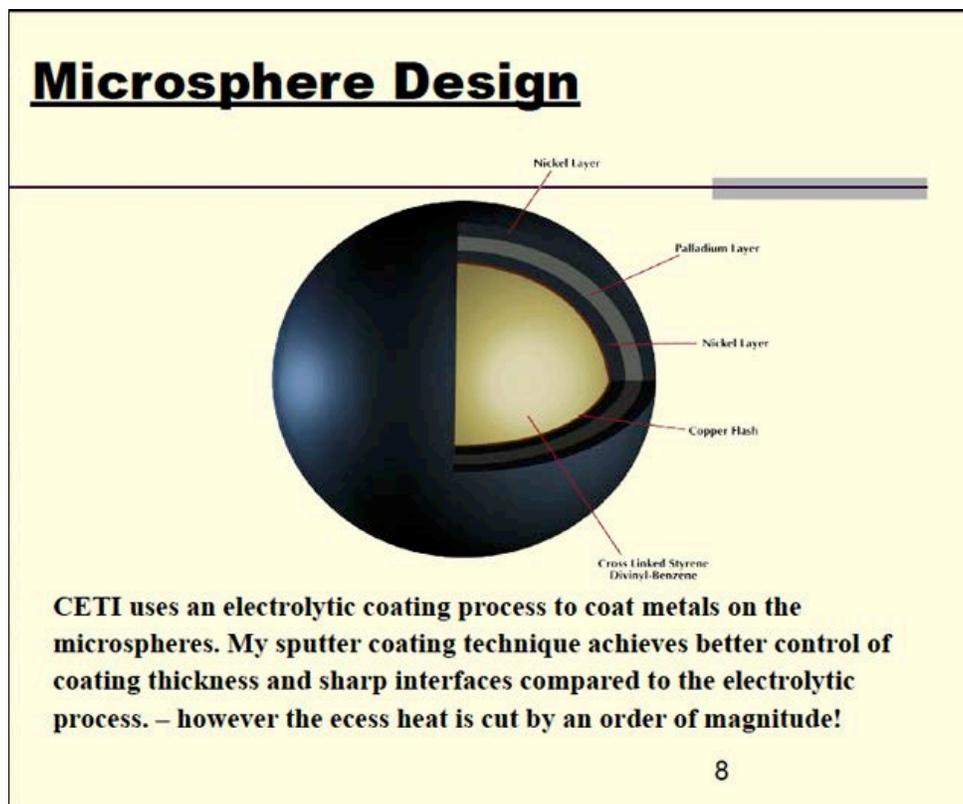
<sup>116</sup> Carat, Ruby. George H. Miley at NETS: Lets find out whats there. *Cold Fusion Now*. 04/09/12. Accessed on 06/12/12, <http://coldfusionnow.org/george-h-miley-at-nets-lets-find-out-whats-there/>.

<sup>117</sup> Carat, Ruby. George H. Miley at NETS: Lets find out whats there. *Cold Fusion Now*. 04/09/12. Accessed on 06/12/12, <http://coldfusionnow.org/george-h-miley-at-nets-lets-find-out-whats-there/>.

<sup>118</sup> The University of Illinois Cold Fusion Battery. *eCat News*. 03/03/12. Accessed on 06/12/12, <http://ecatnews.com/?p=2125>.

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Figure 14. Illustration of a Patterson Cell<sup>119</sup>



#### **A-7.4 Claimed Mechanism for Energy**

LENUCO has a similar theory to the F&P effect, as the experiment has been setup with thin layers of palladium and nickel, which are combined with a metal substrate to form an electrode. This device is placed in heavy water where there are many cycles of loading and de-loading placed on the device. Miley's theory is that within the small cracks and voids in the film layers, there are clusters that form of deuterium nuclei.<sup>120</sup> Figure 13 gives an image of the theory, showing how Miley's device works. This clustering of the nuclei produces heat, as well as new, heavier elements, in a process that Miley calls Nuclear Active Environment (NAE).<sup>121</sup>

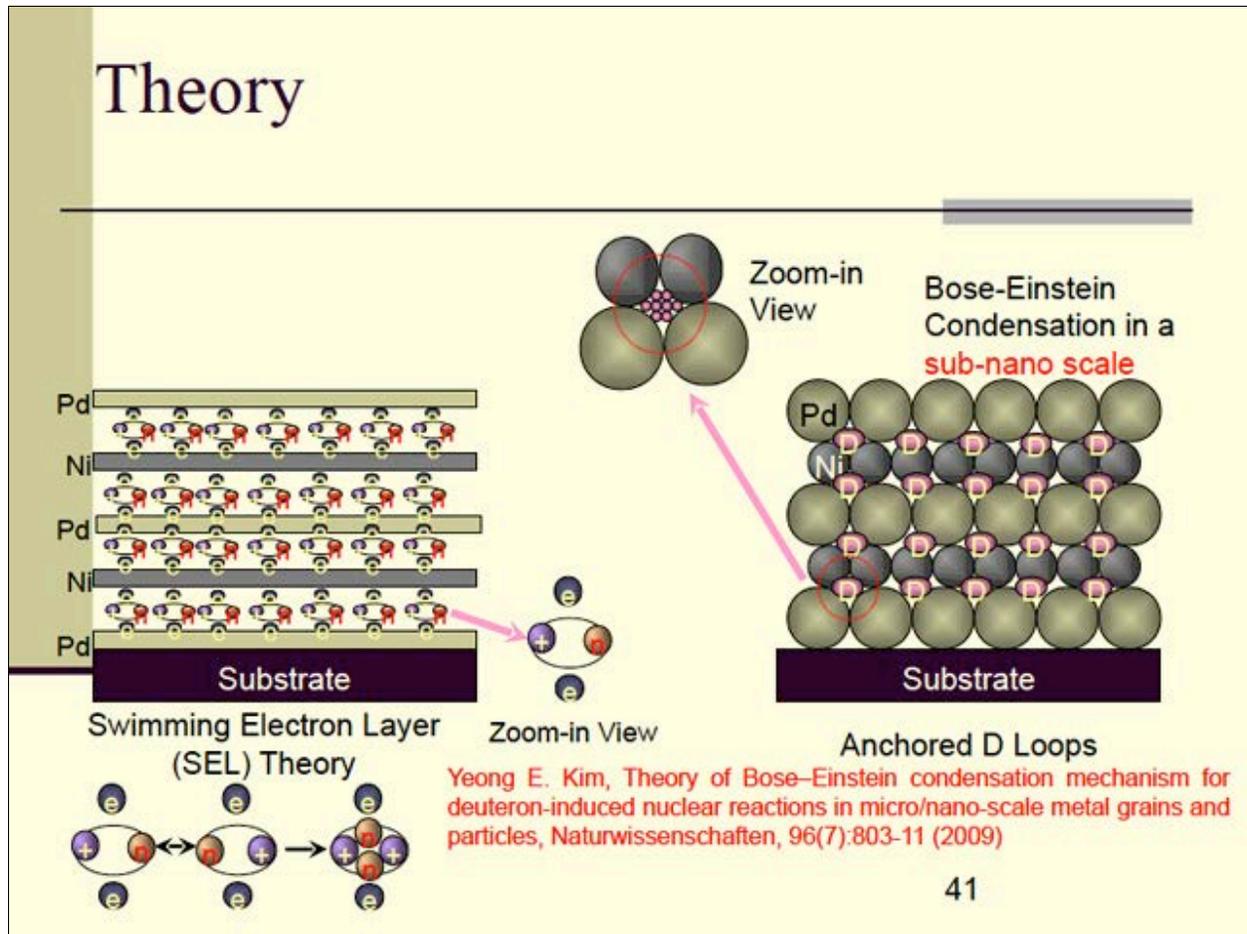
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<sup>119</sup> Carat, Ruby. George H. Miley at NETS: Lets find out whats there. *Cold Fusion Now*. 04/09/12. Accessed on 06/12/12, <http://coldfusionnow.org/george-h-miley-at-nets-lets-find-out-whats-there/>.

