Cold Fusion: A Cogent Topic for Rigorous Policy Analysis

Position Paper

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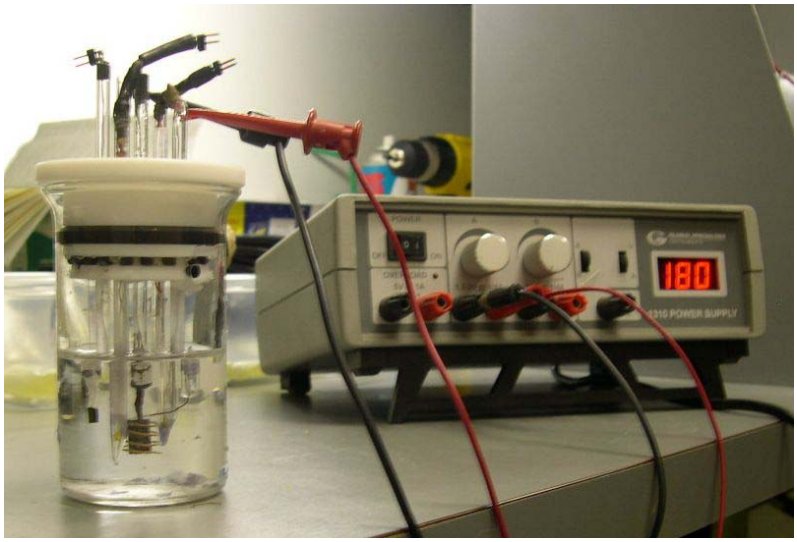
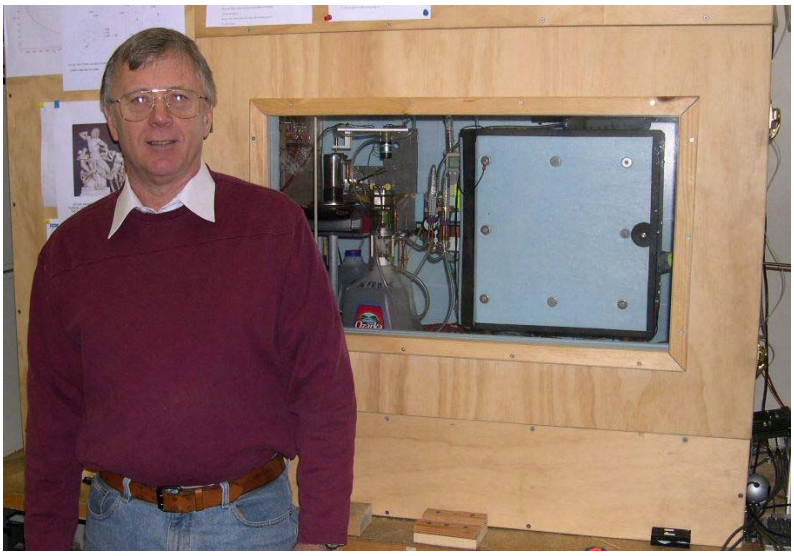


Fleischmann-Pons-type cold fusion cell shown with a small loading power supply attached. The palladium cathode is inside the coiled-wire anode in the cell. The assembly is immersed in lithium deuteroxide (heavy water) solution. Dennis Letts constructed this cell for testing at EarthTech laboratory. Photos taken courtesy of Mr. Letts, February 2006, at EarthTech International, Inc. of Austin, Texas. (See Appendix A for more information.)



Dennis Letts, cold fusion researcher, with calorimeter assembly. The calorimeter containing the cold fusion cell is the insulated box – to the right of Dennis – inside the wooden environmental control chamber. Calorimeter was designed and built by Scott Little and George Luce of EarthTech International, Inc. Photo was taken February 2006 at EarthTech laboratory.

Frontispiece.
Cold Fusion Cell and Calorimeter

Preface

Cold fusion burst upon the scene in 1989 as a major scientific breakthrough with enormous promise as a source of unlimited and virtually free energy to meet society's needs. In the ensuing weeks tremendous fervor in the scientific and political arenas at first gradually and then rather suddenly gave way to disillusion, marginalization and even ridicule. By early 1990 most "mainstream" scientists became convinced that the phenomenon did not exist, and politicians and the public generally followed suit. Since then nearly everyone, including scientists and energy policymakers, have believed that cold fusion is a dead issue. As recently as January of this year, cold fusion was brought up in the context of scientific missteps or fraud[1]

However, a relatively small group of reputable scientists has continued to conduct research and develop theories for what they believe to be a "real" phenomenon of cold fusion. Continued promising experimental results in the 16 years since cold fusion was "debunked" has inspired these dedicated few to continue their efforts in spite of being marginalized and even experiencing damage to their careers in some cases. Cold fusion research since 1989 has been characterized[2] as "undead science" – neither fully alive as part of mainstream scientific research nor fully dead, like N rays, polywater and other phenomena once widely embraced but now fully discredited.

Examination of the record on cold fusion indicates an urgent need for a re-evaluation under a broader context than has previously been accomplished. It appears likely that past evaluations have been fraught with mistakes, have been performed by the wrong experts, have led to erroneous conclusions about cold fusion, and have most probably deprived humankind of a new scientific field – at the least – and perhaps also a new source of cheap unlimited energy.

What should be done regarding research in cold fusion in the future?

This question is particularly well suited to be addressed by a rigorous policy analysis[3,4]. A Conference Course in Policy Analysis has therefore been accomplished with the objectives of "making the case" for a policy analysis of cold fusion research, developing the needed background information, and establishing the framework for conducting the analysis. Specifically, the Conference Course includes five work products:

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[1] Kevles, Bettann, H. "When Fraud Wriggles Itself into Science". *Austin American-Statesman* (January 15, 2006), p. H1, H4.

[2] Simon, Bart. *Undead Science: Science Studies and the Afterlife of Cold Fusion*. New Brunswick, New Jersey: Rutgers University Press, 2002.

[3] Anderson, James. *Public Policymaking – an Introduction*. Boston, Massachusetts: Houghton Mifflin Co., 2006.

[4] Birkland, Thomas. *An Introduction to the Policy Process – Theories, Concepts, and Models of Public Policy Making*. Armonk, New York: M.E. Sharpe, 2001.

- Position Paper. Documents the rationale for a policy analysis study and sets the stage for conducting the study.
- Electronic Presentation. Summary of Conference Course findings, recommendations, and proposal for the cold fusion policy analysis study (in Microsoft PowerPoint).
- Cold Fusion Policy Research Proposal. Lays out the scope of the policy analysis study along with the proposed methodology, budget and schedule, as the basis for funding the study.
- Annotated Bibliography and Website Review. Includes the most significant resources regarding the history, development, technical basis, and current status of cold fusion.
- Hard Copy and Electronic File Library. Contains the principal published and unpublished resources considered in the annotated bibliography and website review for future reference in a policy analysis study.

This Position Paper is the primary work product. The library and the annotated bibliography and website review were developed as preparation for this Paper, and the presentation and proposal flow from the findings and recommendations of the Paper. These work products are provided in Attachments 1 to 4.

1. Introduction

Cold fusion may, or may not, be real. Seventeen years have elapsed since it was announced in a press conference at the University of Utah by Dr. Stanley Pons and Dr. Martin Fleischmann on March 23, 1989[5]. Primarily because of difficulties in reproducibility of the phenomenon, and the absence of expected nuclear byproducts of the energy production (based on hot fusion research), it was quickly – within a few months – deemed to be nonexistent by mainstream science. Continued promising results of research by a few reputable scientists, however, has kept the "dream" of cold fusion alive.

The value of fusion-derived energy for improving the human condition has long been recognized as a matter of public policy, as demonstrated by the more than $15 billion of expenditures on hot fusion research over the past 50 years. Given the dismal results of this effort and expenditure in actual realization of the hoped-for benefit, it is not surprising that another potential source with equal or better promise of success, and with a higher quality and desirability of the associated technology, are receiving the attention of energy policy makers.

It is the position of this paper that a re-evaluation of cold fusion is urgently needed for three primary reasons:

- Mistakes that were made in the months after it was announced, leading to a premature and probably erroneous judgment;
- The continuing observation of the generation of "excess heat" by many researchers in many settings in the 16+ years since it was marginalized; and
- The obvious and major importance of the phenomenon to the future of humankind.

A re-evaluation is needed even if the probability of the reality of cold fusion is low, which is not the case, as indicated by continued research since 1990. In other words, the phenomenon of cold fusion is too important to humankind to be allowed to languish without a full analysis in a public policy context of whether it should receive research and development support.

1.1 Objectives and Approach

The objectives of this paper are to: 1) develop the case that cold fusion, although currently highly marginalized, is nevertheless potentially significant enough to warrant a rigorous policy analysis study; 2) outline candidate policy alternatives for fiscal and other support of cold fusion research; and 3) set the stage for performing a full-blown policy analysis study of the necessity and reasonableness of supporting cold fusion in the future.

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[5] Huizenga, John R. *Cold Fusion: the Scientific Fiasco of the Century*. Rochester, New York: University of Rochester Press, 1992, Appendix I, p. 289.

In this paper, the phenomenon of cold fusion is first summarized in the context of nuclear energy as a whole and in relation to "hot fusion" or "normal fusion" specifically. The history of cold fusion is then described in two phases, first the initial announcement, flurry of research, and eventual discrediting by mainstream science, and second the marginalized research conducted in the years since. A project of rigorous policy analysis research is then outlined, including a several scenarios of support and associated policy approaches. Finally, a proposal for policy analysis of cold fusion is developed to further enhance prospects for this important phenomenon.

1.2 Terminology

Recent research in the area of cold fusion has found that the processes involved are quite complex and include a number of phenomena besides fusion, such as transmutation of elements. Researchers have concluded that the term "cold fusion" has therefore become obsolete and are now favoring "condensed matter nuclear science" (CMNS)[6]. Other terms used for the phenomenon are "low-energy nuclear reactions" (LENR) and "chemically assisted nuclear reactions" (CANR).

It is undoubtedly true that at least part of the driving force for a name change is to avoid or reduce the stigma that has become attached to the term "cold fusion". However, cold fusion is used in this paper because of its broad familiarity and to address "head on" the issues around the phenomenon through a policy analysis perspective. Thus the term is used broadly to refer to both the specific processes of hydrogen fusion to helium at normal ("room") temperatures and the broader associated chemical and nuclear phenomena.

1.3 Literature and Website Review

In preparation for this paper, the principal resources on cold fusion were identified, collected and reviewed. These resources include both hard copy and electronic files and are from published and unpublished sources at libraries and on the Internet (including websites dedicated to the subject of cold fusion). The library of resources assembled to support this paper (and a possible future policy analysis project) is described in Attachment 4.

An Annotated Bibliography for the books and articles was prepared for the identified resources (see Attachment 3). Each annotation includes the table of contents and a summary of the principal findings, points of view, recommendations and potential usefulness for policy analysis. Most of the readily available non-technical sources were included in the review, many of them informally published (not peer reviewed) because of the marginalized status of cold fusion in mainstream science. An attempt was made in the Annotated Bibliography to provide balanced coverage of the points of view and positions of both the proponents and skeptics. Cold fusion proponents must fully understand the reasons and viewpoints of the opponents if they are to be effective in developing counter-arguments and conducting research that fully addresses the issues raised by the skeptics.

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[6] Biberian, Jean Paul, Editor-in-Chief. *International Society for Condensed Matter Nuclear Science*. Online. Available: http://www.iscmns.org. Accessed: January 2006.

One of the salient characteristics of cold fusion as a highly marginalized science is the denial of access to normal scientific publication channels for reporting research results. The availability of the Internet has consequently proven to be a powerful communications tool both for exchange of technical information and as a forum for mutual support among researchers and other interested parties. Approximately a dozen websites that are partly or totally dedicated to cold fusion promotion and information dissemination were reviewed and annotated.

The bibliographic and website reviews conclude with a high-level interpretation, which asserts that there are cogent reasons for conducting a formal policy analysis of cold fusion. A subset of the citations in the Annotated Bibliography and Website Review (Attachment 3) are included in the References Cited for this paper.

1.4 Why Policy Analysis?

Past evaluations of cold fusion have been primarily technical in nature and have focused on whether the phenomenon actually exists or is "voodoo science". If the findings of these evaluations were conclusive and universally accepted, then the "case would be closed" and cold fusion would join the ranks of other debunked phenomena like polywater and N-rays. The reality with respect to cold fusion, however, is that many competent researchers believe that the phenomenon is real and continue to conduct research and find reproducible evidence for its existence.

One salient fact emerges from all the commotion around the cold fusion controversy – <u>excess heat</u> beyond what can be accounted for by chemical reactions is produced, which implies, by default, that a nuclear process is involved. As noted by the U.S. Department of Energy panel that evaluated cold fusion as early as 1989[7] (and recommended that no special funding be provided):

> Ordinarily, new scientific discoveries are claimed to be consistent and reproducible; as a result, if the experiments are not complicated, the discovery can usually be confirmed or disproved in a few months. The claims cold fusion, however, are unusual in that even the strongest proponents of cold fusion assert that the experiments, for unknown reasons, are not consistent and reproducible at the present time. *However, even a single short but valid cold fusion period would be revolutionary* (italics added by author).

Valid observations of excess heat have now been substantiated not in just one, but in many experiments performed by different researchers working in numerous laboratory settings and using a large variety of methods and equipment. Given this strong evidence and the continuing controversy, as well as the importance of cold fusion to society, the decision on whether it should be further investigated must transcend purely technical considerations and opinions.

Furthermore, there is also strong evidence of mistakes, bias and even questionable professional conduct on the part of those most responsible for the marginalization of cold fusion in the early months. For example, the chairman of the 1989 U.S. Department of Energy panel that recommended against support of cold fusion subsequently wrote a book referring to cold fusion as the "scientific fiasco of the century" – hardly an unbiased viewpoint for leadership of this

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[7] U.S. Department of Energy, Energy Research Advisory Board. "Final Report of the Cold Fusion Panel of the Energy Research Advisory Board." Unpublished U.S. DOE Report, 61 p. November, 1989.

important panel. In another case, at a professional meeting (of the American Physical Society) in 1989, a physicist made the statement that "We are suffering from the incompetence and perhaps delusions of Drs. Pons and Fleischmann", both highly credentialed chemists and well respected by their peers. It was at this meeting that the tide turned against cold fusion among the professional scientific community. This community remains sharply divided between those who believe in, or have an open mind about, cold fusion and those who believe adamantly that it is not real, based primarily on past knowledge of fusion that is grounded in hot fusion processes.

Given this dynamic state of affairs and the continuing controversy among the scientists, the decision on cold fusion support must be elevated to a higher level and broadened to include other experts and methods. The methods, discipline, broad range of participants, and proven effectiveness of policy analysis[8,9] makes this approach the best available for conducting a re-evaluation of cold fusion.

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[8]Anderson, James. *Public Policymaking – an Introduction*. Boston, Massachusetts: Houghton Mifflin Co., 2006, p. 2-6.

[9] Birkland, Thomas. *An Introduction to the Policy Process – Theories, Concepts, and Models of Public Policy Making*. Armonk, New York: M.E. Sharpe, 2001, p. 3-21.

2. Cold Fusion: What Is It, and Why Is It Important?

Cold fusion, if it is eventually found to be a real phenomenon, promises to be one of the most important discoveries in human history[10]. It would have a profound effect on almost all aspects of human existence. Both cold fusion and hot fusion are important to humankind because, if successfully developed and commercialized for peaceful purposes, they (either or both) would be a source of unlimited and virtually free (at least in terms of the hydrogen feedstock) source of energy. The following elementary description has been prepared on the assumption that cold fusion is real, which is still a subject of much controversy.

2.1 Cold Fusion and Hot Fusion Overview

Briefly stated, cold fusion generates energy, primarily in the form of heat, through the fusion of hydrogen into helium at ambient ("room") temperatures. By contrast, "hot fusion" generates heat and other forms of energy by fusion of hydrogen atoms to form helium at very high temperatures, such as occur within the interior of the sun and other stars[11].