<sup>120</sup> Carat, Ruby. George H. Miley at NETS: Lets find out whats there. *Cold Fusion Now*. 04/09/12. Accessed on 06/12/12, <http://coldfusionnow.org/george-h-miley-at-nets-lets-find-out-whats-there/>.

<sup>121</sup> Carat, Ruby. George H. Miley at NETS: Lets find out whats there. *Cold Fusion Now*. 04/09/12. Accessed on 06/12/12, <http://coldfusionnow.org/george-h-miley-at-nets-lets-find-out-whats-there/>.

Figure 13. Mechanism for the Swimming Electron Layer for Nuclear Reactions in High Density Clusters of the Deterium Nuclei<sup>122</sup>



Miley has used his theory to create a technology that could be used for space exploration. The Helicon Injected Inertial Plasma Electrostatic Rocket (HIIPER) system has been built to use a helicon and spherical Inertial Electrostatic Confinement (IEC) grid. The helicon generates the plasma and is fed into the IEC unit. The IEC unit accelerates the products fed into it and produces the thrust for the system.<sup>123</sup> This type of system could allow for space missions that are currently unavailable with conventional thrust mechanisms.

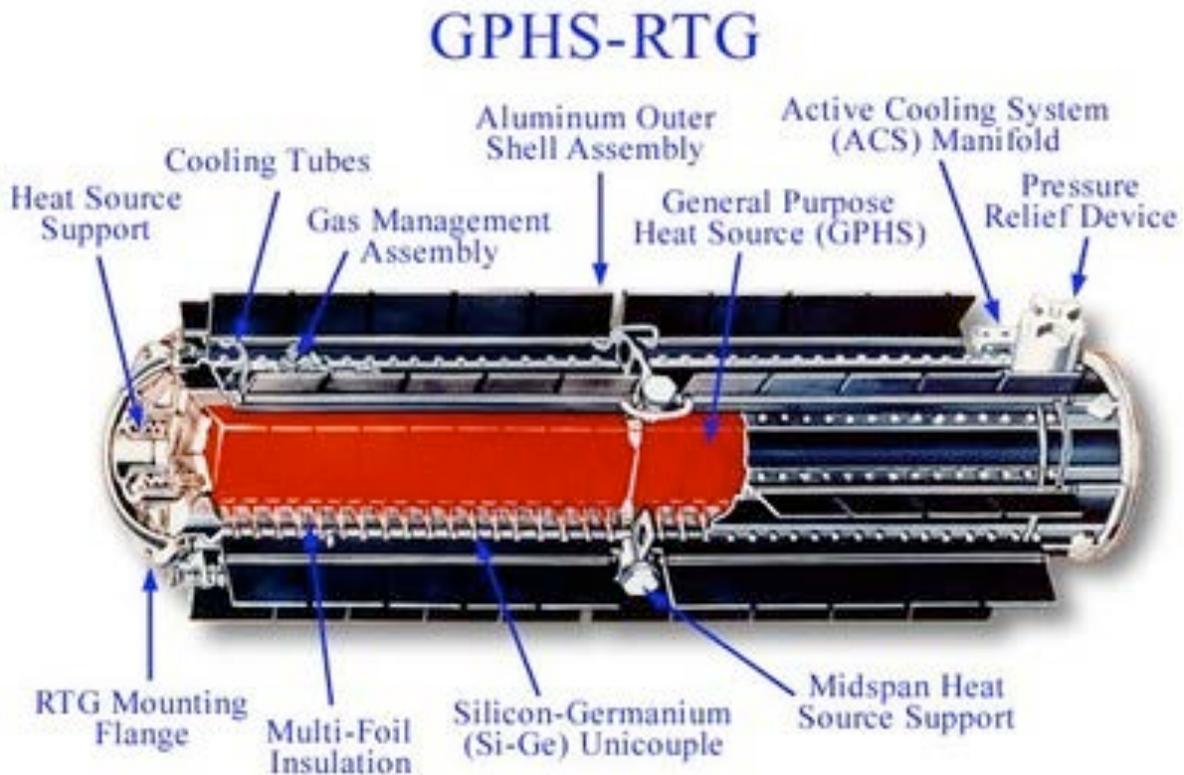
<sup>122</sup> Carat, Ruby. George H. Miley at NETS: Lets find out whats there. *Cold Fusion Now*. 04/09/12. Accessed on 06/12/12, <http://coldfusionnow.org/george-h-miley-at-nets-lets-find-out-whats-there/>.

<sup>123</sup> Krishnamurthy, Akshata, et al. Helicon Injected Inertial Plasma Electrostatic Rocket, HIIPER. *Nuclear and Emerging Technologies for Space*. 2012. Accessed on 02/01/13, <http://www.lpi.usra.edu/meetings/nets2012/pdf/3045.pdf>.

## A-7.5 Current Status

LENUCO's research has been on producing systems of propulsion in space, since the current technology for Radioisotope Thermoelectric Generators (RTGs) for deep-space exploration is insufficient. In a paper presented at the 2012 Nuclear and Emerging Technologies for Space, Miley and his researchers proposed the HIIPER system, discussed above.<sup>124</sup> This system will use a high-intensity, pencil-thin plasma jet exhaust for its thrusting capability. Figure 15 is an example of the current propulsion device for deep space exploration which could place an LENR/CF device to power these space probes.

Figure 15. Radioisotope Thermoelectric Generators for Deep Space Exploration<sup>125</sup>



However, Miley and his team at LENUCO are currently trying to overcome a problem with their technology – the nanoparticles are deteriorating too quickly (on the order of hours as opposed to months, which is what Miley believes would be necessary for this technology to be economic). He currently has conceptual designs for a modular 3 kW unit for domestic use and a 30 kW unit

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<sup>124</sup> Miley et al. Helicon Injected Inertial Plasma Electrostatic Rocket, HIIPER, Nuclear and Emerging Technologies for Space, 2012.

<sup>125</sup> Carat, Ruby. George H. Miley at NETS: Lets find out whats there. *Cold Fusion Now*. 04/09/12. Accessed on 06/12/12, <http://coldfusionnow.org/george-h-miley-at-nets-lets-find-out-whats-there/>.

for industrial use; “both were intended for co-gen operation using thermoelectric energy conversion.”<sup>126</sup>

Despite the numerous failed attempts by many CF/LENR advocates, Miley successfully received a patent on LENR-related technology from the USPTO this past year. The abstract from the patent is as follows:

“Techniques to form dislocation cores along an interface of a multilayer thin film structure are described. The loading and/or deloading of isotopes of hydrogen are also described in association with core formation. The described techniques can provide be applied to superconductive structure formation, x-ray and charged particle generation, nuclear reaction processes, and/or inertial confinement fusion targets.”<sup>127</sup>

### **A-7.6 Future Plans**

LENUCO has two goals for the future: 1) to provide NASA with a replacement for Pu-238 (a radioactive isotope that provides power for space probes) – one that is both safe and long lasting; and 2) to provide an inexpensive, clean, and low-maintenance power source for domestic and industrial use.<sup>128</sup>

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<sup>126</sup> George Miley working on 3KW and 30KW LENR designs. *LENR – Cold Fusion*. 09/21/12. Accessed on 01/23/13, <http://www.lenr-coldfusion.com/2012/09/21/george-miley-working-3kw-30kw-lenr-designs/>.

<sup>127</sup> George Miley’s LENR Patent. *LENR – Cold Fusion*. 09/13/12. Accessed on 01/23/13, <http://www.lenr-coldfusion.com/2012/09/13/miley-patent/>.

<sup>128</sup> Lenuco. *EDUPRESS*. 2013. Accessed on 01/23/13, <http://coldfusioninformation.com/companies/lenuco/>.

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## **Appendix H. Piantelli / Nichenergy – Metalenergy**

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### **A-8.1 Overview**

Nichenergy is the commercial foray for one of the leading LENR researchers in the field, Piantelli Francesco. The company was created in 2011 and is located in Italy. Its main subsidiary is known as Metalenergy, which will be the venture which seeks to raise capital for the research of the company.

Piantelli claims to have a CF/LENR technology that generates energy through a nickel-hydrogen reaction. He has recently expressed the technology may be close to a commercial phase; however, very few specific details are known, and no public demonstrations have been made.

### **A-8.2 Key Players**

Piantelli Francesco is a researcher from the University of Siena in Italy. He has been known as one of the foremost experts in the field and has focused on low-energy reactions, seeking to bring the technology to market. Piantelli has a “mastery of the phenomenon” known as LENR.<sup>129</sup> He has worked with Sergio Focardi in the past; Focardi is one of the primary researchers working with Andrea Rossi and Leonardo Corp.<sup>130</sup> Piantelli is known as a secretive person; he has not made many bold claims and has had a harsh attitude for those who have made claims that have yet to be entirely substantiated.

### **A-8.3 History, Development, Roots of Company**

Piantelli formed two companies – Nichenergy and Metalenergy – in order to develop and distribute his LENR units. Nichenergy functions as the research and development division, while Metalenergy will tend to the commercial activities that result from Nichenergy’s R&D.<sup>131</sup> Metalenergy has begun selling shares of the company in order to raise money for continued research, specifically producing a commercial prototype. The shares are being sold for the Euro-

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<sup>129</sup> Piantelli Moves Closer to Commercialization. *e-Cat Site*. 06/15/12. Accessed on 06/15/12, <http://e-catsite.com/2012/06/15/piantelli-moves-closer-to-commercialization/>.

<sup>130</sup> Piantelli Presents Nickle-Hydrogen LENR Research Data in Siena, Italy—20W In, 71W Out. *E-Cat World*. 04/17/12. Accessed on 06/17/12, <http://www.e-catworld.com/2012/04/piantelli-presents-nickel-hydrogen-lenr-research-data-in-siena-italy/>.

<sup>131</sup> Nichenergy. *EDUPRESS*. Accessed on 01/23/13, <http://coldfusioninformation.com/companies/nichenergy/>.