Cold fusion is believed to occur within the space between atoms (or molecules) of a solid substance (or near the surface of the solid). Through a process not yet fully understood, the natural repulsion of hydrogen nuclei (protons, with a strong positive charge) is overcome, and the nuclei are brought close enough together for the nuclear force to take over[12][13]. The individual protons then fuse to form the nuclei of helium, which has two protons in its nucleus.

In hot fusion, the individual protons fuse into the two-proton nuclei of helium as a result of very high-speed collisions brought on by extremely high temperatures. In cold fusion, the natural repulsion of the protons occurs at low temperature through pressure within the lattice of the solid or some other, as yet not understood, process.

Both cold fusion and hot fusion produce energy because the mass of the helium nuclei formed in the fusion is slightly less than the combined mass of the hydrogen nuclei (protons) from which they were formed. This difference in mass is converted into energy according to Einstein's famous equation, $E=mc^2$. Because "c" – the speed of light – is a very large number (which

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[10] Rothwell, Jed. *Cold Fusion and the Future*. Published by LENR-CANR, December 2004, p. 42-61. Online. Available http://www.lenr-canr.org. Accessed August 2005.

[11] The use of hydrogen and helium here is somewhat oversimplified. In actuality, different forms (isotopes) of each are involved, depending on the number of neutral particles, neutrons, that are present in the nuclei of each.

[12] Storms, Edmund. *A Student's Guide to Cold Fusion*. LENR-CANR.org. Online. Available http://www.lenr-canr.org, 2003 Accessed: January 2006.

[13] Krivit, Steven B. and Nadine Winocur. *The Rebirth of Cold Fusion: Real Science, Real Hope, Real Energy*: Los Angeles, California: Pacific Oaks Press, 2004, p. 224.

becomes very much larger when multiplied by itself, or squared), even a small amount of mass, "m", when converted, yields a great deal of energy, "E".

The processes of hot fusion in the interior of the sun and other stars have been understood for many years. The first achievement of man-made hot fusion was when the first hydrogen bomb was exploded in 1952. Since then, attempts have been made – so far without success – to harness hot fusion for constructive, peaceful purposes, in the form of usable energy for power generation or other useful purpose[14]. This failure of development continues in spite of ever larger and more expensive equipment and devices as well as the expenditure of more than $15 billion.

Both cold fusion and hot fusion have experienced major problems in their successful development for the benefit of humankind. The development of hot fusion for peaceful purposes is limited primarily by technical difficulties in achieving fusion in a controlled, stable and usable manner that can be used for power generation. Development of cold fusion, on the other hand, is limited by insufficient scientific belief that the phenomenon actually exists, and, therefore, inadequate dedication of resources to prove (or disprove) its existence – and then developing it as a viable source of energy if it does exist.

2.2 The Cold Fusion Nuclear Reaction

For both hot fusion and cold fusion, the proton that enters the fusion reaction is accompanied by a neutron to form a "deuteron" (D)[15]. The fusion reactions of deuterons to form other isotopes or elements are complex in the case of hot fusion and consist of three "branching ratios"[16]

D + D → triton (1.01 MeV) + proton (3.02 MeV) + energy
D + D → helium-3 (0.82 MeV) + neutron (2.45 MeV) + energy
D + D → helium-4 + gamma rays (23.77 MeV)

The first two reactions occur about 50% of the time each, whereas the third reaction occurs only 0.00001% of the time. All three branching ratios produce high energy nuclear particles or radiation that make the reactions deadly to life.

In the case of cold fusion, the predominant (or only) nuclear reaction appears to be similar to the least common branching ratio for hot fusion[17]:

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[14] A similar path of development was achieved for nuclear fission, in which nuclear energy is derived from splitting large atomic nuclei rather than fusing small hydrogen nuclei into larger helium nuclei. Fission nuclear bombs were dropped on Hiroshima and Nagasaki in 1945. Nuclear fission in the form of nuclear energy was then developed and is used in all nuclear power plants in the world today.

[15] Normal hydrogen has a single proton as its nucleus. When a deuteron (proton plus neutron) forms the nucleus of hydrogen, and when the hydrogen combines with oxygen, the result is *deuterium* or "heavy water".

[16] Simon, Bart. *Undead Science: Science Studies and the Afterlife of Cold Fusion*. New Brunswick, New Jersey: Rutgers University Press, 2002, p. 48.

D + D → helium-4 + energy (23.8 MeV) in the form of lattice heat or "phonons"

The primary difference between the above reaction and the third branching ratio of hot fusion is the transfer of energy to the lattice as heat (which may be recovered for useful purposes) rather than a high energy gamma ray, which is emitted and escapes without being captured for useful applications.

If this simple and benign reaction proves to be correct for cold fusion, it will explain the absence of expected nuclear byproducts of hot fusion – a long-held argument used against cold fusion. The benign nature of the reaction – no deadly particle emissions or radiation – will also make cold fusion much more "user friendly" for practical applications in the future.

2.3 Potential Importance of Cold Fusion

Cold fusion is potentially extremely important both as a new field of scientific investigation and as a source of cheap, unlimited energy[18]. At a minimum, if the existence of cold fusion and associated phenomena is confirmed, and accepted into mainstream science, an exciting major new scientific field will be opened – regardless of potential practical applications[19]. The ability to achieve nuclear fusion at ambient temperatures through chemically assisted processes would enable scientists to investigate and develop entire new areas of the natural realm. These areas include not just power-generating fusion involving elementary particles and small nuclei (protons, helium), but other phenomena as well, including transmutation of elements – a dream of chemistry since the days of medieval alchemists. The research possibilities in these areas would seem to be almost without limit.

The implications of cold fusion for the future depend upon its eventual proof of existence and how well it lives up to its development potential for practical applications. Once it is fully established, cold fusion can be expected to follow the well trodden path of other new discoveries as they have been developed into economic production. Particularly if it proves to accomplish elemental transmutation as well as power generation, however, the impacts on human welfare and the functions of society will be much larger than most previous discoveries and follow-on technological developments. Yet to be determined, for example, are the minimum size required for power-generating units, the power generation density (power per unit weight of functioning units), fueling and maintenance requirements, waste generation and management (including waste heat), and many other parameters that will determine potential applications and associated capital and operational costs.

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[17] Mallove, Eugene F. *Fire from Ice: Searching for the Truth Behind the Cold Fusion Furor*. New York: John Wiley & Sons, 1991, p. 277-279, p. 183.

[18] Peat, F. David. *Cold Fusion – the Making of a Scientific Controversy*. Chicago: Contemporary Books, 1989, p. 149-161.

[19] Beaudette, Charles G. *Excess Heat: Why Cold Fusion Research Prevailed*. 2nd ed. South Bristol, Maine: Oak Grove Press, 2002, p. 273-283.

At the current stage of development in the validity of the cold fusion discovery, it is easy (and tempting) to make "blue sky" predictions[20] about future applications and impacts. Given the technical difficulties experienced in obtaining consistent, reproducible performance of experiments, to say that cold fusion has been oversold would be an understatement. This tendency for overstatement goes back to the 1989 press conference, in which Fleischmann made the statement[21], "Our indications are that the discovery will be relatively easy to make into a usable technology for generating heat and power, but continued work is needed, first, to understand the science and secondly, to determine its value to energy economics"[22]. On balance, however, cold fusion remains a very significant development in "the course of human events", and the promise or potential far exceeds the level of support that it currently receives.

2.4 Nuclear "Magic"

We humans live in a "chemical" world. The history of the earth and the evolution of life, including humans, have been based almost exclusively on chemical processes, which involve the electrons of atoms and not their nuclei. While it is true that processes of radioactive decay, which are nuclear processes, do occur on the earth, they have not played a significant role in our lives or in our history. The closest active nuclear process that has a significant impact on human life is the fusion of hydrogen into helium in the far-away sun.

Because of our chemical heritage and the almost exclusively chemical basis of our existence, we have a world view that is based on chemical phenomena. The introduction of nuclear-based phenomena into everyday human existence presents an entirely new slate of possibilities and paradigms for humans to adjust to[23]. Nuclear processes are qualitatively different from, and often much more powerful than, chemical processes. For example, in the nuclear realm, ultimately destructive(thermonuclear) bombs have become a reality unlike any previously present in human existence. It may fairly be said that during the 20th century Hiroshima and Nagasaki did more to dramatically change human perceptions of reality than did the photos of the earth taken from the missions to explore the moon. The elusiveness of hot fusion as a reliable source of energy for constructive purposes has no doubt further "mystified" nuclear processes for human experience.

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[20] Rothwell, Jed. *Cold Fusion and the Future*. Published by LENR-CANR, December 2004, p. 42-61. Online. Available http://www.lenr-canr.org. Accessed August 2005.

[21] Huizenga, John R. *Cold Fusion: the Scientific Fiasco of the Century*. Rochester, New York: University of Rochester Press, 1992, Appendix I, p. 289.

[22] Cold fusion critics have tended to end the quote at "heat and power", thus skewing the intent of Fleischmann in his statement, which was to make the point that while there is promise, additional study is necessary to prove up on the promise.

[23] Mallove, Eugene F. *Fire from Ice: Searching for the Truth Behind the Cold Fusion Furor*. New York: John Wiley & Sons, 1991, p. 277-279.

It could well be that one of the primary obstacles to cold fusion may be our inability to comprehend that it could be possible – that it seems too good to be true[24]. Our chemical-based heritage and perception are challenged by the possibility of obtaining free (or nearly so) energy supplies from a nuclear source that does not carry the "penalties" of chemical sources of energy, such as energy consumption (it takes a great deal of energy to produce energy), environmental degradation, and global warming. It goes against our (chemistry-based) intuitive sense that deuterium, a form of water, could – in combination with a metal (palladium) – produce vast amounts of energy. To us, water does not "burn" – produce heat – it is used instead to quench fires.

The advent of cold fusion as a source not only of free, unlimited energy, but also the possibility of elemental transmutation (the ancient dream of alchemy), may be too much for human culture to grasp and embrace without a significant period of adjustment. During this adjustment period, the fall-back position seems to be one of rejection because it seems more like magic than technological reality. This sort of reaction to new discoveries is not, of course, new in the annals of science history. Excellent comparisons have been made[25] of cold fusion with the discovery of radioactivity as reported by Marie Curie and the 1911 discovery of superconductivity[26], which took until the late 1980s to explain and then develop into technological applications.

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[24] Krivit, Steven B. and Nadine Winocur. *The Rebirth of Cold Fusion: Real Science, Real Hope, Real Energy*: Los Angeles, California: Pacific Oaks Press, 2004, p. 14.

[25] Beaudette, Charles G. *Excess Heat: Why Cold Fusion Research Prevailed*. 2nd ed. South Bristol, Maine: Oak Grove Press, 2002, p 3-4.

[26] Mallove, Eugene F. *Fire from Ice: Searching for the Truth Behind the Cold Fusion Furor*. New York: John Wiley & Sons, 1991, p. 272-273.

3. Cold Fusion History

Although there was a report[27,28] in the 1920s on cold-fusion-type experiments[29], the modern history of the phenomenon began with the March 23, 1989 announcement by Pons and Fleischmann. The sequence of events, rather high drama, questionable behaviors on the part of both proponents and skeptics, and probable erroneous outcome of cold fusion history to date are the subject of the sociology of science (much has already been written on the subject) and are outside the scope of this paper. The chronology of events has been well summarized[30,31] and is provided in Appendix A. The historical highlights are described below in two phases – initial announcement through marginalization in 1989, and continued research outside the mainstream of science from 1990 through the present.

The primary reason for summarizing the history here is to establish the necessary context for a future policy analysis project. As noted previously, the objective of this Position Paper is in fact to provide the basis for re-evaluating cold fusion because of the inappropriate marginalization that emerged from its history.

3.1 Announcement, Rejection, and Marginalization: 1989

During the weeks and months after the March 23 announcement, there was a tremendous response in the research community to verify (or refute) the assertions of Fleischmann and Pons[32,33]. Many researchers at laboratories across the U.S. and around the world sought to build cold fusion cells of similar design, based on meager information available from the news conference and pre-prints of the supporting technical paper, which was not published until

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[27] Paneth, Fritz, and Kurt Peters. "On the Transmutation of Hydrogen into Helium.' *Ber*. 59, p. 2039 (in German).

[28] Peat, F. David. *Cold Fusion – the Making of a Scientific Controversy*. Chicago: Contemporary Books, 1989, p. 128-129.

[29] However, experimental findings of helium produced were subsequently found to be the result of contamination of glassware, and the findings were subsequently retracted. No further pursuit of the phenomenon or experimental findings were apparently subsequently published.

[30] Huizenga, John R. *Cold Fusion: the Scientific Fiasco of the Century*. Rochester, New York: University of Rochester Press, 1992, Appendix III, p. 294-304.

[31] Beaudette, Charles G. *Excess Heat: Why Cold Fusion Research Prevailed*. 2nd ed. South Bristol, Maine: Oak Grove Press, 2002, Appendix 1, p. 361-365.

[32] Taubes, Gary. *Bad Science – the Short Life and Weird Times of Cold Fusion*. New York, Random House, 1993, p. 109-300.

[33] Mallove, Eugene F. *Fire from Ice: Searching for the Truth Behind the Cold Fusion Furor*. New York: John Wiley & Sons, 1991, p. 63-101, 131-187.

May[34]. The results of the attempts at verification were decidedly mixed – some researchers reported success at achieving excess heat, while others found the expected nuclear byproducts. Many were not successful in achieving any results at all. In addition, some initially positive results were subsequently retracted because of contamination or experimental error. Based on their experience with high-temperature plasma reactions, most hot-fusion physicists were skeptical from the outset and were consistently the most critical and outspoken antagonists.

The "story" of all the events and players during the initial weeks of cold fusion's life is complex and filled with drama. However, three events, all of which occurred before the end of 1989, stand out as particularly influential in the ejection of cold fusion from mainstream science.

News Conference Announcement and Subsequent Publication of Paper. The announcement in a public forum prior to publication in a peer-reviewed journal was viewed as improprietary by many scientists and set up a negative attitude at the outset[35]. When the paper appeared several weeks later, it was found to be lacking in many details needed to run independent experiments to establish reproducibility. Worse, some aspects of the work related to nuclear products was found to be erroneous. The claim of excess heat – the main point of the paper – was never challenged successfully, however. But this claim was largely ignored by the critics as focus was placed on the peripheral problems rather than the true meaning of the paper[36]. It seems apparent that critics were successful in achieving rejection of cold fusion by placing the focus on the problems with rather than the pioneering achievements of Pons and Fleischmann.

American Physical Society Meeting in Baltimore, May 1 to 4, 1989. Through the forums of technical sessions and news conferences during this meeting, which was not attended by Pons or Fleischmann, several hot-fusion scientists collaborated successfully in calling the existence of cold fusion into question[37]. Many observers felt that questionable tactics, bordering on character assassination and professional misconduct, were used to ridicule not only the phenomenon, but also the pioneering scientists who discovered and announced it[38]. In any case, this meeting proved to be the turning point in the scientific community from hopeful support to

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[34] Fleischmann, M. and Stanley Pons. "Electrochemically Induced Nuclear Fusion of Deuterium." *J. Electroanal. Chem.*, vol. 261, p. 301 and Errata in vol. 263 (1989).

[35] Huizenga, John R. *Cold Fusion: the Scientific Fiasco of the Century*. Rochester, New York: University of Rochester Press, 1992, Appendix III, p. 218-222.

[36] Beaudette, Charles G. *Excess Heat: Why Cold Fusion Research Prevailed*. 2nd ed. South Bristol, Maine: Oak Grove Press, 2002, p. 4-5.

[37] Taubes, Gary. *Bad Science – the Short Life and Weird Times of Cold Fusion*. New York, Random House, 1993, p. 264-266.