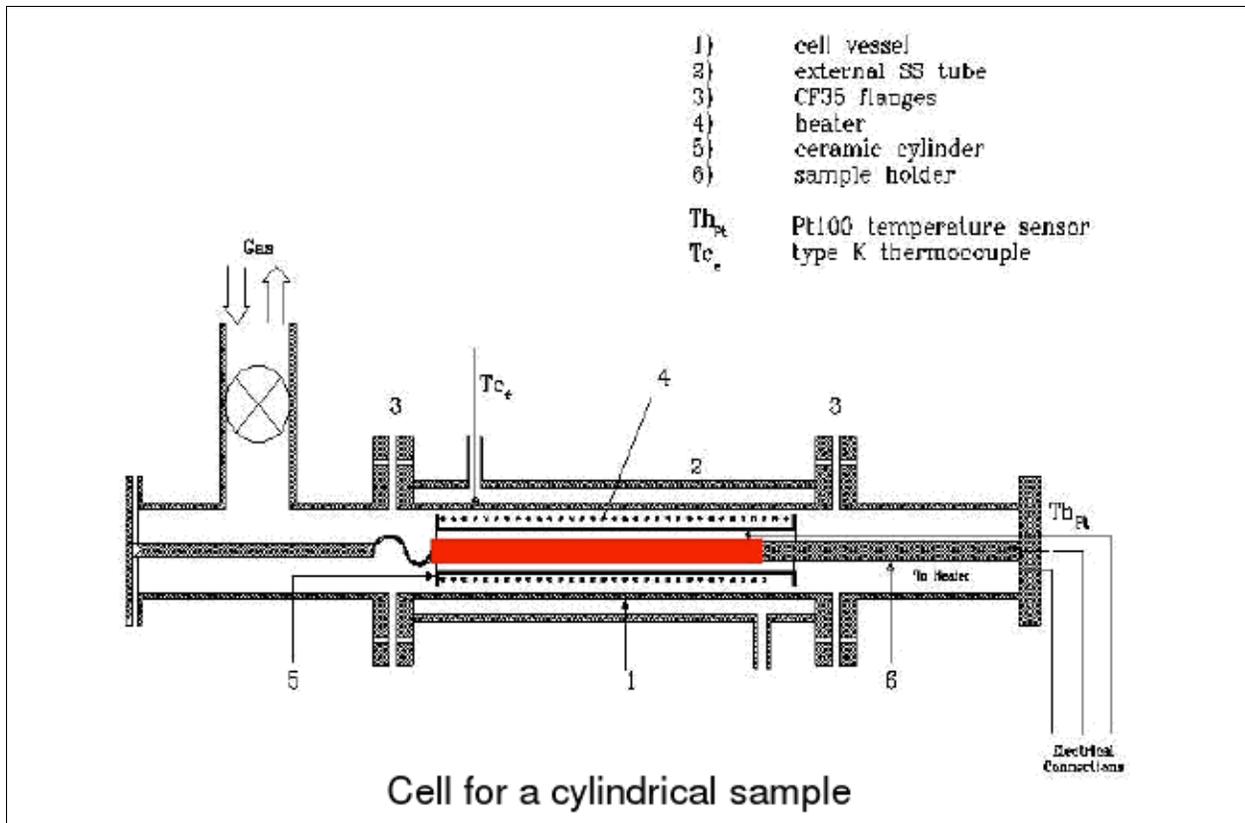
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equivalent of \$126 to \$1,260; their fundraising goal is between 50,000 and 100,000 Euros. It has been said that the facilities necessary to develop the generators are already underway.<sup>132</sup>

#### A-8.4 Claimed Mechanism for Energy

A nickel-hydrogen reaction is the claimed mechanism for energy generation with this LENR technology.<sup>133</sup> Not many other details have been offered at this time. Figure 16 is a mock-up of how Piantelli has described how the device works.

Figure 16. Vessel for the Piantelli Reaction Cell [missing source]



#### A-8.5 Current Status

Piantelli's goal is very similar to Andrea Rossi – he wants to bring a cold fusion reactor to market for domestic use.<sup>134</sup> Piantelli has claimed Nichenergy could be in a position to talk about

<sup>132</sup> Nichenergy. *EDUPRESS*. Accessed on 01/23/13, <http://coldfusioninformation.com/companies/nichenergy/>.

<sup>133</sup> Piantelli Presents Nickle-Hydrogen LENR Research Data in Siena, Italy—20W In, 71W Out. *E-Cat World*. 04/17/12. Accessed on 06/17/12, <http://www.e-catworld.com/2012/04/piantelli-presents-nickel-hydrogen-lenr-research-data-in-siena-italy/>.

<sup>134</sup> Grassadonio, Guido. Cold Fusion: Francesco Piantelli challenge Rossi and his E-Cat. *Green Style*. 04/18/12. Accessed on 06/16/12, <http://www.greenstyle.it/fusione-fredda-francesco-piantelli-sfida-rossi-e-il-suo-e-cat-8931.html>.

commercialization in a matter of months; "...[the current state of research], at present is only research, and it could be translated in a few months into industrial products."<sup>135</sup>

Piantelli has further claimed that his research and technology is, "close to the auto-sustenance (less than 20W introduced and 71W produced = 91 W)(t=260 C), the energy produced can be obtained between 200°C and 400°C, and [has] indication that the phenomenon takes place at the surface of the sample; we have seen in previous experiments a transmutation effect."<sup>136</sup>

Piantelli received a patent from the European Patent office this January for his LENR technology, which produces energy from a nickel-hydrogen reaction.<sup>137</sup> Although not the USPTO, the European Patent office is a significant step toward commercialization.

### **A-8.6 Future Plans**

Piantelli spoke at the International Society for Condensed Matter Nuclear Science (ISCMNS); he reported his results and some of the future plans for the technology that he has been researching. Piantelli would like to "...evaluate the possibility to increase the produced power to 100W, evaluate the best temperature interval inside that region [between 200°C and 400°C], evaluate the effect of a magnetic field on the absorption and on the primer of the energy emission, and evaluate the residue by means of SEM-EDAX and SIMS technique."<sup>138</sup>

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<sup>135</sup> Piantelli Moves Closer to Commercialization. *E-Cat Site*. 06/15/12. Accessed on 02/01/13, <http://e-catsite.com/2012/06/15/piantelli-moves-closer-to-commercialization/>.