[38] Beaudette, Charles G. *Excess Heat: Why Cold Fusion Research Prevailed*. 2nd ed. South Bristol, Maine: Oak Grove Press, 2002, p. 59-62.

marginalization and ridicule. Subsequent mainstream publications have referred to cold fusion as "bad science", "pathological science", and "voodoo science."[39]

U.S. Department of Energy, Energy Research Advisor Board (ERAB), Cold Fusion Panel Report. The Secretary of Energy established the cold fusion panel with the charter to assess the status of the phenomenon and make recommendations on whether research funding should be made available for its investigation and development. The panel was co-chaired by Norman Ramsey and John Huizenga, one of the most outspoken critics of cold fusion. The Panel issued a draft report in July and a final report in November 1989[40]. It was widely recognized that Huizenga (later the author of "Cold Fusion – the Scientific Fiasco of the Century") was the stronger force of the two chairmen. The Panel's not-very-surprising recommendation was that the U.S. DOE not to provide support for cold fusion research. The Panel report was one of the most influential factors in the marginalization of cold fusion[41][42].

3.2 Undead Science: 1990 to Present

After its peremptory rejection by mainstream science by the end of 1989, cold fusion was widely anticipated to "die a natural death" – joining a number of other discoveries that proved not to be so, such as N rays and polywater. From the viewpoint of most scientists, and the public as a whole, cold fusion did indeed pass away and lose its interest and attention. However, a relatively small number of researchers, most of whom felt they had achieved positive results in their attempts at confirmation in 1989 and 1990, continued their work, albeit in a highly marginalized way in comparison to previous efforts. The marginalization of cold fusion for the past 16 years has been experienced in several different ways, for example:

- Inability to obtain funding from normal sources, both government and private sector, for energy research
- Refusal of peer-review journals to accept papers for publication, or even to forward submitted papers for peer review
- Publication of books and articles characterizing cold fusion as pathological or even fraudulent science
- Denial of access to resources of mainstream research organizations and academic institutions, including graduate student labor for support of projects

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[39] Park, Robert L. *Voodoo Science – the Road from Foolishness to Fraud*. New York: Oxford University Press, 2000.

[40] U.S. Department of Energy, Energy Research Advisory Board. "Final Report of the Cold Fusion Panel of the Energy Research Advisory Board." Unpublished U.S. DOE Report, 61 p. November, 1989.

[41] Huizenga, John R. *Cold Fusion: the Scientific Fiasco of the Century*. Rochester, New York: University of Rochester Press, 1992, p. 218-222

[42] Mallove, Eugene F. *Fire from Ice: Searching for the Truth Behind the Cold Fusion Furor*. New York: John Wiley & Sons, 1991, p. 176-181.

The status and characteristics of cold fusion research since marginalization in 1989 has been insightfully described[43] as "undead science" – neither fully alive as an essential part of mainstream science nor fully dead, as is the case for fully discredited phenomena such as N rays or polywater. Within the U.S. the most active enthusiasts fall generally into two categories – researchers who maintain laboratories and build and operate cold fusion experiments, and other interested parties who provide support in a variety of ways, such as preparing promotional pieces and maintaining websites.

One of the principal forums for sharing research results in the cold fusion community (besides the internet) is the series of International Conferences on Cold Fusion (ICCF), which have been held approximately annually and which generally rotate among the U.S. Europe and Russia, and the Far East, especially Japan. The first ICCF was held in Salt Lake City in 1990, and the most recent was ICCF12 in Yokohama, Japan in November and December 2005. The fitality of the field is indicated by the number of papers (48) and posters (38) presented during the six days of the conference. ICCF 13 is scheduled to be held in Russia, and ICCF 14 in Washington, D.C.

Much of the research since 1990 has been to improve reproducibility, detect and measure nuclear byproducts, and answer other criticism posed by the skeptics. However, research agendas have also extended well beyond answering the critics, and includes elemental transmutation and many new experimental concepts for obtaining excess heat from cold fusion type processes. Particularly interesting are the observations of "heat after death"[44], in which the electrodes in cold fusion cells continue to generate heat even after the electrolyte is boiled away and the circuit that operates the cell is broken. The observation of excess heat when plain water (rather than deuterium) and nickel (rather than palladium) are used in the cold fusion cell may portend the possible use of more common and less expensive materials for cells in the future.

3.3 Principal Reasons for Cold Fusion Marginalization

No single cause, or even a few causes in combination, but many factors conspired together to bring about the marginalization of cold fusion and its continued existence as a pariah in the scientific community. Chief among these factors are the following:

Methods of Initial Announcement and Publication. As noted, many scientists were offended by the "publication by news conference[45]" The peer-reviewed publication, when it did finally appear several weeks later lacked enough detail to support experiments to verify reproducibility. And several aspects of the paper – except for the central feature, excess heat – proved to be erroneous, which put the entire paper under a cloud of suspicion.

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[43] Simon, Bart. *Undead Science: Science Studies and the Afterlife of Cold Fusion*. New Brunswick, New Jersey: Rutgers University Press, 2002.

[44] Beaudette, Charles G. *Excess Heat: Why Cold Fusion Research Prevailed*. 2nd ed. South Bristol, Maine: Oak Grove Press, 2002, p. 214-217.

[45] Huizenga, John R. *Cold Fusion: the Scientific Fiasco of the Century*. Rochester, New York: University of Rochester Press, 1992, Appendix I, p. 1-12.

Mistakes Made by Both Proponents and Antagonists. Given the large number of mistakes made by cold fusion advocates when it was announced and in the weeks and months that followed, and in light of the errors and outright misconduct of the antagonists during the same timeframe[46], the wonder is that it has as much inability as a scientific phenomenon that it does. Perhaps the greatest mistake of all is the inability or refusal of the skeptics to have a more open mind in light of the failure of "conventional" views in similar situations so many times in the past and with the continuing corroboration of the existence of excess heat in a large variety of circumstances.

Erratic Reproducibility. Cold fusion remains a relatively poorly understood phenomenon[47]. The details of how it occurs at a microscopic level have not yet been systematically observed, and there is still no satisfactory theoretical explanation of the processes at work. In this situation, it is not possible to know, let alone control, the variables that determine whether cold fusion will occur in a given cell. Without the knowledge of the variables governing the occurrence, or lack thereof, of cold fusion, it is impossible to consistently achieve reproducible results. It is, however, known to be a much more complex phenomenon than originally thought, and the resources required to define and control the governing variables have thus far not been allocated to its investigation.

Understatement of the Compexity of the Phenomenon. The initial model or explanation for cold fusion was simple and straightforward – that deuterons dissolved in the metal lattice of palladium at high concentrations (load factors) 'somehow" become involved in fusion reactions to form helium-4 and heat that is transferred to the lattice. Unfortunately, this model has proved to be too simplistic for the actual cold fusion processes, which appear to take place near the surface of the solid, involve complex chemical compounds rather than just palladium, and occur when conditions are right – in microscopic volumes for a very short time but repeatedly and very quickly in many different places in close proximity to each other[48].

Difficulties in Selection of Control Experiments. One of the main arguments leveled by the critics at cold fusion scientists is inadequate experimental procedure as evidenced by the lack of control experiments. Proponents counter with the argument that the large magnitude of excess heat is *prima facie* evidence of an experimental result even without the benefit of control experiments. Proponents further argue that adequate control experiments – such as plain water in place of deuterium or another metal besides palladium – are not available because some cold fusion experiments indicate that plain water may be coaxed into acting like deuterium under certain conditions, and that other metals (e.g., nickel) may also be implicated in cold fusion reactions.

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[46] Beaudette, Charles G. *Excess Heat: Why Cold Fusion Research Prevailed*. 2nd ed. South Bristol, Maine: Oak Grove Press, 2002, p. 287-288.

[47] Storms, Edmund. *A Student's Guide to Cold Fusion*. LENR-CANR.org. Online. Available http://www.lenr-canr.org, 2003 Accessed: January 2006.

[48] Storms, Edmund. *A Student's Guide to Cold Fusion*. LENR-CANR.org. Online. Available http://www.lenr-canr.org, 2003 Accessed: January 2006.

Antagonism of the Hot Fusion Scientist Community. From the outset the plasma physicists collectively had deep misgivings about the reality of cold fusion based on their understanding of nuclear processes at very high temperatures (hotter than the interior of the sun). In particular, they insisted that the evidence or fusion be based not on the excess heat observed, but on the nuclear byproducts that would be expected as if the fusion were occurring in a plasma environment. As noted, cold fusion appears to occur through fusion of two deuterons to form helium-4 (which occurs in only 0.05% of fusion reactions in plasmas), and since heat (phonons) are generated rather than a gamma ray, the hot fusion scientists do not believe the reaction actually occurs. Inasmuch as plasma physicists have tremendous power and influence in the scientific community, their adverse reactions and behavior proved fatal to the acceptance of cold fusion into mainstream science[49].

Incorrect Interpretation as Pathological Science. One of the main points of the sociology of science is that what gets accepted as science, or rejected as non-science, depend as much (or more) upon who "gets to decide" as it does upon the truth[50]. One of the key publications for this "boundary work" was the delineation of criteria indicating pathological science[51]. Critics of cold fusion have attempted to apply the Langmuir criteria[52] to cold fusion in order to characterize it as pathological science. Cold fusion advocates, however, have effectively countered the application of the Langmuir to cold fusion.

Failure of the Scientific Process. Observers of the sociology of the events around the announcement and subsequent history of cold fusion, in consideration of the above observations, suggest that the whole scientific process has been compromised[53]. The process was flawed, and the outcome erroneous. The continued polarization of views, and the dogged refusal of mainstream scientists to consider the evidence with an open mind, suggest that this view of the compromised status of objective views in this case may well be correct.

3.4 Recap of the Current Situation

Cold fusion has experienced a difficult birthing process. Many mistakes were made at the time of its discovery and announcement, and many more mistakes – some bordering on professional misconduct – were made as it was being evaluated in the initial weeks after announcement. The result was a premature and inappropriate ejection of the phenomenon from mainstream science.

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[49] Beaudette, Charles G. *Excess Heat: Why Cold Fusion Research Prevailed*. 2nd ed. South Bristol, Maine: Oak Grove Press, 2002, p. 59-62.

[50] Simon, Bart. *Undead Science: Science Studies and the Afterlife of Cold Fusion*. New Brunswick, New Jersey: Rutgers University Press, 2002.

[51] Park, Robert L. *Voodoo Science – the Road from Foolishness to Fraud*. New York: Oxford University Press, 2000, p. 40-43.

[52] Langmuir, Irving. "Pathological Science." *Physics Today*, vol 42 (October 1989), p. 44.

[53] Beaudette, Charles G. *Excess Heat: Why Cold Fusion Research Prevailed*. 2nd ed. South Bristol, Maine: Oak Grove Press, 2002, p. 337-354.

Were it not for the dedicated efforts of a few competent researchers, who have continued to achieve positive experimental results, cold fusion would have been relegated to the dustbin of discredited phenomena 17 years ago. The positive results achieved during the years of marginalization, coupled with the urgent need of society for alternate sources of energy besides the dwindling and polluting fossil energy sources, demand that cold fusion be given a serious re-evaluation.

Cold fusion has a long way to go to regain its standing in the scientific community and in the eyes of the general public. It has repeatedly been (and continues to be) held up as a premier example of bad, fraudulent, or voodoo science – the (greatest) fiasco of the (20th) century. But given the potential payoff to society (even if the probability were low, which it appears not to be) makes the effort not only worthwhile, but urgently necessary.

Who, really, is qualified to say definitively that cold fusion does not occur or is not based on as-yet poorly understood processes? If "excess" heat – beyond what can be accounted for by chemical processes – is generated in cold fusion (which is the best-established proof" of the phenomenon), diligent research should – must – be performed to discover its source. As pointed out by Ramsay[54], even just "a single short but valid cold fusion period would be revolutionary". Such a single observation of heat in an apparatus at room temperature should call forth immediate and massive efforts to discover the materials and conditions that produce the phenomenon, given the significance to human welfare. There appear to have been not just one, but hundreds, of experiments that have successfully generated such excess heat in the past 17 years.

The question at this juncture is clearly, "What's next for cold fusion?"

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[54] Beaudette, Charles G. *Excess Heat: Why Cold Fusion Research Prevailed*. 2nd ed. South Bristol, Maine: Oak Grove Press, 2002, p. 129-133.

4. What Should Be Done About Cold Fusion in the Future?

A rigorous, well-balanced policy analysis is clearly called for in the case of cold fusion. Decision-making methods and outcomes in the past have been completely inadequate to the task, given the potential importance of cold fusion to human welfare, the continuing promising research results even in a marginalized research setting, and the mistakes made by both advocates and opponents when cold fusion was first introduced and in the years since.

Despite the fact that it has gotten deeply buried by a host of adverse events and potential outright conspiracy or unprofessional conduct, it must be re-evaluated. The stakes are too high not to give cold fusion every possible chance to be proven real. Furthermore, the accumulating evidence for its having a basis in reality in the past 17 years of marginalized research is too strong not to give cold fusion a broader and fairer hearing.

The re-evaluation must improve upon the two cold fusion evaluations performed previously by the U.S. Department of Energy in 1989[55] and 2004[56]. Past evaluations have been too narrowly focused, have been performed by scientists having a too-limited perspective, and have led to erroneous conclusions regarding the potential existence of cold fusion and the appropriate level of funding and other support that it should be given.

Even the most avid skeptics of cold fusion will admit that the history of science is replete with instances where discoveries were initially rejected based on then-current paradigms and were ultimately exonerated and recognized as being valid[57]. Some of the greatest leaps forward in science have in fact occurred when science was confronted with challenging new discoveries and was "forced" to respond with revised ideas, paradigms and methods. Much of the skepticism concerning cold fusion comes from researchers whose understanding of nuclear science comes from investigation of high-temperature fusion, whose processes may or may not be totally relevant to cold fusion phenomena.

4.1 Policy Analysis Approach to Cold Fusion Re-evaluation

Given the potential social significance of cold fusion (should it eventually be proven to exist), the choice of how much to support it is as much (or more) a public policy question as it is a scientific or technical question. Scientific considerations must, of course, play a prominent or

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[55] U.S. Department of Energy, Energy Research Advisory Board. "Final Report of the Cold Fusion Panel of the Energy Research Advisory Board." Unpublished U.S. DOE Report, 61 p. November, 1989.

[56] U.S. Department of Energy. "Report of the Review of Low Energy Nuclear Reactions". Unpublished U.S. DOE Report, 5 p. December 1, 2004.

[57] In fact, given this ready recognition, the strength of cold fusion opposition from some quarters seems peculiar and difficult to comprehend. The extent of closed-mindedness seems remarkable among prominent and knowledgeable researchers.

preeminent role in the decision, but they must be balanced with other cogent social and ethical criteria. The question then becomes: "If a potential and hugely beneficial discovery such as cold fusion is made, and if current scientific paradigms and methods do not support the discovery, how does public policy-making respond?" As noted in Section 1.0, policy analysis provides the needed framework and method for a broad-based and more relevant evaluation of cold fusion than has been accomplished previously[58].

Current and recent writings on cold fusion are generally quite technical (by active researchers), skeptical (by other scientists), sociological (on the rapid rise and fall of cold fusion, and the associated reasons), and communications-related (the role of the press in relation to "normal" peer-review methods of scientific communication). It appears that a balanced, systematic and rigorous policy analysis has not yet been performed on cold fusion.

The first step of a cold fusion policy analysis would be to construct various scenarios of level of support. The second step would be to carefully select a panel or committee of those most qualified to conduct the evaluation. To avoid the errors of past evaluations, representation on the panel must be extended beyond those qualified only to make technical judgments of cold fusion and must include "new blood" that is not biased by the past history. The criteria for evaluation would then be defined and carefully articulated so that the panel would have clear guidance on how to perform the evaluation. Based on these criteria, the panel would perform the evaluation of the alternatives, which would then result in a set of findings and recommendations. The final step would be to implement the panel recommendations through revisions, as required, to current public policy regarding cold fusion research and development.

4.2 Policy Alternatives for Research Support

Effective analysis of public policy toward cold fusion begins with a clear statement of the available policy alternatives[59]. It appears that there are four basic alternatives for cold fusion support, stated below in summary form:

- Business as Usual. Continue the current de facto policy of "binding" researchers through denial of funding, refusal to publish peer-reviewed papers, stigmatization with "pathological science" accusations, career thwarting measures, etc.

- Discontinue Research. Give up any hope of investigating and developing cold fusion as a source of energy. Allow (or push) it down the annihilation path of N rays, polywater, and similar debunked scientific phenomena.

- Confer Scientific Legitimacy. Accept the results, erratic and confusing though they may be (not atypical of newly discovered and poorly understood phenomena), of

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[58] Anderson, James. *Public Policymaking – an Introduction*. Boston, Massachusetts: Houghton Mifflin Co., 2006, p. 3-6.

[59] Ibid, p. 103-105.

research performed to date under marginalized conditions. Use these results as a platform for a comprehensive and well-funded research program on a par with, say, hot fusion, or comparable energy research programs.

- "Manhattan Project" Level of Support. Accept the true social implications of cold fusion and the promising research results to date. Develop and conduct a massive, worldwide research program in an accelerated manner as though it were on a wartime basis.

Clearly, these four basic alternatives could be divided into subcategories to allow greater precision in the analysis.

4.3 Broad-based Qualifications of Evaluation Panel

It has been argued previously in this paper that the cold fusion policy decision-makers of the past have been too few in number, too scientifically and technically focused, too biased in their viewpoints and judgment, and too narrow in their fields of specialization. Consequently, many mistakes have been made in the approach, methods and outcome of previous evaluations, as exemplified in both reviews conducted by the U.S. Department of Energy in 1989 and 2004.

Whereas cold fusion, if it exists, is a natural phenomenon subject to scientific methods, and its research and development are technical in nature, policy decisions on its support must be made by a more diverse group representing non-technical perspectives than has been called upon previously. The evaluation panel should also have representation, for example, of sociologists of science, energy policy specialists, political scientists, politicians, commercial development experts, and other specialists.

4.4 Criteria for Evaluating Alternatives

The evaluation panel will be called upon to assist with definition of the appropriate criteria for the evaluation. Candidate types of criteria that would be applied during evaluation of the alternatives would include extent of previous research and careful (unbiased) assessment of the results (as well as the quality of the research), probability of success, cost to achieve the level of support, technical feasibility to accomplish, potential benefit to society as a whole and to various stakeholders, and infrastructure capacity (including funding sources and competing priorities) to implement the alternatives.

4.5 Evaluation of Policy Alternatives

To the extent possible, the specific methodology for conducting the evaluation of alternatives will be selected from previously developed methods, such as multicriteria decision analysis[60], for

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[60] Anderson, David R., Dennis J. Sweeney, and Thomas A. Williams. An Introduction to Management Science – Quantitative Approaches to Decision Making. Mason, Ohio, South-Western, 2003, p. 701-716.

similar policy analysis situations. Draft solutions for the alternatives, criteria, and evaluation methods will be prepared in draft ("strawman") form, and the evaluation panel will be engaged to assist with the final development of all three. The panel will then be convened, and the evaluation will be performed using the selected methodology – as adapted for this evaluation – and applying the criteria to the alternatives. The results of the evaluation will then be written up as a draft report, which will be finalized after review by members of the evaluation panel.

4.6 Implementation of Policy Analysis Findings

Implementation of the policy recommendations of the evaluation panel will depend to a large extent upon what they turn out to be[61]. The articulation of the recommendations will likely be very important also, given the history and current status of cold fusion, particular with respect to the attitudes of mainstream science toward it.

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[61] Birkland, Thomas. *An Introduction to the Policy Process – Theories, Concepts, and Models of Public Policy Making*. Armonk, New York: M.E. Sharpe, 2001, p. 177-187.

5. Setting the Stage for a Cold Fusion Policy Analysis Study

A research proposal for the policy analysis project outlined in Section 4.0 has been prepared (see Attachment 2) and is summarized here. The proposal includes the following parameters for the policy analysis project:

- Policy Alternatives. For various levels of support, at a high level, to be subdivided into sub-alternatives as needed during the study
- Evaluation Panel Participants. In terms of the types of qualifications and areas of expertise. Broad-based definitions, with formalization and selection of individuals in the study
- Evaluation Criteria. Specification of the parameters to be used to conduct the evaluation of the defined alternatives.
- Methods of Analysis. Analysis methods, tools, and reporting in accordance with accepted practices and standards of policy research at the LBJ School of Public Affairs
- Management. Utilizing a work breakdown structure approach common to project management. Subdivide the work into manageable tasks and monitor progress of each against a pre-defined schedule

The specific scope, organization, management, schedule and budget are summarized below.

5.1 Scope of Analysis

Eight tasks have been established for the proposed project. The first task is to build upon the Conference Course work products (this Position paper and the Attachments 1 to 4) by conducting interviews of knowledgeable persons. The literature review will be updated and expanded at the same time. Based on the result of these two activities, a Work Plan will be prepared using the proposal in Attachment 2 as the point of departure.

The five policy alternatives for research support set forth in Section 4.2 will then be updated and subdivided as required. Members of the Evaluation Panel will be selected, and the criteria for evaluation of the alternatives will be finalized. The evaluation methodology, selected during preparation of the Work Plan, will be implemented, and the policy analysis will be conducted. Based on the results of the analysis, recommendations on the level of research and development support for cold fusion will be developed. Similarly, recommendations for the implementation of the selected alternative will be prepared.

5.2 Organization and Management

The policy analysis project will be performed under the supervision of a faculty member at the LBJ School of Public Affairs, The University of Texas at Austin. Day-to-0day management will be accomplished by a Project Manager (PM) who is a senior graduate student in the program leading to a Master of Public Affairs (M.P.Aff.) degree. The work will be accomplished primarily by a Project Team consisting of the PM and two to five additional M.P.Aff. graduate students. Accepted policy analysis methods and practices at the LBJ School will be used in performing the project. Work products prepared by the Evaluation Panel and the Project Team will be reviewed and approved by the faculty supervisor.

5.3 Schedule and Budget

A total of 26 weeks is proposed to complete the policy analysis project for cold fusion. The work activities of some of the tasks are set up in an overlapping manner in order to allow telescoping of the schedule.

The proposed budget for the project is $120,000, including about $80,000 for labor, $20,000 for travel and other direct costs, and $20,000 for contingency, which is necessary due to the many unknown factors associated with the project.

6. Summary and Recommendations

Cold fusion holds great promise of potential benefit to mankind as a source of virtually free, unlimited energy. Because of mistakes made by both proponents and skeptics of the phenomenon in the initial months after its announcement in 1989 and in the years since, it was subjugated and marginalized by mainstream science. As a result, public policy toward cold fusion has also been one of neglect and lack of support.

Research under marginalized conditions by a relative small group of reputable scientists continues to show promising results, however, particularly in the generation of excess (non-chemical) heat. Despite the clear record in the history of science of new phenomena initially, and erroneously, being rejected based on existing knowledge and paradigms, many mainstream researchers continue to reject cold fusion as being "impossible" based on what is known of nuclear science.

In the case of hot fusion, public policy has been supportive because of the promise of cheap, unlimited energy – despite the failure of beneficial hot fusion after 50 years of research and development, and over $15 billion of expenditure. The failure of public policy support of cold fusion, given the promising research results, may constitute a tragedy of national proportions. Even one experiment that generates excess heat in an apparatus that operates at room temperature should be pursued with as many resources and as much scientific talent as possible, and as rapidly as feasible. In the case of cold fusion, hundreds of experiments have definitively demonstrated excess heat generation in the past 17 years.

A new and greatly improved approach to analysis of public policy toward cold fusion – one that involves a broader base of experts, that is free of the biases and mistakes of the past, and that uses rigorous methods and tools of policy research – is clearly needed. To do less, given the potential importance of cold fusion for human welfare, and the clear indication that energy is generated by processes not yet understood, would be to perpetuate the mistakes of the past. And it would be to turn away from the possibility of reducing human suffering and of improving the human condition worldwide.

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Appendix A. Frontispiece Information

The following description of the calorimeter shown in the Frontispiece is from the New Energy Times website at the following address:

http://www.newenergytimes.com/news/NET12.htm#earthtech

EarthTech International Inc. Announces the "Mother of All Calorimeters"

[Editor's note: The following text is provided by Scott Little, an experimenter and engineer at EarthTech International Inc. Photos of this testing device are on the New Energy Times Web site at http://newenergytimes.com/Conversations/LettsPhotos.htm]

EarthTech International announces a new high-accuracy calorimeter at our lab in Austin, Texas. Ambitiously dubbed "MOAC" (Mother Of All Calorimeters), this instrument is specifically designed to test cold fusion cells operating in the 0-20 watt range.

A brief description of the system:

The calorimeter chamber is relatively roomy, and the space available for the cell is a rectangular prism volume about 24cm high, 14 cm wide, and 24 cm deep. There are three optical ports which enter the chamber. One of these is fitted with a borescope which permits inspection of the cell during calorimetric measurements. The other two permit laser beams to be directed at the cell cathode if desired. Provision is also made for actuation of a mechanical device near the cell (for example, rotation of magnets around the cell) during calorimetric measurements.

In addition to the device under test, the calorimeter chamber also contains a liquid-to-air heat exchanger and a fan which circulates the chamber air across the device under test and through the heat exchanger. Thus, the heat evolved by the device under test is coupled to the water flowing through the passages in the heat exchanger.

An active insulation system essentially eliminates heat loss through the walls of the calorimeter chamber. Each wall panel consists of a 6mm thick active insulation inner plate, 4 cm of styrofoam insulation, and a 6mm thick active insulation outer plate. With temperature sensors on both active insulation plates and heaters on the outer active insulation plate, each wall panel is independently servo controlled to maintain a zero delta-T across the styrofoam insulation.

Water is circulated around the heat exchange loop by a precision pumping system. An automated batch-weighing flowmeter regularly monitors the actual water flowrate, which is about 2.2 gm/sec. Three independent stages of temperature regulation bring the inlet water to 25.000 degrees C with a typical standard deviation of +/- 0.0006 degrees before it enters the calorimeter chamber.

The calorimeter chamber and the water circulation system are enclosed in a temperature-controlled environmental enclosure. This effectively eliminates problems caused by room temperature variations.

Data collection and experiment control are accomplished with two computers. One is devoted to housekeeping activities such as temperature control of the environmental enclosure and the servo control of the six active insulation panels. The other computer is responsible for the calorimetry measurements such as electrical input power to the device under test, water flowrate measurements, temperatures of the inlet and outlet water streams, etc. In all, MOAC monitors 44 analog input channels and operates 15 analog output channels to control the system.

Both of these computers run Labview programs which serve up their front panel images as web pages. This permits anyone with Internet access to see what MOAC is doing. In addition, the experiment logbook is

maintained as a Microsoft Frontpage HTML document which is also served up as a web page so you can see what we're trying to do with MOAC.

All data is recorded to disk and may be replayed by the Labview program to recreate any display obtained during a run.

Accuracy:

We set out to design a calorimeter that would achieve +/- 0.1 percent accuracy. For example, with 10.000 watts going into the cell, we wanted MOAC to read between 9.990 and 10.010 watts of heat coming out of the cell (assuming no excess heat). MOAC is close to this goal now. However, there are "bad days" when MOAC exhibits mysterious shifts of 0.2 or 0.3 percent relative. We are working to resolve these issues now.

Specimen Versatility:

Because of the total heat collection design of the calorimeter chamber, MOAC exhibits excellent specimen versatility. For example, we have a 10-watt calibration resistor permanently mounted inside the calorimeter chamber (near the heat exchanger), a control electrolysis cell with H2O-H2SO4 electrolyte, and an immersed calibration resistor in that cell. All three of these heat sources read the same in MOAC to within +/- 0.1 percent relative.

Cell Access:

MOAC's roomy calorimeter chamber will accommodate a variety of cell sizes and shapes. In addition, the mechanical actuator feature and optical access ports permit a variety of things to be done to the cell during calorimetric measurements.

Dual Method Calorimetry:

Because the cell is located in a stirred-air chamber during calorimetric measurements, MOAC performs an isoperibolic measurement of the heat evolved from the cell while the water-flow calorimetry is underway. The isoperibolic measurement is accomplished by comparing cell temperature to the calorimeter chamber air temperature.

Our Offer:

Earthtech hereby offers to test promising cells in MOAC free. We believe that the opportunity of observing a genuine excess heat effect in an accurate calorimeter is well worth the time, energy, and money we will expend in the process. A promising cell is one that typically shows at least 0.20 watts of excess heat and is reasonably repeatable. The terms "typically" and "reasonably" are open to interpretation.

Our goal is to identify cold fusion technology that works, then to help develop it into a useful energy source for mankind.

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Appendix B. Chronological Summary from Beaudette, 2002

The following chronology is not meant to be a cold fusion history. It includes primarily those items referenced in the text.

1866	First investigation of hydrogen in metals by Thomas Graham.
1903	Pierre Curie discovers that radium is always warmer than its environment.
1926	Paneth and Peters report fusion of hydrogen to make helium. The following year they retract the report as mistaken.
1929	Cohn demonstrates that hydrogen in metals migrates toward the negative terminal.
1935	Ludwik Fleck published his definitive account of the difficult-to-replicate scientific experiment: the Wassermann Test for syphilis. His account is titled, Genesis and Development of a Scientific h act.
1950	Fleischmann awarded Doctorate in Chemistry by the Imperial Collage of the University of London.
1967	Fleischmann accepts Faraday Chair in electrochemistry at Southampton University.
1972	Fleischmann collects together materials to drive deuterium into palladium very hard. The effort is abandoned for lack of time.
1975	Pons admitted to postgraduate studies at Southampton University. Receives Doctorate two years later.
1983	Pons accepts position in the chemistry department at University of Utah. Fleischmann and Pons begin their collaboration
1984	Fleischmann and Pons plan to try an electrolytic cell experiment to fuse deuterium inside a palladium lattice. Electrolyte temperature rise is to be the parameter to watch.
1985	Fleischmann elected member of the Royal Society of London.
Winter	Large release of energy from early cold fusion experiment in laboratory in the north Henry Eyring Building at University of Utah.
1986	Pons appointed a full professor. 1987
July	Scientific American magazine published "Cold Nuclear Fusion" by Jones and Rafelski.
1988	Pons becomes Chairman of the Chemistry Department.
August	Two Utah chemists submit proposal to fund their cold fusion studies to the DOE.
September	DOE selects S. Jones at Brigham Young University (BYU) to evaluate the proposal.
Fall	M. Hawkins, graduate student in the Department of Chemistry, begins experiments with the Fleischmann and Pons designed Dewar cell.
1989	
February	Fleischmann and Pons undertake nuclear measurements to back up excess heat results.
March 22	Preliminary Note manuscript received by the journal of Electroanalytical Chemistry.
March 23	Press announcement of cold nuclear fusion at the University of Utah.
April 10	Publication of the Preliminary Note.
April 18	E Scaramuzzi announces the detection of neutron emission from titanium infused with deuterium gas and then temperature cycled.
April 24	Secretary of Energy Admiral James Watkins forms a panel on cold fusion under joint chairmanship of J. Huizenga and N. Ramsey.
Baltimore	The American physical Society spring meeting at
May I	Baltimore, MD
4:00 P.M.	First press conference. Nothing transpires. I There have not :- _ _ - yet been any presentations.
5:00 p.m.	Second press conference. N. S. Lewis asserts there is absolutely nothing to the claims of excess heat.