<sup>136</sup> Piantelli Presents Nickle-Hydrogen LENR Research Data in Siena, Italy—20W In, 71W Out. *E-Cat World*. 04/17/12. Accessed on 06/17/12, <http://www.e-catworld.com/2012/04/piantelli-presents-nickel-hydrogen-lenr-research-data-in-siena-italy/>.

<sup>137</sup> European Patent Granted for Francesco Piantelli's LENR Process. *E-Cat World*. 01/18/13. Accessed on 01/23/13, <http://www.e-catworld.com/2013/01/european-patent-granted-for-francesco-piantellis-lenr-process/>.

<sup>138</sup> Piantelli Presents Nickle-Hydrogen LENR Research Data in Siena, Italy—20W In, 71W Out. *E-Cat World*. 04/17/12. Accessed on 06/17/12, <http://www.e-catworld.com/2012/04/piantelli-presents-nickel-hydrogen-lenr-research-data-in-siena-italy/>.

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## **Appendix I. Sonofusion**

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### **A-9.1 Overview**

Sonofusion is technology (not a company) that relies on acoustic energy to produce ultrasonic waves within heavy water, an alternative to the conventional CF/LENR reactions. When these devices are amplified, the deuterium interaction with the sound waves produces heat and helium.<sup>139</sup> Sonofusion research was very active initially, but little recent news or updates can be found.

### **A-9.2 Key Players**

Roger Stringham was the first to experiment with sonofusion processes. He pioneered this method of using acoustic cavitation to produce cold fusion effects in 1989.<sup>140</sup> Over the years, his work has inspired a number of individuals, leading to the creation of a research and development corporation.

### **A-9.3 History, Development, Roots of Company**

After several years of sonofusion research, Stringham and his team formed EQuest Science, a research and development corporation. Stringham brought on experts from companies around Palo Alto, California, specifically recruiting people from Electric Power Research Inc. (EPRI) and SRI International. These people were from the same groups as Michael McKubre, a well-known CF/LENR researcher who is associated with SRI and has also worked with EPRI.<sup>141</sup> Personal conflicts led to the shutting down of EQuest; however, Stringham continued his interests, forming the company now known as First Gate Energies; it is located in Hawaii.<sup>142</sup>

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<sup>139</sup> Directory: Sonofusion Reactor. *Pure Energy Systems: PESWiki*. Accessed on 06/20/12, [http://peswiki.com/index.php/Directory:Sonofusion\\_Reactor](http://peswiki.com/index.php/Directory:Sonofusion_Reactor).

<sup>140</sup> Krivit, Steven B. Roger Stringham: First Gate Energies. *New Energy Times*. Accessed on 02/04/13, <http://newenergytimes.com/v2/views/StringhamR/StringhamR.shtml>.

<sup>141</sup> Profiles: Company: First Gate Energies. *Pure Energy Systems: PESWiki*. Accessed on 06/19/12, [http://peswiki.com/index.php/Directory:Sonofusion\\_Reactor#Profiles](http://peswiki.com/index.php/Directory:Sonofusion_Reactor#Profiles).

<sup>142</sup> Stringham, Roger. Low Mass 1.6 MHz Sonofusion Reactor. *Eleventh International Conference on Condensed Matter Nuclear Science*. 2004. Marseille, France. Accessed on 06/20/12, <http://www.lenr-canr.org/acrobat/StringhamRlowmassmhz.pdf>.

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### **A-9.4 Claimed Mechanism for Energy**

“Acoustic cavitation uses ultrasonic waves to create gas bubbles within heavy water.”<sup>143</sup> The cavitation device is the product that was designed to produce the heat and helium from the deuterium interaction. Stringham describes the process in the following way:

“Natural cavitation phenomena in D<sub>2</sub>O using piezo devices, are now amplified initiating DD fusion events that produce heat and helium... The transient cavitation bubble, TCB, has been harnessed to produce high densities of deuterons... An electrically driven piezo device filled with D<sub>2</sub>O produces acoustic field generating TCBs that are, in the final collapse stage, micro accelerators. The result is the implanting of deuterons into a target foil producing 4He originating from the Pd foil and T from the Ti foil.”<sup>144</sup>

### **A-9.5 Current Status**

The company has focused its resources on an LM 1.6 MHz sonofusion system. Recent innovations, such as increasing the cavitation frequencies, have solved many key issues (e.g. size, cost, energy density, and durability). The size of the device has been reduced to 20 grams, and the estimated price range is between \$15,000 and \$150,000.<sup>145</sup> The lifespan has been said to be approximately one year, but further testing is needed to confirm. The company continues to research the sonofusion process. Figure 17 is an example of how sonofusion measures the excess heat in its reactions.

### **A-9.6 Future Plans**

Economic feasibility of sonofusion technologies has been said to be through space heating applications.<sup>146</sup> Though no specific goals or plans could be found, it can be assumed that Stringham will continue his research and development with sonofusion processes in order to achieve a commercial product.

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<sup>143</sup> Krivit, Steven B. Roger Stringham: First Gate Energies. *New Energy Times*. Accessed on 02/04/12, <http://newenergytimes.com/v2/views/StringhamR/StringhamR.shtml>.

<sup>144</sup> Stringham, R. Cavitation and Fusion – Poster Session. *Tenth International Conference on Cold Fusion*. 2003. Cambridge, MA: LENR-CANR.org. Accessed on 06/20/12, <http://www.lenr-canr.org/acrobat/StringhamRcavitationb.pdf>.