7:00 p.m.	First special session on cold fusion. - Koonin reports no possibility of d-d fusion producing the excess hear and comments on the mental and professional status of Fleischmann and Pons - N. S. Lewis reports no evidence of heat or nuclear effects from his experiments at Caltech. He also reports that Fleischmann and Pons did not obtain excess heat in their experiments in Utah. Their faulty results are attributed to a lack of stirring in their cells
May 2 10:00 a.m.	Third press conference (conducted by S. Koonin).
7:00 p.m.	Second special session on cold fusion that ended late in the evening. (This was the end of the APS special program on cold fusion research.)
Los Angeles	American Electrochemical Society meeting session on cold fusion research at Los Angeles, CA
May 8	.
5:00 p.m.	Session on cold fusion research. N. S. Lewis and M. Fleischmann speak.
9:00 p.m.	Fourth press conference: Bockris, Appleby, Fleischmann, and Pons. (N. S. Lewis takes a microphone, stands on chair and asks "loaded" questions.)
May 18	Petrasso report in Nature shows fatal flaws in Fleischmann and Pons claim to have detected neutrons.
May ?3	DOE sponsored meeting on cold fusion reports. Santa Fe, NM
July 12	Interim report of the DOE Panel.
August 11	N. S. Lewis's report published in Nature.
September	Oriani submits anomalous power corroboration report to Nature.
September 15	Deadline set by the DOE Panel for receipt of reports about cold fusion research. Presumably its final report reflects nothing that developed after this date.
September 24	New York Times Sunday Magazine published the (:tease and Samios lampoon about Fleischmann and Pons and their claims.
October 16	EPRI/NSF meeting in Washington. N. S. Lewis hears Fleischmann report on excess heat generation and raises no argument about the validity of the work.
November 11	Final DOE Panel report issued.
December 21	Fleischmann and Pons manuscript of anomalous power measurements received by its publisher, the journal of Electroanalytical Chemistry.
1990 January	Nature decides to not publish Oriani's confirmation of the anomalous power phenomenon first reported by Fleischmann and Pons The Wall Street journals Jerry Bishop receives award from the All) for his reporting of cold fusion events during 1989
January 26	Oriani informed referees do pass his paper for publication, but Washington, DC, editor rejects it.
March	First Annual Conference on Cold Fusion - Huggins reports 5.6 watts peak power generated . - McKubre reports a D/fd threshold effect
March	Nature says "farewell" to cold fusion.
July 25	Fleischmann and Pons's 56-page seminal paper is published. It describes anomalous power generation and its calorimetry.
1991 Spring	W Hansen, professor of physics at Utah State University, Logan, prepares an important report for the Utah State Fusion/Energy Council supportive of excess heat
June	Second ACCF held at Villa Olmo, Como, Italy
1992 July	Wilson, et al., publish substantial critique of the Fleischmann and Pons paper of July 1990. Fleischmann and Pons's defense is published concurrently
October 21	ICCF-3 Nagoya, Japan
November	Storms reviews the field to date in an extensive summary article in Fusion Technology (20, 1991, p. 433).
1993 December	Fourth ICCF at Maui, Hawaii. More definitive data on D/Pd loading threshold is presented

1994 Autumn	The American Scholar publishes article by David Goodstein, "Pariah Science."
December	By this time, anomalous power (excess heat) was widely confirmed by replication in many independent laboratories using different types of cells and calorimeters.
1995 Spring	Dr. Edmund Storms reviews the field to date in the Journal of Scientific Exploration (10, no. 2, 1996,p. 185).
Spring	Dr. G. Preparata published QED Coherence in Matter (World Scientific Int. Publisher, May 1995).
Spring	Dr. N. Hoffman's book, A Dialogue on Chemically Induced Nuclear E fects, is published.
April	Fifth ICCF held in Monaco.

Attachment 1. Cold Fusion Policy Analysis: Presentation

Attachment 2. Proposal for Cold Fusion Policy Analysis Project

Attachment 3. Annotated Bibliography and Website Reviews

Attachment 4. Library of Resources

Cold Fusion:

A Cogent Topic for Rigorous Policy Analysis

Thomas W. Grimshaw, Ph.D.

March 2006

Cold Fusion Overview

- Introduced March 1989 at University of Utah
- Intensively studied at numerous laboratories for verification
- Dismissed as non-existent by mainstream science by end of 1989
- Continued research under marginalized conditions, 1990 to present
- Observation of “excess” heat verified in many labs, large variety of conditions
- Strong need for re-evaluation under broader venue

Conference Course Objectives

- Develop the case for re-evaluation of cold fusion
- Propose that evaluation be expanded and performed as *Policy Analysis*
- Outline alternatives for levels of research support
- Set the stage for full-blown Policy Analyses study

Context of Conference Course

- LBJ School of Public Affairs, The University of Texas at Austin
- PA 389, “Conference Course in Policy Analysis”
- Dr. Kenneth Flamm, Professor
- Fall 2005 and Spring 2006

Terminology

- “Cold Fusion” has become stigmatized and does not encompass all phenomena
- Preferred term is now “CMNS” – Condensed Matter Nuclear Science”
- Alternative terms also widely used
  - “LENR” – Low-Energy Nuclear Reactions
  - “CANR” – Chemically Assisted Nuclear Reactions
- “Cold Fusion” used for Conference Course
  - Term is widely recognized (even if negatively)
  - Addresses issues head-on

Conference Course Work Products

- Position Paper
- PowerPoint Presentation
- Proposal for Cold Fusion Policy Analysis
- Annotated Bibliography and Website Review
- Library of Resources

Why Policy Analysis?

- Past cold fusion evaluations too narrow and inadequate (given cold fusion importance)
- Issue of support and development transcends purely technical considerations
- Numerous mistakes by both advocates and antagonists led to incorrect outcome
- Continued promising experimental results indicating excess heat
- Importance to human welfare necessitates best effort possible

What Is Cold Fusion?

- First, what is fusion, generally?
- Fusion of nuclei of hydrogen atoms to form helium atoms
- Hydrogen nucleus is one proton and one neutron (normal hydrogen has only one proton)
- Heavy isotope called “deuteron” (D)
- Reaction: 2 ^{2}H ? ^{4}He
- Mass of 2 ^{2}H is slightly greater than ^{4}He
- Difference is expelled as energy according to Einstein’s equation:
  - $E = mc^2$
  - “c” is a very large number

“Hot Fusion” Reactions

- Occurs inside sun and other stars
- Three nuclear reactions (“branching ratios”)
  - D + D ? triton (hydrogen-3) + proton + energy [50%]
  - D + D ? helium-3 + neutron + energy [50%]
  - D + D ? helium-4 + energy (gamma ray) [0.00001%]
- Deadly emissions of nuclear particles and gamma radiation

Cold Fusion Nuclear Reaction

- Reaction is similar to very rare reaction of hot fusion [0.00001%]
- D + D ? helium-4 + energy (heat into lattice)
- Benign products – normal helium and heat energy
- No deadly gamma rays
- Energy captured as heat in lattice

Cold Fusion Cell: Overview

- Sealed container with deuterium (heavy water) solution
- Electrolytic cell setup with gold anode and palladium (Pd) cathode
- Applied voltage causes deuterium to hydrolyze (into D & O) and D to enter Pd cathode
- Recombiner (top of cell) causes D & O to re-form into deuterium
- Entire assembly is contained in calorimeter to measure heat input and output
- Cold fusion reaction occurs when Pd is sufficiently "loaded" with deuterium (***SOMETIMES***)
- "Excess heat" (non-chemical) indicates that cold fusion reaction is occurring

Cold Fusion Cell

- Glass container (200 mL)
- Deuterium (heavy water) solution
- Anode (coiled wire)
- Cathode (Pd plate inside anode)
- Thermistors (temperature)
- Direct current supply
- Recombiner for D & O (at top)

Why is Cold Fusion Important?

- New field of scientific investigation (at a minimum)
- Potential contributor to meeting world energy needs
- Reduce dependence on fossil fuels and associated drawbacks
  - o High cost of production
  - o Environmental damage (e.g., global warming)
  - o World political liabilities

Nuclear “Magic”

- Humans have a world view based on chemical (not nuclear) processes
- Nuclear processes generally much more powerful
  - For example, thermonuclear bombs
  - New to human experience
- Cold fusion barriers to acceptance may be caused by its “unbelievable” nature
  - “Too good to be true”
  - Intuitively, energy cannot come (free) from water and a metal

Cold Fusion History: 1989

- Marvh 23 announcement
- Very quick evaluation, rejection, marginalization
- Three major events contributed to “downfall”
  - Publication by news conference; subsequent paper was weak and contained errors
  - American Physical Society meeting; hot fusion scientists gained upper hand
  - U.S. Department of Energy cold fusion report; recommended no special funding
- Beginning of characterization of cold fusion as “bad science”, “pathological science”, “voodoo science”

“Undead Science”: 1990 to Present

- Cold fusion marginalized but not defunct (like N-rays, polywater)
- Greatly reduced band of researchers continued lab work and exchanged results
- Annual International Conference on Cold Fusion“ (ICCF)
- Marginalized conditions
  - Inability to obtain conventional funding
  - Professional papers refused by peer-reviewed journals
  - Books and papers characterizing cold fusion as fraudulent or pathological
  - Access to mainstream research organizations (e.g., academia) denied
  - Creativity and labor of graduate students not available

Why Was Cold Fusion Marginalized?

- Method of initial announcement and publication
- Mistakes by both proponents and antagonists
- Erratic reproducibility (variables not understood)
- Understatement of complexity
  - Simple model had to be abandoned
  - Difficulties in selection of control experiments
- Antagonism of hot fusion physicists
- Incorrect interpretation as pathological science
- Overall failure of the scientific process

What Should Cold Fusion‘s Future Be?

- *Policy Analysis* – best next step for re-evaluation
- Provides improved methods, setting, participants, tools
- Expands venue of evaluation
- Corrects errors of the past
- Provides best possible opportunity to succeed
- Maximizes chances for realization of potential benefits of cold fusion

Research Support Alternatives

- Business As Usual – continue marginalization
- Discontinue Research – abandon cold fusion entirely
- Confer Scientific Legitimacy – fund R&D along with hot fusion
- "Manhattan Project" – as though on wartime footing

Broad-Based Evaluation Panel

- Physicists and other scientists (as before)
- Sociologists of science
- Economists
- Political scientists
- Commercial development specialists
- Politicians
- *Select unbiased candidates (if possible)*

Scope of Cold Fusion Policy Study

- Eight tasks in Work Breakdown Structure
- Begin with interviews of experts and preparation of Work Plan
- Finalize support alternatives and select Evaluation Panel
- Develop evaluation criteria and finalize methodology
- Conduct Policy Analysis
- Develop recommendations and prepare report
- Organize and manage the project

Organization, Management, Schedule, Budget

- Overall supervision by LBJ School faculty member
- Project team consisting of graduate students at LBJ School
- Evaluation Panel selected from candidates nationwide
- Accepted LBJ policy analysis methods and tools utilized
- Approximately 26-week project
- Budget of about $120K

Summary

- Cold fusion has great potential benefit to human welfare
- Numerous mistakes were made at the outset (and subsequently)
- Continued research has verified the phenomena (but still lacks underpinnings)
- Policy Analysis is best approach for a fairer and broader evaluation
- Framework established in Conference Course for “full-blown” Policy Analysis study

Cold Fusion: A Cogent Topic for Rigorous Policy Analysis

Proposal for Policy Analysis Project

Presented to:

Kenneth Flamm, Ph.D., Professor

PA 389, Conference Course in Policy Analysis

LBJ School of Public Affairs

The University of Texas at Austin

By:

Thomas W. Grimshaw, Ph.D.

March 21, 2006

Contents

Preface

Cold fusion burst upon the scene in 1989 as a major scientific breakthrough with enormous promise as an unlimited and virtually free source of energy. In the ensuing months tremendous fervor in scientific and political arenas at first gradually and then rather suddenly gave way to disillusion, marginalization and even ridicule. By late 1990 most "mainstream" scientists became convinced that the phenomenon did not exist, and politicians and the public generally followed suit. Since then nearly everyone, including scientists and the general public, has believed that cold fusion is a dead issue.

However, a relatively small number of reputable scientists – including both physicists and chemists – have continued to conduct research and develop theories for what they believe to be a "real" phenomenon. Continued promising experimental results in the 16 years since cold fusion was "debunked" has inspired these dedicated few to continue their efforts in spite of being marginalized and even experiencing damage to their careers in some cases. Cold fusion has been characterized as "undead science"[1] – neither fully alive as part of mainstream scientific research nor fully dead, like N rays, polywater and other phenomena once widely embraced but now fully discredited.

Several aspects of cold fusion make it a particularly cogent topic for a policy analysis investigation:

- The enormous potential benefit to mankind should it eventually prove to be "true" – for energy supply, pollution reduction, alleviation of poverty, and abatement of human suffering

- The proper way to balance the probability of a potential major new discovery becoming valid – even if at first widely considered to be very low – against the size of the social benefit of the discovery, if the benefit is very large

- How to allocate resources to marginalized (but potentially very important and beneficial) phenomena in the context of large expenditures for other perceived national priorities, such as transportation infrastructure projects or pursuit of potentially non-defensive wars to assure petroleum supplies

A Conference Course in Policy Analysis has been accomplished with the objectives of "making the case" for a policy analysis of cold fusion research, developing the needed background information, and establishing the framework for conducting the analysis. Specifically, the Conference Course includes the following five work products:

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[1] Simon, Bart. *Undead Science: Science Studies and the Afterlife of Cold Fusion*. New Brunswick, New Jersey: Rutgers University Press, 2002.

- Position Paper. Documents the rationale for a policy analysis study and sets the stage for conducting the study.
- Electronic Presentation. Summary of Conference Course findings, recommendations, and proposal for the cold fusion policy analysis study (in Microsoft PowerPoint).
- Cold Fusion Policy Research Proposal. Lays out the scope of the policy analysis study along with the proposed methodology, budget and schedule, as the basis for funding the study.
- Annotated Bibliography and Website Review. Includes the most significant resources regarding the history, development, technical basis, and current status of cold fusion. (Referred to hereinafter as "Annotated Bibliography" to conserve space).
- Hard Copy and Electronic File Library. Contains the principal resources considered in the annotated bibliography and website review for future reference in a policy analysis study.

This proposal lays out a program of work for a policy analysis on the question of future support for research and development of cold fusion.

The Library (last work product listed) is in the possession of the author and will be made available to the project when it is initiated. A copy of the Position Paper is provided in Appendix A of this Proposal. The Presentation is in Appendix B. The Annotated Bibliography and Website Review is included in Appendix C.

1. Introduction

Cold fusion may, or may not, be real. Nearly 17 years have elapsed since it was announced in a press conference at the University of Utah in March 1989. After the initial announcement, cold fusion was intensively studied at numerous organizations and by many scientists. Primarily because of difficulties in reproducibility of the phenomenon, and the absence of expected nuclear byproducts of the energy production (based on hot fusion research), it was quickly – within a few weeks – deemed to be nonexistent by mainstream science.

For at least two reasons – the apparent numerous mistakes that were made in the way cold fusion was dealt with (by both proponents and skeptics) in the initial weeks (as well as the years since), and the enormous potential benefit to humanity – the phenomenon is worthy of careful policy analysis. This is so if even if the probability of its being real is low, which is not the case, as indicated by continued research since 1990. The phenomenon of cold fusion is too important to be allowed to languish without a full analysis in a public policy context of whether it should receive research and development support. Decision-making methods and outcomes in the past have been completely inadequate to the task, given the potential importance of cold fusion to human welfare, the continuing promising research results even in a marginalized research setting, and the mistakes made by advocates and opponents when cold fusion was first introduced and in the years since.

The Position Paper prepared as the primary work product of the Conference Course in Policy analysis accomplishes several tasks: 1) provides a high-level technical overview; 2) reviews the history of cold fusion; 3) develops the case that cold fusion, although currently highly marginalized, is potentially important enough to mankind to warrant a rigorous policy analysis study; and 4) outlines candidate policy alternatives, methods and criteria for fiscal and other support of cold fusion research. Finally, Section 5 of the Position Paper sets the stage for a "full-blown" policy analysis study of cold fusion support. It includes the following components:

- Policy Alternatives. At a high level, to be subdivided into sub-alternatives as needed during the study.
- Panel Participants. In terms of the types of qualifications and areas of expertise. Broad-based definitions, with formalization and selection of individuals in the study.
- Evaluation Criteria. Specification of the parameters to be used to conduct the evaluation of the defined alternatives
- Methods of Analysis. Analysis methods, tools, and reporting according to accepted practices and standards for policy research at the LBJ School of Public Affairs.
- Implementation of Findings. Outline of necessary considerations in implementing the panel recommendations given the marginalized status of cold fusion

The purpose of this proposal is to flesh out these activities outlined in the Position Paper and organize them into a work breakdown structure format which allows clear specification of the activities to be performed. The overall strategy of the project will be to assemble a Project Team that will perform most of the work and fully support the Evaluation Panel as it conducts the policy analysis.

2. Scope of Work

The scope of activities to be performed for the policy analysis project for cold fusion is organized using a work breakdown structure format – with tasks and work elements. For each task, an introduction is provided along with the objectives of the task.

2.1 Task 1. Conduct Interviews of Knowledgeable Persons

The Conference Course work products (Library, Annotated Bibliography, and Position Paper) are intended to be a "starting point" for setting up the policy analysis project. The purpose of this task is to contact key persons knowledgeable of the technical aspects cold fusion, current status of development, and support requirements to maximize potential for future development. The Project Team will perform this task using the following work elements:

- Determine qualifications criteria for candidates based on background, familiarity with cold fusion issues, credentials in past contributions and other factors
- Using the Position Paper and Annotated Bibliography as the starting point, and subsequently by networking, identify "long list" of candidates to be interviewed
- Make initial contact with long-list candidates to determine interest in participation
- Prepare short list of candidates after screening
- Develop interview checklist to meet the objectives of this Task
- Make contact and conduct interviews with short-listed candidates
- Prepare summary reports of individual interviews as well as a consolidated report of findings

The interview reports and consolidated report will be used as resource material for conducting the policy analysis project.

2.2 Task 2. Prepare Work Plan

A Work Plan will be prepared by the Project Team at the outset to guide the work of the project. The contents of this proposal will serve as the starting point, and the results of the interviews in Task 1 will provide the basis for finalizing the Work Plan. Work elements for this task include the following:

- Determine final Work Plan format to comply with any requirements of the funding entity or other identified internal or external requirements
- Carry over the relevant components of this proposal into the formatted Work Plan

- Incorporate the results from Task 1 interviews to finalize the Work Plan

- Perform updates and modifications as required, including fleshing out the scope as envisioned in this proposal with specific details and conditions at the outset of the project

The Work Plan will then be updated as necessary during the conduct of the project to reflect changed conditions or to incorporate interim findings that have an impact on the scope or conduct of the project.

2.3 Task 3. Finalize Support Alternatives

High-level alternatives (scenarios) for cold fusion support were outlined in Section 5 of the Position Paper. The Project Team will use these scenarios as a starting point for completing support scenarios at the appropriate level of detail. The following work elements will be performed for this task:

- Establish requirements to be met by scenario candidates, such as degree of "fineness" or "coarseness" (translating into different numbers of candidates) for policy analysis project

- Review the previously prepared alternatives and modify them as necessary to meet project requirement

- Prepare final write-ups of each alternative with range of content and level of detail to fully support the policy analysis

2.4 Task 4. Select Evaluation Panel

One of the principal criticisms of past cold fusion evaluations has been that the evaluators selected represented a far too narrow range of expertise and perspective for the potential importance of the phenomenon to society. The objective of this task is to select a broad-based panel to conduct the policy analysis and make recommendations for the future support of cold fusion. The Project Team will perform this task with the following work elements:

- Establish criteria for specifying the qualifications of the members of the panel, with emphasis not only on technical ("reality of cold fusion") considerations, but other socially and ethically important factors as specified in the Position Paper

- Based on the selected criteria, determine the number of participants and specification of anticipated background and qualifications of each (or each category)

- Determine the "top three" candidates for each panel position (or category of position) on a nationwide basis

- Establish technological basis for conducting the Panel's work, including teleconference or videoconferencing, in order to conserve project resources

- Based on the Work Plan, summarize the scope of activities of Panel members and associated schedule and budget

- Contact Panel candidates, provide copies of the Work Plan and Panel Scope of activities; secure commitments for participation

Backup candidates will be tentatively identified for each Panel member in the event of dropouts or unforeseen conflicts of interest, or other factor that prevent participation in Panel functions.

2.5 Task 5. Finalize Evaluation Criteria and Methodology

The methodology selected and configured for the specific needs of the policy analysis for cold fusion is one of the most important tasks of the project, not only to ensure a sound and useful outcome, but also because of the problems experienced and documented in past evaluations. The objective of this task is to ensure that the methods used are specific and defensible. The Project Team will identify the best approach by performing the following work elements:

- Conduct a survey of policy analysis methods used in previous work involving similar types of support phenomena and associated issues

- Review each method for applicability to the cold fusion policy analysis, giving particular consideration to the unique status of the phenomena as "undead science" but with enormous potential for social benefit

- Select the most appropriate methods(s) and configure it for the specific circumstances of cold fusion and its marginalized condition

- Prepare a brief report describing the selected method(s), applicability to the cold fusion case, and configuration accomplished

It is anticipated that a level of "iterative" effort will be required for this task to fine-tune the methodology to ensure a good outcome, given the unusual circumstances, complexity of issues, history of marginalization, and continued widespread perceptions of cold fusion as a case study in "bad", "fraudulent" or "voodoo" science..

2.6 Task 6. Conduct Policy Analysis and Develop Recommendations

This task is the heart of the policy analysis project for cold fusion support. The preparatory tasks come to fruition at this stage as the policy analysis work is actually accomplished. The following work elements will be performed by the Project Team:

- Engage the Evaluation Panel in the policy analysis methodology to evaluate the selected support scenarios using the selected criteria

- Carefully consider the merits of each scenario and document the results in a systematic and defensible manner

- Tabulate the results and summarize for review and preliminary approval by the Panel members as the concluding work of the Panel for the analysis

- Compile the tabulated results into a draft report after the Panel completes its work; the draft report will then be reviewed by the Panel members individually and, if necessary, as a group to resolve remaining issues or address open items for the various scenarios

- Finalize the report after Evaluation Panel has completed its review and submit it to the sponsoring entity

2.7 Task 7. Develop Implementation Recommendations

It may be anticipated that the Evaluation Panel will gain an in-depth and knowledgeable perspective as a result of its policy analysis work. The Project Team will engage the Panel to perform the following work elements to develop additional recommendations for implementation.

- Review current public policies toward cold fusion and the history that resulted in those policies

- Consider the Panel's policy recommendations in light of the current policies

- Make additional implementation recommendations to enhance, to the extent possible, the probability that the Panels policy recommendations will be adopted.

Given the situation with cold fusion, the implementation recommendations may be as important as the policy recommendations for the best possible outcome.

2.8 Task 8. Organize and Manage the Project

Effective organization and management are key to the success of complex policy analysis projects such as the one proposed here for cold fusion. The Project Team will perform the following work elements to assure adequate management of the project:

- Organize and initiate the project, beginning with the Work Plan specified in Task 1 and following the provisions of the Work Plan thereafter

- Provide periodic progress reports (generally monthly) as specified by the sponsoring entity; include technical progress, schedule status, and budget expenditures for each task in comparison with the value of work performed

3. Organization

The policy analysis project will be performed under the supervision of a faculty member at the LBJ School of Public Affairs, The University of Texas at Austin. Day-to-0day management will be accomplished by a Project Manager (PM) who is a senior graduate student in the program leading to a Master of Public Affairs (M.P.Aff.) degree. The work will be accomplished primarily by a Project Team consisting of the PM and two to five additional M.P.Aff. graduate students. Accepted policy analysis methods and practices at the LBJ School will be used in performing the project. Work products prepared by the Evaluation Panel and the Project Team will be reviewed and approved by the faculty supervisor.

4. Schedule and Budget

A high-level schedule for the Tasks specified in Section 1 is shown below. The schedule will be amplified as required when the Work Plan is prepared to incorporate the specific conditions of the project as approved by the sponsoring entity.

Task	Length (weeks)
1	4
2	3
3	2
4	6
5	3
6	8
7	Unspecified
8	Project Duration
Total	26

Note: Some tasks may be "telescoped" to allow shortening of the overall timeframe.

The proposed budget for the proposed policy analysis project for cold fusion is $120,000. A tabulated budget breakdown by work breakdown structure is shown below.

Labor

Task	Level (persons)	Length (weeks)	Total (p-w)
1	2	4	8
2	1	3	3
3	2	2	4
4	0.5	6	3
5	2	3	6
6	2	8	10
7	-	-	-
8	0.25	26	6.5
Total	-		39.5 ~ 40

Labor cost = 40 wk x 40 hr x $50/hr	$80,000
Other Costs (travel, supplies, etc.)	$20,000
Contingency (20%)	$20,000
Total Cost	$120,000

5. Reference Cited

1. Simon, Bart. *Undead Science: Science Studies and the Afterlife of Cold Fusion*. New Brunswick, New Jersey: Rutgers University Press, 2002.

Cold Fusion: A Cogent Topic for Rigorous Policy Analysis

Annotated Bibliography and Website Reviews

Presented to:

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PA 389, Conference Course in Policy Analysis

LBJ School of Public Affairs

The University of Texas at Austin

By:

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March 21, 2006

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Preface

Cold fusion burst upon the scene in 1989 as a major scientific breakthrough with enormous promise as a source of unlimited and virtually free energy to meet society's needs. In the ensuing weeks tremendous fervor in the scientific and political arenas at first gradually and then rather suddenly gave way to disillusion, marginalization and even ridicule. By early 1990 most "mainstream" scientists became convinced that the phenomenon did not exist, and politicians and the public generally followed suit. Since then nearly everyone, including scientists and energy policymakers, have believed that cold fusion is a dead issue. As recently as January 2006, cold fusion was brought up in the context of scientific missteps or fraud[1]

However, a relatively small group of reputable scientists has continued to conduct research and develop theories for what they believe to be a "real" phenomenon of cold fusion. Continued promising experimental results in the 16 years since cold fusion was "debunked" has inspired these dedicated few to continue their efforts in spite of being marginalized and even experiencing damage to their careers in some cases. Cold fusion research since 1989 has been characterized[2] as "undead science" – neither fully alive as part of mainstream scientific research nor fully dead, like N rays, polywater and other phenomena once widely embraced but now fully discredited.

Examination of the record on cold fusion indicates an urgent need for a re-evaluation under a broader context than has previously been accomplished. It appears that past evaluations have been fraught with mistakes, have been performed by the wrong experts, have led to erroneous conclusions about cold fusion, and have most probably deprived humankind of a new scientific field – at the least – and perhaps also a new source of cheap unlimited energy.

What should be done regarding research in cold fusion in the future?

This question is particularly well suited to be addressed by a rigorous policy analysis. A Conference Course in Policy Analysis has therefore been accomplished with the objectives of "making the case" for a policy analysis of cold fusion research, developing the needed background information, and establishing the framework for conducting the analysis. Specifically, the Conference Course includes five work products:

- Position Paper. Documents the rationale for a policy analysis study and sets the stage for conducting the study.
- Electronic Presentation. Summary of Conference Course findings, recommendations, and proposal for the cold fusion policy analysis study (in Microsoft PowerPoint).

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[1] Kevles, Bettann, H. "When Fraud Wriggles Itself into Science". *Austin American-Statesman* (January 15, 2006), p. H1, H4.

[2] Simon, Bart. *Undead Science: Science Studies and the Afterlife of Cold Fusion*. New Brunswick, New Jersey: Rutgers University Press, 2002.

- Cold Fusion Policy Research Proposal. Lays out the scope of the policy analysis study along with the proposed methodology, budget and schedule, as the basis for funding the study.
- Annotated Bibliography and Website Review. Includes the most significant resources regarding the history, development, technical basis, and current status of cold fusion.
- Hard Copy And Electronic File Library. Contains the principal resources considered in the annotated bibliography and website review for future reference in a policy analysis study.

1 Introduction

Despite its problems of stigmatization and marginalization as a "respectable" area of energy research, cold fusion may hold sufficient promise, both as a new field of scientific investigation and as a source of abundant, very low-cost energy, to warrant a rigorous policy analysis study. A review of the most relevant previously published studies is essential to determining whether such a study is warranted.

This review of previous work on cold fusion includes peer-reviewed papers, general and specific books on the topic, "gray" (non-peer-reviewed) literature, and websites that contain information on the subject. An attempt has been made to provide reasonably balanced coverage of materials prepared by both proponents and skeptics of cold fusion. Coverage of the points of view and positions of the skeptics is particularly necessary because cold fusion proponents must fully understand the viewpoints of the opponents if they are to be effective in developing counter-arguments and conducting research that fully addresses the issues raised by the skeptics.

At the same time, a bias toward at least giving cold fusion "a second chance" or a more balanced (fairer) hearing – given the numerous mistakes that were made by both proponents and skeptics when it was initially introduced – is freely admitted. Otherwise there would be no motivation to conduct the review, and cold fusion could be left in its current marginalized state.

One salient fact emerges from all the commotion around the cold fusion controversy – excess heat beyond what can be accounted for by chemical reactions is produced, which implies, by default, that a nuclear process is involved. As noted by the U.S. Department of Energy panel that evaluated cold fusion as early as 1989 (and recommended that no special funding be provided):

> Ordinarily, new scientific discoveries are claimed to be consistent and reproducible; as a result, if the experiments are not complicated, the discovery can usually be confirmed or disproved in a few months. The claims of cold fusion, however, are unusual in that even the strongest proponents of cold fusion assert that the experiments, for unknown reasons, are not consistent and reproducible at the present time. *However, even a single short but **valid** cold fusion period would be revolutionary* (italics added by author).

Valid observations of excess heat have now been made and substantiated not in just one, but in many experiments performed by different researchers working in numerous laboratory settings and using a large variety of methods and equipment.

This Annotated Bibliography and Website Review has been prepared in support of a proposed re-evaluation of cold fusion in a broader context, as a policy analysis project. Many references and websites on cold fusion have been identified, and the ones most relevant to a policy analysis were selected for annotation. Section 2 provides the annotated references first, and then lists those that were reviewed but not annotated. Section 3 is organized in a similar manner for websites that were reviewed and annotated in part. The conclusions and recommendations that emerge from the review of resources are provided in Section 4. A library containing most of the resources reviewed has been assembled and is described in Section 5; it will be made available to the project team when the cold fusion policy analysis project is conducted. Homepages from the websites selected for annotation are provided in Appendix A.

2 Annotated Bibliography

Numerous papers have been prepared on the topic of cold fusion. Most of them are highly technical in their content and contributions to the subject. Many are available in non-peer-reviewed sources because of the marginalization of cold fusion from mainstream scientific research. A comprehensive survey of the most significant references on cold fusion research results, history and development was performed. The references selected for annotation include the following:

- Introductory books and papers that are useful for "grounding" those becoming interested in cold fusion.
- Descriptive works that cover the 1989 announcement and subsequent events that affected cold fusion development.
- Non-technical publications on the relation of cold fusion and its history to various topics, such as the role of the press in science communication, the peer-review method of scientific verification, the sociology of the research community of chemists and physicists, and public policies adopted to date toward cold fusion.
- Semi-technical or "light" technical works that bring out key facts or clearly support (or debunk) the cold fusion phenomenon.

The primary criterion used to determine whether a candidate reference was selected for annotation was how well it supports (or does not support) the case for conducting a policy analysis study, and how useful it is likely to be when the study is performed in the future.

2.1 Bibliography with Annotations

The references selected for annotation are included below. Each reference consists of four parts:

- Citation. Following the format specified by the LBJ School of Public Affairs
- Contents. Chapters or headings and subheadings, if present, to provide an overview of the contents
- Annotations. Significant findings or key points in summary form, using a "bullet" format
- Significance to Policy Analysis. Usually as a concluding bullet or two in the Annotations

The references are shown in alphabetical order by lead author.

Beaudette, Charles G. *Excess Heat: Why Cold Fusion Research Prevailed*. 2nd ed. South Bristol, Maine: Oak Grove Press, 2002.