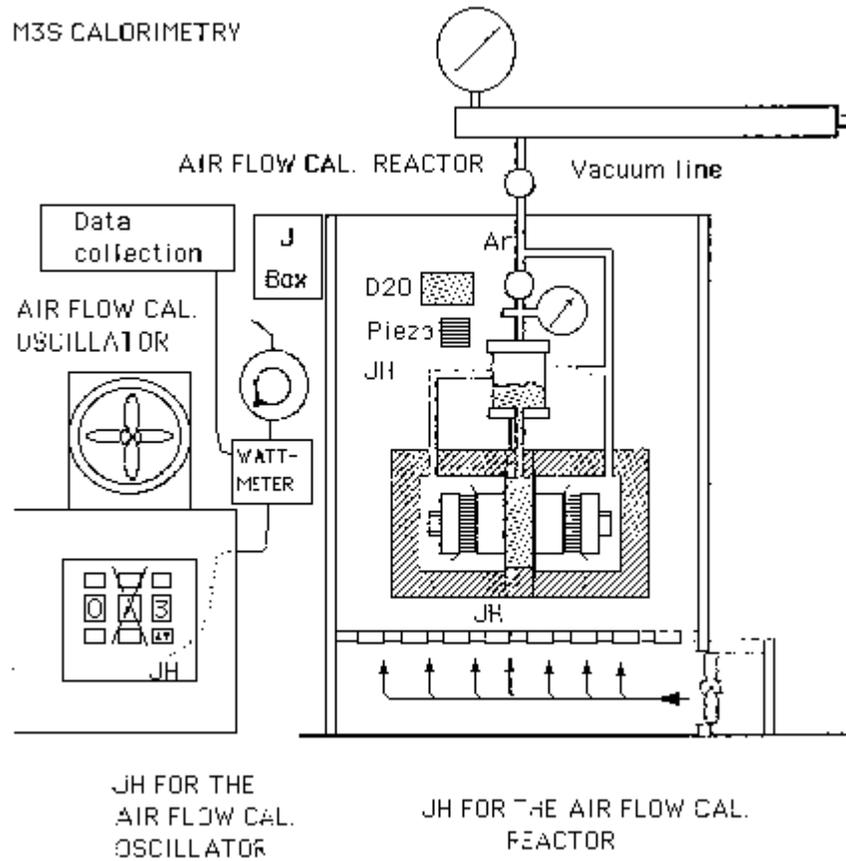
<sup>145</sup> Stringham, R. Low Mass 1.6 MHz Sonofusion Reactor. in Eleventh International Conference on Condensed Matter Nuclear Science. 2004. Marseille, France. Accessed on 02/04/13, <http://www.lenr-canr.org/acrobat/StringhamRlowmassmhz.pdf>.

<sup>146</sup> Stringham, Roger. Introduction to Sonofusion. Accessed on 02/04/13, <http://www.sonofusionjets.com/>.

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Figure 17. Sonofusion Calorimetry Processes [missing source]

M3S CALORIMETRY



## **Appendix J. Continuing NASA Interest**

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### **A-10.1 Overview**

NASA has sought an energy system to provide propulsion to deep space exploration for many years. In deep space, the sun's energy is dissipated, so solar power is not a viable option. The expense of preloaded conventional fuel has made other forms of propulsion prohibitive. There exists an opening for NASA to pursue a cheap and powerful source of energy; LENR is one potential source where NASA's space exploration initiatives would benefit.

Recent statements (January 2012) by NASA's key supporters for LENR show continued interest and research by NASA in LENR technologies. They appear to be actively investigating different theories and have even applied for an LENR-related patent through the USPTO.

### **A-10.2 Key Players**

Joseph Zawodny is a Senior Research Scientist in the Climate Science Branch of the Langley Research Center. He has a BS in Physics, a Masters in Astrogeophysics, and a PhD in Astrophysical, Planetary, and Atmospheric Sciences. His connection to NASA's LENR research was made after he was heavily featured in a recent video which covered LENR advancements.<sup>147</sup>

Dennis Bushnell is a Chief Scientist at NASA's Langley Research Center as well. He has six patents and has authored over 250 publications and presentations, "often on the future of technology and the impact it will have on our society"<sup>148</sup>. He recently wrote a blog entry which attempts to explain what NASA sees as the role for LENR.<sup>149</sup>

### **A-10.3 History, Development, Roots of Company**

NASA's desire to pursue LENR research has been mixed. The Glenn Research Center has posted that they have observed "anomalous heat" with LENR experiments which would confirm that

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<sup>147</sup> Method for Enhancement of Surface Plasmon Polaritons to Initiate & Sustain LENR. *NASA: Technology Gateway*. Accessed on 02/04/13, <http://technologygateway.nasa.gov/media/CC/lenr/lenr.html>.

<sup>148</sup> Dennis M. Bushnell. *NASA: Future Innovation*. Accessed on 02/04/13, <http://futureinnovation.larc.nasa.gov/view/articles/futurism/bushnell/bushnell-bio.html>.

<sup>149</sup> Bushnell, Dennis. Low Energy Nuclear Reactions, the Realism and the Outlook. *NASA: Future Innovation*. Accessed on 06/16/12, <http://futureinnovation.larc.nasa.gov/view/articles/futurism/bushnell/low-energy-nuclear-reactions.html>.

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LENR has some mainstream science behind it.<sup>150</sup> However, after some questioning, a NASA spokesperson indicated that the research is taking place outside of officially sanctioned NASA business.

#### **A-10.4 Claimed Mechanism for Energy**

NASA is not stating what the exact drivers for the reaction are at this time. There is discussion of “the enhancement of surface plasmon polaritons to initiate and sustain LENR in metal hydride systems”, with some mention of nickel, carbon, and hydrogen as key elements.<sup>151</sup> The evidence appears to show similarities with the Widom-Larsen Weak Interaction Theory.<sup>152</sup>

#### **A-10.5 Current Status**

The publication of the Widom-Larsen Weak Interaction LENR Theory sparked real interest at NASA; this theory is said to be under current study and experimental verification at Langley.<sup>153</sup> According to Bushnell, ongoing efforts are being pursued to explore the validity of the theories that have emerged, as well as efforts to create said “devices”.<sup>154</sup>

In January 2012, NASA posted a video describing the current research into LENR that NASA is participating in.<sup>155</sup> The name of the video: “*Method for Enhancement of Surface Plasmon Polaritons to Initiate & Sustain LENR in MHS (Metal Hydride Systems)*” indicates that there is significant research being poured into LENR. There is also evidence on various blogs that NASA has filed a patent for LENR technology. Zawodny has submitted a patent application under a “Method for Producing Heavy Electrons”, mentioning low energy nuclear reactions and the Widom-Larsen theory, with the purpose of energy generation.<sup>156</sup>

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<sup>150</sup> Hambling, David. Race for cold fusion: Nasa, MIT, Darpa and Cern peer through the keyhole. *Wired.co.uk*. 02/27/12. Accessed on 06/16/12, <http://www.wired.co.uk/news/archive/2012-02/27/rossi-roundup?page=all>.