Contents

- The definitive later work on the development and current status of cold fusion (2002) [Eugene Mallove's "Fire on Ice", 1991 is the definitive earlier work]
- An excellent summation of the status, and correct way to think about cold fusion, is in Nagel's "Introduction":

  > This book lays the needed foundation for a forward-looking plan to (1) put the experimental situation on a firm basis, (2) arrive at the desired understanding, and (3) exploit the remarkable new effect(s) of cold fusion for the good of humans and their planet

- Makes an excellent case for the reality of cold fusion through several means:
  - Points out the errors in science committed during the early weeks after announcement, and since
  - Demonstrates multiple full, independent verifications of excess heat by 1994 by more than 100 researchers, and reviews the specifics for seven – Hansen, Wilson, McKubre, Oriani, Huggins, Miles, Arata
  - Answers each of the skeptics (Huizenga, Close, Taubes, Park, etc.) and their respective objections point by point
  - Specifically addresses the primary objection of the lack of nuclear byproducts
  - Outlines progress in the theoretical underpinnings of cold fusion to date
- Tends to be more retrospective, with focus on errors of the past (to get the recognition needed for cold fusion) rather than prospective – what to do next – and solutions-oriented
- A clear defense of cold fusion that is essential background to a rigorous policy analysis; probably the best overall reference for cold fusion analysis
- Includes good summary of the ERAB 1989 report and its flaws
- Provides a good description of the May 1-2, 1989 assault at the APS meeting in Baltimore – central roles of Lewis and Koonin

Beaudette, Charles. Response to the DOE/2004 Review of Cold Fusion Research. Unpublished Paper, 16 p. March 1, 2005. Online. Available www.lenr-canr.org. Accessed October 2005.

Contents

No subsections included

- Begins with a review of the 2004 DOE review process
- "The DOE/OS accomplished the best peer-review evaluation that was possible under the difficult circumstances of the CFRs (cold fusion research's) place in the professional community"
- Implies that reviewers were chosen 'who were not active in the field, did not know of its key experiments, and were ignorant of its literature".
- According to Peter Hagelstein, "In the end, the reviewers said that a study should be funded if a proposal is strong. You can't ask for much more than that".
- Uses an unusual approach – outlines the claims of Pons and Fleischmann and discusses the 2004 Review results in that format:
    1. First claim, 89/3
    2. Second claim, 89/3
    3. Third claim, 89/3
    4. Fourth claim, 89/3
- Lays to rest the problem of reproducibility

Brassani, T, E Del Giudice, and G Perparata. *The Science of Cold Fusion – Proceedings of the II Annual Conference on Cold Fusion*. Bologna, Italy: Italian Physical Society, 1991

Contents

- Second ICCF conference, 1991, which is now up to #12 as of November 2005 (Yokohama, Japan)
- Broad range of papers presented, generally supportive of cold fusion
- Highly technical reports, in general, except for portions of the two summaries
- Primarily useful as an example of the apparently high quality of research reported in the ICCF meetings

Close, Frank. *Too Hot to Handle: the Story of the Race for Cold Fusion*. London: W.H. Allen, 1990.

Contents

- Has intro chapter on the announcement by Pons & Fleischmann
- Well written, with rich detail on the events and players
- Not as definitively or as negatively written as Huizenga's "Fiasco" or Park's "Voodoo Science"
- "Genesis" provides background – elementary fusion, pre-1989 history, muon-catalyzed fusion, Steven Jones and the BYU experiments, individual and joint biographies, the UU-BYU dispute
- "Deuteronomy" relates the events after the March 23 announcement, by location and installation or provider; major focus on CalTech; chapter on international research
- "Revelations" is an interpretation of what happened – perception of the actual vs what the cold fusion proponents thought, with respect to data obtained in experiments and deuterium vs water reactions
- Focus is on credibility of the researchers and the potential for data manipulation
- "Assessment" (Ch 19) covers several elements of the controversy
  - Pons & Fleischmann problems and mistakes around the announcement
  - Role of the media
  - The role of belief – by Pons & Fleischmann and by other researchers
- The irregularity of the Pons & Fleischmann report on March 23 was caused by the sense of competition from Jones & others at BYU

Fleischmann, M. and Stanley Pons. "Electrochemically Induced Nuclear Fusion of Deuterium." *J. Electroanal. Chem.*, vol. 261, p. 301 and Errata in vol. 263 (1989).

Contents

- A very short paper to have created such a stir!
- Highly technical and very dense with numerical data
- "Discussion" includes appropriate qualifier that seems to be routinely overlooked or ignored: "We realize that the results reported here raise more questions than they provide answers, and that much further work is required on this topic."
- The technical nature of the paper – directed to peer professionals rather than lay persons – limit its direct input or usefulness for Policy Analysis for cold fusion
- Rather, secondary sources that provide reliable, accurate interpretations will be more useful for non-chemists and non-physicists

Fox, Hal. *Cold Fusion Impact in the Energy Age. 2nd ed*. Salt Lake City, Utah: Fusion Information Cente,. 1992.

Contents

- A highly promotional piece published by the Fusion Information Center in the early period after rejection
- References cold fusion as "Fleischmann-Pons Effect" (FPE)
- Very similar, highly optimistic (and premature) approach of Rothwell, ____
- Written for lay audiences
- Good summary of "Essential Conditions for Commercialization"
    1. The amount of excess heat generated must be sufficient for economic performance
    2. The phenomena must be repeatable, controllable, reliable, and safe.
    3. The costs of production plus operation must be economically attractive, or have an economical advantage over the competing energy systems.
    4. The systems must be clean, non-polluting and non-hazardous
    5. There must be market acceptance
- 1992: EPRI funded $2 M of SRI (McKubre) work
- The "Impact On…" sections are hypothetical prognoses under highly optimistic assumptions
- Chapter 11 appears to be an unfortunate and very damaging description of non-cold-fusion devices that seem to violate the laws of thermodynamics
- Chapter 12 provides an excellent chronology of cold fusion events, starting with Rafelski and Jones article ("Cold Nuclear Fusion" in Scientific American (7/87) and ending with ICCF 3, Nagoya, Japan (10/92)
- Excellent summary of patent applications as of 1992 in Appendix 1
- Floppy disk (3.5") containing 90 pages of "Bibliography of Cold Fusion"

Hagelstein, Peter L., Michael C.H. McKubre, David J. Nagel, Talbot A. Chubb, and Randall J. Hekman. "New Physical Effects in Metal Deuterides." Paper prepared for U.S. Department of Energy Review Panel on Cold Fusion. 2004.

Contents

- The paper published by CF protagonists in preparation for the 2004 U.S. DOE review (see also U.S. DOE….)
- Somewhat technical in content, of necessity, but a mandatory paper for review by serious CF researchers
- Two topics were selected from a broad spectrum for the DOE review – excess heat and nuclear emissions from deuterated metals
- Most skeptics of excess heat attribute the observations as errors in calorimetry, which has been shown to be accurate
- Excess heat is generated when loading (D/Pd ratio) exceeds 0.875; is parabolic above that level
- "The notion that deuterons are somehow squeezed together, so as to fuse at high loading or high fugacity…is not considered a plausible explanation."
- Excess heat generation is affected by several variables – loading, surface chemical potential, temperature, current density, and deuterium flux
- "Searches for neutrons, tritons, and other energetic emissions in quantitative association with excess heat effect have uniformly produced null results."
- "The main focus of attention has been on helium as the primary nuclear reaction product."
  - Helium production varies linearly with excess power
  - The amount of helium produced is lower than expected by a factor of two
  - "Helium is partially retained, and dissolved helium is released only slowly to the gas phase for analysis."
- "…the argument in support of reaction mechanisms consistent with D+D->^{4}He is indirect."
- "The importance of the basic Fleischmann-Pons effect…is primarily scientific in the sense that the research provides strong evidence of a new excess heat effect of nuclear origins."
- Conclusions
  - "The research discussed in this paper provides evidence for effects in three categories:

(1) The existence of a physical effect that produces heat in metal deuterides. The heat is measured in quantities greatly exceeding all known chemical processes and the results are many times in excess of determined errors using several kinds of apparatus. In addition, the observations have been reproduced can be reproduced at will when the proper conditions are obtained, and show the same patterns of behavior. Furthermore, many of the reason for failure to reproduce the heat effect have been discovered.

(2) The production of 4He as an ash associated with the excess heat, in amounts commensurate with a r4actio mechanism consistent with D+D -> ^{4}He + 23.8MeV (heat)

(3) A physical effect that results in the emission of: (a) energetic particles consistent with d(d,n) 3He and d(d,p)t fusion reactions, and (b) energetic alphas and protons with energies in excess of 10 MeV, and other emissions not consistent with deuteron-deuteron reactions.

Hideo, Kozima. Discovery of the Cold Fusion Phenomenon – Development of Solid State – Nuclear Physics and the Energy Crisis in the 21st Century. Tokyo, Japan, Ohotake Shuppan Inc., 1998.

Contents

- Obtained from Inter-library loan and copied portions only
- Appears to be a translation from Japanese
- Recounts the author's personal experience in cold fusion research
- Provides a review of various aspects of cold fusion in a series of technical chapters
- Sets forth his own Trapped Neutron Catalyzed Fusion (TNCF) model as a theory for cold fusion phenomena
- Scope is broadened to include non-cold-fusion topics, including the 21st Century energy crisis and paradigm shifts.
- Includes five essays by other scientists on cold fusion and other scientific topics

  > Peter Gluck: "…all the unexpected and highly desirable phenomena take place in very limited active areas, and the research strategy is to breed and multiply and reinforce and enhance these active areas."

- Primary significance to Policy Analysis for cold fusion is its role as another major reinforcement of the reality of the cold fusion phenomenon

Hoffman, Nate. *A Dialogue on Chemically Induced Nuclear Effects: a Guide for the Perplexed about Cold Fusion*. La Grange Park, Illinois: American Nuclear Society, 1995.

Contents

- Study funded by PERI and performed by U.S. DOE Energy Technology Center (ETEC)
- "Summary" provides an excellent summary of the positions and contributions of "pro" and "anti" cold fusion scientists
- Appears to provide a reasonably balance, if somewhat negative position based on a thorough review of work up to the time
- Uses a dialogue metaphor to convey the information
- Q: "Is the heat real?" A: "The simple facts are as follows. Scientists experienced in the area of calorimetric measurements are performing these experiments. Long periods occur with no heat production, then, occasionally, periods suddenly occur with apparent heat production. These scientists become irate when so-called experts call them charlatans. The occasions when apparent heat appears seem to be highly sensitive to the surface conditions of the palladium and are not reproducible at will."
- A highly technical work covering many faces of the cold fusion phenomenon in summary form
- Directed to a technical audience, but without heavy emphasis on underlying mathematics
- The presence of anomalous heat is acknowledged, but the source is not attributed to D-D fusion in the absence of nuclear ash production
- Most useful for PA for cold fusion for being relatively even-handed for a technical work; also for the excellent summaries of past works and the stances of the players in the controversy

Huizenga, John R. *Cold Fusion: the Scientific Fiasco of the Century*. Rochester, New York: University of Rochester Press, 1992.

Contents

- One of the "definitive" works that cast cold fusion out of mainstream science
- Very detailed accounting of the events, starting with the March 23, 1989 press conference
- As co-chairman of the U.S. DOE ERAB Cold Fusion Panel, Huizenga was in an excellent position to know the events and the unfolding of the controversy
- The tone and presentation of the book clearly demonstrates the author's biased attitude
- Huizenga was a key member of the "core set" (from Simon Bard) that was responsible for discrediting cold fusion
- Cold fusion apologists and proponents must be aware of the points made in this work, and be prepared to answer them (already largely accomplished by Beaudette 2002)
- The overall condescending and ridiculing tone that emerges throughout the book reflects the position of having the "upper hand"
- The lack of objectivity, which is understandable given the author's beliefs, seems to border on hubris
- Nevertheless, the work is a rich source of factual material
- Valuable to cold fusion Policy Analysis because (as noted) it clearly lays out the points that must be answered
- A lesser attitude of "interpretive charity" would be hard to imagine – Where do such strong positions come from in the knowledge of abundant paradigm surprises in the past? Where is the modicum of caution?
- Nothing appears to be mentioned of the other co-chairman's (Ramsey's) point that even one successful demonstration of excess heat would be revolutionary and worthy of strong pursuit
- Skates very close to making a connection between cold fusion and the Mormon faith
- An effective technique for marginalization is employed in chapter 12 – juxtaposition of cold fusion with polywater
- Chapter 13, Lessons, is characteristically biased and based on assumptions about cold fusion that may, or may not, prove out
- Although now very dated (1992), continues to have strong influence on the marginalization of cold fusion

Josephson, Brian D. "Pathological Disbelief". Presentation to Nobel Laureates' meeting, Landau, Germany, June 30, 2004.

Contents

54 Powerpoint slides

- Paper prepared with the assistance of Beaudette and Krivit
- "Generally accepted views" regarding a phenomenon can be wrong in two ways
  - -A non-existent phenomenon is considered real (e.g., N-rays, polywater)
  - -A real phenomenon is considered non-existent (e.g., continental drift, meteorites)

  Langmuir focuses on the first
- For the record: "What makes the scientific establishment, in some cases, vehemently deny phenomena for which there is strong evidence?"
- Quotes Koonin and Goodstein on how cold fusion was marginalized
- Focuses somewhat on cold fusion, but gives equal or greater treatment to parapsychology. Also to memory of water
- Quotes Lewis, Huizenga and Maddox on cold fusion marginalization
- "In fact, the nuclear measurements carried out in order to try to establish what the process was that generated the excess heat were inaccurate. But the assertion of Pons and Fleischmann that heat was generated in excess of anything that could be accounted for in terms of chemistry depended on their calorimetry, which has never been successfully challenged. The DoE committee seemed not to have appreciated this fact. And the Pons-Fleischmann excess-heat observations have been replicated many times since, in many different laboratories"
- The 1989 U.S. DOE report said skeptically:

  > 'Nuclear Fusion at room temperature, of the type discussed in this report, would be contrary to all understanding gained of nuclear reactions in the last half century; it would require the invention of an entirely new nuclear process.'
  >
  > Comment: It does happen from time to time in science that a discovery is made that is 'contrary to all present understanding' in the field concerned (e.g., the discovery of the acceleration of the expansion of the universe and the non-zero cosmological constant). It also happens occasionally that a new process is discovered!

- "What happened with cold fusion (and what happens in other cases as well) was the creation of a myth, the myth that the phenomenon was unreal. Such a myth consists of an elaborate story, which in principle might be true."
- "In conclusion: 'we think that we think clearly, but that's because we don't think clearly'"

Krivit, Steven B. and Nadine Winocur. *The Rebirth of Cold Fusion: Real Science, Real Hope, Real Energy*: Los Angeles, California: Pacific Oaks Press, 2004.

Contents

- A recently published unabashedly protagonistic evaluation of cold fusion and its status
- Covers a broad waterfront of topics – context of other energy sources (both conventional and exotic), cold fusion history, pathological skepticism, nuclear products, and sociology of cold fusion science
- An excellent starting point for those with an open mind about cold fusion
- The superiority of cold fusion over other energy sources is described fro fossil fuels, fission reactors, hot fusion, hydrogen, and other exotic sources
- Excellent brief biographies are provide for Pons and Fleischmann
- Good historical summary of cold fusion events, but (as expected) presented from a proponent's point of view
  - Refers to Caltech, MIT and Harwell as "bungled experiments"
  - Makes a strong case for corroboration primarily of excess power, but also of helium and tritium
- Excellent chapter on the pathology of excessive criticism and refusal to consider new data or new evidence when it becomes available
- Good coverage of progress of verification in last 15 years – reproducibility (especially excess heat), tritium, helium-4, neutrons
- Lengthy section on the events around Bockris and others at Texas A&M; major concern expressed for academic freedom
- Emphasizes need for adequate ("Nobel Prize-Winning) theoretical explanation of cold fusion
- Covers transmutation as well as fusion aspects of cold fusion

Krivit, Steven B. "How Can Cold Fusion Be Real, Considering It Was Disproved by Several Well-Respected Labs in 1989?" Paper presented at 12th International Conference on Emerging Nuclear Energy Systems (ICENES'2005), Brussels, Belgium, August 21-26, 2005. Online. Available http://www.lenr-canr.org. Accessed September 2005.