<sup>151</sup> Method for Enhancement of Surface Plasmon Polaritons to Initiate & Sustain LENR. *NASA: Technology Gateway*. Accessed on 02/04/13, <http://technologygateway.nasa.gov/media/CC/lenr/lenr.html>.

<sup>152</sup> More on LENR at NASA: Bushnell and Zawodny Speak. *E-Cat World*. 05/24/12. Accessed on 06/16/12, <http://www.e-catworld.com/2012/05/more-lenr-at-nasa-zawodny-and-bushnell/>.

<sup>153</sup> Bushnell, Dennis. Low Energy Nuclear Reactions, the Realism and the Outlook. *Future Innovation: NASA*. Accessed on 02/04/13, <http://futureinnovation.larc.nasa.gov/view/articles/futurism/bushnell/low-energy-nuclear-reactions.html>.

<sup>154</sup> Bushnell, Dennis. Low Energy Nuclear Reactions, the Realism and the Outlook. *Future Innovation: NASA*. Accessed on 02/04/13, <http://futureinnovation.larc.nasa.gov/view/articles/futurism/bushnell/low-energy-nuclear-reactions.html>.

<sup>155</sup> Method for Enhancement of Surface Plasmon Polaritons to Initiate and Sustain LENR. *Technology Gateway*. Accessed on 06/15/12, <http://technologygateway.nasa.gov/media/CC/lenr/lenr.html>.

<sup>156</sup> NASA Publicly Reveals LENR Research. *Free Republic*. 02/02/12. Accessed on 06/17/12, <http://www.freerepublic.com/focus/f-chat/2841858/posts>.

### **A-10.6 Future Plans**

The recent video and blog posts show a potential future for LENR research by NASA. “The ultimate goal, according to Zawodny, is to find a way to create an inexpensive, clean form of energy which could be used not only by NASA in its space operations, but also something that could provide cheap, abundant energy for the whole world.”<sup>157</sup>

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<sup>157</sup> More on LENR at NASA: Bushnell and Zawodny Speak. *E-Cat World*. 05/24/12. Accessed on 06/16/12, <http://www.e-catworld.com/2012/05/more-lenr-at-nasa-zawodny-and-bushnell/>.

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## **Appendix K. University of Missouri – Kimmel Institute**

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### **A-11.1 Overview**

Robert Duncan, an expert in measuring energy, first became involved with LENR when he was contacted by *60 Minutes* to explore the phenomenon known as anomalous heat generation. Following this endeavor, Duncan released a report on LENR which led to the creation of the Sidney Kimmel Institute for Nuclear Renaissance at the University of Missouri. The institute will seek to determine the scientific reasons for the “Anomalous Heat Effect” (AHE).<sup>158</sup>

The Institute is currently undergoing multiple different experiences, seeking to establish a scientific cause behind the LENR phenomenon. Reports of initial results show promise for their research efforts.

### **A-11.2 Key Players**

Robert Duncan is currently the Vice Chancellor for Research at the University of Missouri. He is also the Founder and Interim Director for the Sidney Kimmel Institute for Nuclear Renaissance (SKINR). He holds a doctorate in physics and is known as an expert in low temperature physics, specifically. With his expertise, he has assisted NASA as well as the Los Alamos National Laboratory, among many other institutions.<sup>159</sup>

### **A-11.3 History, Development, Roots of Company**

The LENR research that now takes place at the University of Missouri began with a company known as Energetics Technology, which was created in Israel. After a successful LENR experiment, Duncan was asked to visit Energetics Technology to verify their claims. In 2009, Sidney Kimmel contacted Duncan to discuss bringing Energetics Technology to the University of Missouri Life Science Business Incubator. The plan was to use the Incubator for access to the

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<sup>158</sup> Carat, Ruby. Robert Duncan discusses experiments at Sidney Kimmel Institute for Nuclear Renaissance. *Cold Fusion Now*. 07/02/12, <http://coldfusionnow.org/robert-duncan-discusses-experiments-at-sidney-kimmel-institute-for-nuclear-renaissance/>.

<sup>159</sup> Vice Chancellor for Research: Robert Duncan. *University of Missouri: Research*. Last updated 01/23/13. Accessed on 01/23/13, <http://research.missouri.edu/about/bios/duncan.php>.

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great facilities and team up with other frontier scientists who were looking into plasma physics, nanotechnology, electrochemistry, and material science.<sup>160</sup>

After this initiation, a \$5.5 million dollar gift from the Sidney Kimmel Foundation created SKINR. “The institute will study the physics of certain little understood energy-producing reactions in its quest to develop new forms of energy.”<sup>161</sup>

#### **A-11.4 Claimed Mechanism for Energy**

The Institute is looking into all of the claims and is trying to determine which materials will work best to produce a continuous and reliable LENR reaction. Specifically, SKINR is planning neutron scattering experiments for the hydrogen and deuterium system, as well as x-ray scattering experiments in the palladium lattice – simultaneously.<sup>162</sup>

#### **A-11.5 Current Status**

There is so much controversy surrounding the LENR field; this Institute provides a unique opportunity to focus solely on research – Kimmel’s donation will allow for research that puts a stronger emphasis on the pure science rather than being sidetracked by deployment opportunities for the technology.<sup>163</sup>

SKINR is currently conducting a series of experiments, which are “designed to elucidate the physical mechanism that is responsible for the AHE [Anomalous Heat Effect]”.<sup>164</sup> A few details have been published regarding the results of initial experiments being held at the institute; neutron production in their experiment vastly surpassed Prelas and his team’s expectations.<sup>165</sup> These findings are very positive and affirm their research efforts.

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<sup>160</sup> Greaney, T.J. Cold science heats up. *Columbia Daily Tribune*. 10/09/10. Accessed on 01/23/13, <http://www.columbiatribune.com/news/2010/oct/09/cold-science-heats-up/>.

<sup>161</sup> Research and Public Service 2011: University of Missouri Annual Report of Grants and Contracts. *University of Missouri*. 2011. Accessed on 02/05/13, [http://research.missouri.edu/assets/ORAR\\_11.pdf](http://research.missouri.edu/assets/ORAR_11.pdf).

<sup>162</sup> Carat, Ruby. Robert Duncan discusses experiments at Sidney Kimmel Institute for Nuclear Renaissance. *Cold Fusion Now*. 07/02/12. Accessed on 02/05/13, <http://coldfusionnow.org/robert-duncan-discusses-experiments-at-sidney-kimmel-institute-for-nuclear-renaissance/>.

<sup>163</sup> Silvey, Janese. Billionaire helps fund MU energy research: Billionaire gives MU \$5.5 million. *Columbia Daily Tribune*. 02/10/12. Accessed on 09/22/12, <http://www.columbiatribune.com/news/2012/feb/10/billionaire-helps-fund-mu-energy-research/>.

<sup>164</sup> Carat, Ruby. Robert Duncan discusses experiments at Sidney Kimmel Institute for Nuclear Renaissance. *Cold Fusion Now*. 07/02/12. Accessed on 02/05/13, <http://coldfusionnow.org/robert-duncan-discusses-experiments-at-sidney-kimmel-institute-for-nuclear-renaissance/>.

<sup>165</sup> AP Reports on U of Missouri Cold Fusion Program. *E-Cat World*. 11/04/12. Accessed on 01/24/13, <http://www.e-catworld.com/2012/11/ap-reports-on-u-of-missouri-cold-fusion-program/>.

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### ***A-11.6 Future Plans***

No specific future plans for SKINR could be found; however, it may be inferred that the institute will continue with their LENR endeavors, seeking to find the science behind the AHE.

## **Appendix L. National Instruments**

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### **A-12.1 Overview**

National Instruments (NI) is an Austin, Texas-based company, which makes tools for engineers and scientists. With their innovative systems, they seek to foster “productivity, innovation, and discovery.” With NI’s approach to software and hardware platforms, the company’s goal is to make measurement and control more straightforward.<sup>166</sup>

NI has recently formed a presence in the LENR field, primarily through funding and the development of measurement devices and other tools to facilitate LENR-related experimentation.

### **A-12.2 Key Players**

James Truchard is the co-founder, President, and Chief Executive Officer of National Instruments. He has a background in physics with a doctorate in electrical engineering. “Under Truchard’s leadership, NI has pioneered the development of virtual instrumentation software and hardware that revolutionizes the way engineers design and develop test and measurement application...Dr. Truchard leads the graphical system design vision that expands virtual instrumentation to encompass embedded systems.”<sup>167</sup>

### **A-12.3 History, Development, Roots of Company**

National Instruments, founded in 1976, has developed and grown into a prominent, worldwide company, serving over 35,000 companies annually. Their mission is to equip engineers and scientists with “tools that accelerate productivity, innovation, and discovery”.<sup>168</sup>

### **A-12.4 Claimed Mechanism for Energy**

National Instruments does not have an LENR system; their involvement is in providing better measurement tools and technologies to aid CF/LENR researchers in their experiments – to help improve accuracy and to explain the science behind this phenomenon.

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<sup>166</sup> Company: Committed to Engineers and Scientists. *National Instruments*. 2012. Accessed on 09/24/12, <http://www.ni.com/company/>.

<sup>167</sup> Leadership: Dr. James Truchard. *National Instruments*. 2012. Accessed on 02/05/13, <http://www.ni.com/company/our-vision/leadership/truchard.htm>.

<sup>168</sup> Company: Committed to Engineers and Scientists. *National Instruments*. 2012. Accessed on 01/24/13, <http://www.ni.com/company/>.

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### **A-12.5 Current Status**

Recently, NI has taken an interest in CF/LENR research. They have become a part of this community by providing tools and equipment for researchers to improve the precision and accuracy of measurements.<sup>169</sup> They are also providing funding for research activities. From a release by NI in August 2012: “NI is interested in providing the best tools such as LabVIEW software and NI PXI and CompactRIO hardware towards science research to help understand the underlying physical phenomena behind LENRs and to perform advanced measurements and control on the experiments.”<sup>170</sup>

### **A-12.6 Future Plans**

With over 200 instances of excess heat generation, one of two things is happening; “this demonstrates either an unknown physical event or a need for better measurement and control tools. In both cases, NI can provide the tools to accelerate innovation and scientific discovery.”<sup>171</sup> With this vested interest, it can be expected that NI plans to continue to create the controls and system integration for the LENR industry.<sup>172</sup>

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<sup>169</sup> Mills, Hank and Sterling D. Allan. National Instruments Provides Tools for Cold Fusion Researchers. *Pure Energy Systems*. Accessed on 01/24/13, [http://pesn.com/2012/07/18/9602139\\_National\\_Instruments\\_Provides\\_Tools\\_for\\_Cold\\_Fusion\\_Researchers/](http://pesn.com/2012/07/18/9602139_National_Instruments_Provides_Tools_for_Cold_Fusion_Researchers/).

<sup>170</sup> Krivit, Steven B. LENR Gets Boost From National Instruments. *New Energy Times*. 08/07/12. Accessed on 09/24/12, <http://blog.newenergytimes.com/2012/08/07/lenr-gets-major-boost-from-national-instruments/>.

<sup>171</sup> Participate. *National Instruments*. Accessed on 02/05/13, [http://www.ni.com/niweek/summit\\_physics.htm](http://www.ni.com/niweek/summit_physics.htm).

<sup>172</sup> Participate. *National Instruments*. Accessed on 09/24/12, [http://www.ni.com/niweek/summit\\_physics.htm](http://www.ni.com/niweek/summit_physics.htm).

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