Contents

- A recent brief review of the status of cold fusion, with emphasis on falsity of the debunking studies and proofs in recent work
- Each of the three negative studies at Caltech, MIT, and Harwell were found to be erroneous or to actually produce heat in 8 different post-mortem analyses
- Excellent diagram showing reactants and reaction products for deuterium and water cold fusion systems
- Six selected reports of excess heat
- 23 "myths" cover key aspect of cold fusion and associated controversy
- Asserts that the 2004 U.S. DOE Review was "poorly orchestrated and poorly executed."
- Good comparison of cold fusion and hot fusion in six areas and 17 sub-areas
- Primary significance for Policy Analysis of cold fusion is the very brief but very recent summary of the positive standing of the phenomenon

Mallove, Eugene F. *Fire from Ice: Searching for the Truth Behind the Cold Fusion Furor*. New York: John Wiley & Sons, 1991.

Contents

- The definitive earlier pro-cold fusion work (1991) [cf Excess Heat, 2002, by Beaudette for the earlier definitive work
- Two background chapters – fusion in general, and hot fusion
- Eleven chapters (3-14) on the 1989-90 events, starting with March 23, 1989
- Five chapters (15-19) of summation, speculation, and future developments (including hot fusion)
- Author left science journalism position at MIT over ethical concerns about MIT's behavior around cold fusion
- Ch. 15, "Whither Cold Fusion?" is particularly insightful
    - Table – "Groups reporting Cold Fusion Evidence" with 92 entries
    - "Open Questions" shows essential path to be taken (p 253-255)
    - "Funding" – need for reversal of ERAB (1989) report
- Ch. 16 addresses the role of the press – journalism
- Ch. 17: "Hard Lessons in Science"
    - Resistance to Paradigm Shift
    - The Majority fails to Risk
    - Dangerous Analogies
    - The Pathology of "Pathological Science"
    - Ockham's Razor
    - Theory vs Experiment
    - Peer Review
    - The Fear of Error
    - Vested Interests
    - Wishful Science or a Wish Come True

Mizuno, Tadahiko. *Nuclear Transmutation: the Reality of Cold Fusion* (translated by Jed Rothwell). Concord, New Hampshire: Infinite Energy Press, 1998.

Contents

- Originally published in Japanese under the same title in 1997
- "Among (the author's) achievements in cold fusion were the first extensive reports of neutron measurements in Japan, pioneering work on loaded solid-state proton conductors, and key new studies of transmutation products"
- An excellent summary of the status of cold fusion at the time in the Foreword by Eugene Mallove, one of cold fusion's strongest proponents.
    - "We … learn (from the book) about the political storms that erupted as the reigning scientific paradigm that separated chemistry from nuclear physics begin to collapse." (p. x)
    - "The evidence before us has become mountainous. It is no longer 'overwhelmingly compelling; it is now certain. We now know that the oceans, lakes, rivers, and streams of the world can be virtually infinite sources of clean and inexpensive energy for humankind." (p. x-xi)
- Translation and introduction by Jed Rothwell
    - Introduction has excellent description of an undocumented 1991 event of heat after death in Mizuno's lab
    - By far the most significant event of its type, and not successfully repeated
    - Heat release continued after electrolysis was stopped for at least 12 days, releasing at least 85, and possibly 114, megajoules
    - Heat released was 27 times the heat from a mass of gasoline equal to the mass of palladium
    - Once started, cold fusion "tries" to continue and seeks to equilibrate at a particular temperature
    - Lily-shaped eruptions at the surface show where hot spots develop in the metal and fuse or melt the metal in the process of erupting
    - Not only deuterium is involved in the as-yet-unknown reactions, but also the palladium, in the transmutation to other elements

- Mizuno was one of the first to confirm neutron emissions in cold fusion experiments
- "…this field of research has become a tangled mess."
- Most of the book is a discourse of events of the author's personal experiences with cold fusion research
- Narratives also include attendance at cold fusion conferences in considerable detail
- Worked with ceramic proton conductors as well as palladium and platinum in electrolysis cells
- The primary significance of this work is the strong evidence of cold fusion and its various aspects based on the author's personal experience.

Moon, David, *Carbon Dating, Cold Fusion, and a Curve Ball – Element Transmutations from Cold Fusion – Implications for Radioactive Dating*. Victoria, BC: Trafford Publishing, 2004

Contents

- Not a scientific work – reference on back cover is made to "…extensive element transmutations (that) occurred from intense hydrodynamics during the Flood of Noah (Genesis 6-8)"
- Page 22 (Preface): "One catastrophic event in man's history was the Flood of Noah, as described in the Bible in the book of Genesis. *Carbon Dating, Cold Fusion, and a Curve Ball* will explain how it is thought that the monstrous Flood – called the Great Deluge – cold conceivably bring about massive amounts of nuclear changes in earth material further upsetting the balance of certain elements used to 'date' things"
- The principal meaning or implication of this work is the marginalia that are attracted to cold fusion in its current marginalized state

Nagel, David J. "The Status of Cold Fusion". *Radiological and Physical Chemistry*, v. 51, no. 4-6, p. 653-698

Contents

- Recommends research programs in several fields related to cold fusion as being well within the scope of mainstream science
- A way of legitimizing cold fusion research is to conduct it in marginal, related and non-marginalized fields
- Provides an excellent summary of events in 1989 and thereafter to about 1997
- Gives a good review of the conferences and publications on the subject
- Over 100 reports of anomalous effects of cold fusion experiments
- Good section on how cold fusion might "come out"
- Includes rather technical summation of experiments and results
- Products of cold fusion: heat, nuclear products, radiation
- "It is…likely…that theoretical understanding will only follow achievement of experimental reproducibility"
- Related fields – hydrogen embrittlement, phases and their dynamics; ion beam experiments
- Describes implications of "exothermic nuclear reactions at ordinary temperature"
- Primary implication for Policy Analysis of cold fusion is the well balanced and positive approach in a mainstream journal, with good placement of cold fusion aspects alongside related fields

Park, Robert L. *Voodoo Science – the Road from Foolishness to Fraud*. New York: Oxford University Press, 2000.

Contents

- One of the definitive works for the marginalization of cold fusion
- Uses cold fusion as a prominent (<u>the</u> prominent) example of voodoo science
- Voodoo science includes several categories – pathological science, junk science, pseudoscience, and fraudulent science
- Good exposition of the limiting role of the laws of thermodynamics (p. 7)
- "The reluctance of scientists to publicly confront voodoo science is vexing. While forever bemoaning general scientific illiteracy, scientist suddenly turn shy when given an opportunity to help educate the public by exposing some preposterous claim." (p. 27)
- "Andre Gide, the great French moralist, wrote in his journal a half century ago: 'Man's responsibility increases as that of the gods decreases.' Every step taken by science claims territory once occupied by the supernatural." (p. 31)
- Excellent definition of science, and associated rules (p. 39)
- Langmuir: pathological science – the science of things that are not so
- Cold fusion is included in the scope of coverage of many marginal and outright bogus phenomena outside of, or at the fringe of, science; "guilt by association"
- Goes well with Bards' concept of boundary work in the definition and scope of science
- Claims that Pons & Fleischmann crossed the line from foolishness to fraud when they failed to release the results of helium analysis in the palladium electrode (p. 122-123). This claim must be (may already be?) answered for legitimacy
- The overall point of this work is very valid; the question for cold fusion is whether it fits the mold into which Park puts it
    1. Does cold fusion violate the laws of thermodynamics? (no more so than the H-bomb)
    2. Should the cold fusion proponents have withdrawn their claims as knowledge grew? (as negative evidence emerged, so did confirmatory evidence)

Peat, F. David. *Cold Fusion – the Making of a Scientific Controversy*. Chicago: Contemporary Books, 1989

Contents

- An early work that was published when the "jury was still out" on cold fusion
- A layman-directed work that begins with a summary of early events after the March 23, 1989 press conference
- A simplified description of nuclear energy follows, to provide context
- A very good explanation of muon-catalyzed fusion (an alternate form of cold fusion) is provided
- Pons-Fleischmann's discovery is presented, interestingly, as an alternative to muon-catalyzed fusion
- A "novelette" approach is used to describe the Pons-Flieschmann relationship, the Steven Jones connection, and the cold fusion cell developed by P&F
- Relatively easy reading for getting a high-level introduction, but not as well organized as other sources
- The "Implications" chapter, in particular, covers a variety of only loosely related topics in somewhat random order
- The "Conclusions" chapter seems to add little or no value beyond what is covered earlier in the book
- The Appendices are elementary and simplified to the point of not being useful

Rafelski, Johann and Steven E Jones. “Cold Nuclear Fusion”. *Scientific American*, v 287 (July 1987), p. 84-89.

Contents

No subsection breakdown

- This article, published two years before Pons & Fleischmann, was the origin of the term “cold fusion”, subsequently transferred
- The process of fusion is completely different (muon-catalyzed fusion), however, from the process proposed by P&F
- Like the P&F process, muon-catalyzed fusion was initially thought to be a source of very low-cost fusion energy
- “The heat from muon-catalyzed reactions might someday drive turbines for generating electricity”
- “It is now conceivable that cold fusion may become an economically viable method of generating energy”
- However, new problems emerged subsequently (probably the short life of muons in relation to the reaction rates, of the energy generating processes), which negated the possibility
- One of the authors, Jones, was subsequently the primary source of competition that led the University of Utah into the hasty conference of P&F on March 23, 1989
- Jones conducted research on low-temperature fusion as a geochemical process and source of heat within the earth, but with little emphasis on the process as a source of fusion energy for society

Rothwell, Jed. *Cold Fusion and the Future*. Published by LENR-CANR, December 2004. Online. Available http://www.lenr-canr.org. Accessed August 2005.

Contents

- Contains a great deal of elementary and mid-level information on cold fusion; intended mostly for the uninitiated
- An imaginative excursion into the impact of cold fusion on human life in the future in many different facets of existence
- In some areas, the imaginative treatment crosses over into political issues and somewhat socialistic and humanistic values
- The work is based on many assumptions, about how cold fusion technology can, and will, develop
- Also, in several areas, projections into the future drifts into fanciful wishful thinking; not very realistic
- But the main message is clear and cogent – if cold fusion "pans out", its impact will be monumental, comparable to the discovery of fire, on human existence
- The type and scope of impact will depend on what the cold fusion phenomenon turns out to be and how useful it proves to be as a compact, efficient energy source
- Some parts, as well as reflecting personal taste, demonstrates considerable naiveté
- Serves, as intended by the author, to project a very positive image of cold fusion and its impacts on society, at least in part to help reverse resistance and marginalization
- Compiled in large part from articles previously prepared for Infinite Energy magazine
- Significance to PA of cold fusion is the favorable vision that it provides under an optimistic scenario for the outcome of cold fusion

Simon, Bart. *Undead Science: Science Studies and the Afterlife of Cold Fusion*. New Brunswick, New Jersey: Rutgers University Press, 2002.

Contents

- Excellent analysis of the status and difficulties of cold fusion that is very useful for policy analysis for the path forward
- A very important analysis of the status of cold fusion after the 1989-90 course of events; very recent publication
- Despite unfair treatment and excessive marginalization, cold fusion research continued by reputable researchers
- Despite the stigma, lack of resources and rejection for publication, a dedicated few continued their efforts
- Cold fusion events, and continued research, related from a sociological point of view ("sociology of science")
- Incisive interpretation of the marginalizing events and motivations and the reasons for continued dismissal as pathological science
- Cold fusion is neither fully alive (a subject of mainstream science) nor fully dead (quality research continues at the margin); hence *undead*
- Excellent source of guidance for defining and evaluating alternatives and mapping the policy path forward
- "…to ignore the operations of the undead is simply to neglect the fact that they will be back to haunt us."
- Analysis using parallels from the dead and their ghosts
- Excellent overview in "Summary of Chapters" (p. 20)
- One of the main factors in determining the outcome – closure – was the core set that got the power to make the decisions – nuclear physicists – very significant observation for Policy Analysis
- A different core set may have reached a different outcome
- Presents what happened to cold fusion from a sociological point of view, which is very beneficial for Policy Analysis
- Two key retractions were particularly harmful – Mahaffey (neutrons) and Martin (excess heat)
- Another key concept – decline in "interpretive charity" – giving the experiments the benefit of the doubt
- "Experimenters regress" occurs when replication is not achieved, controls are not used (or are not effective)

- Closure occurred when core set prevailed in the opinion that cold fusion does not exist
- Results of closure – death-like measures taken to strangle investigation – resource deprivation (funds, labor, time equipment), communication (mainstream publications)
- "…controversies concerning novel experimental phenomena do not reach closure in the logical or rationalist sense of the term." (p. 89)
- "Closure is a product of participants' social and material maneuvers to establish a collective sense of what will count as a fact and what will not." (p. 90)
- "..knowledge about the nonexistence of cold fusion was stabilized through the delegitimization of dissenting actors and the deprivation of resources needed to sustain their dissent"
- Upshot: if the core set was constituted incorrectly, the closure was likely to have been wrong

Storms, Edmund. *A Student's Guide to Cold Fusion*. LENR-CANR.org. Online. Available http://www.lenr-canr.org, 2003 Accessed: January 2006.

Contents

- Author's interest in cold fusion is driven by his own experience in having achieved it at Los Alamos in 1991 (and since in his own lab, after retirement?)
- Directed toward an audience with technical training
- Sets forth five (5) key observations:
  1. The effect occurs in the surface of an electrolyzing cathode, not in bulk material
  2. Active material causing the Pons-Fleischmann effect is not β-PdD of any composition, but is a complex compound of unknown but high composition and of unknown structure
  3. Nuclear reactions are found to occur in many materials treated in a variety of ways, and not just when palladium and deuterium are present
  4. An environment consisting of nano-sized particles is very frequently observed when nuclear effects occur
  5. All isotopes of hydrogen can be involved in the cold fusion process
- "Apparently a mechanism exists in a lattice structure that is capable of circumventing any Coulomb barrier"
- "These anomalous nuclear reactions require a special environment in which to operate, the so-called Nuclear Active Environment (NAE)"
- Nuclear products when measured with anomalous heat show a correlation – helium-4 and transmutation both
- "…the nature of the NAE has been difficult to discover because the reactions only occur in very small regions that have properties much different from the surrounding bulk material."
- Four methods of obtaining anomalous energy – electrolysis, gas loading, electrodiffusion, and sonic
- Excellent discussion of the three "branching ratios" of nuclear reaction in fusion an dhow they are not followed by cold fusion

- Good technical description of the NAE and the behavior of palladium when loaded with hydrogen
- Provides a recipe on how to produce the Pons-Fleischmann effect
- Covers the various aspects of theories developed to date – role of neutrons, phonons, particle-wave conversion, "strange" particles, tunneling, multi-body fusion
- "Skepticism, when carried to extreme, is as damaging as naïve acceptance. At the present time, many people respect the skeptic for guarding the high ideals of science. In fact, skeptics frequently stop important progress, stifle originality, and turn creative people away from science altogether."

Storms, Edmund. *A Response to the Review of Cold Fusion by the DOE.* Unpublished Report by Lattice Energy, December 15, 2004, 16 p. Online. Available http://www.lenr-canr.org. Accessed October 2005.

Contents

- Readily acknowledges the problem of poor or inadequate quality of papers – then blames the lack of adequate funding
- Also acknowledges that claims are inconsistent with "accepted knowledge about the well-known fusion reactions"
  - Neutrons and tritium are expected in equal amounts but are not seen
  - Instead, 4He is produced, and not with expected gamma ray but with heat instead
  - Choice is then to reject out of hand or to accept the experimental observations and keep an open mind
- Counters the claim that little has changed since 1989 with a list of five changes
  - A claim for anomalous energy production is now based on numerous results using a variety of calorimeter designs at many different laboratories world-wide
  - Evidence for unexpected nuclear reactions, in addition to fusion, has been reported based on emitted radiation and accumulated reaction products
  - Reproducibility using certain methods has now increased to significant levels
  - A variety of methods can be used to initiate both anomalous energy and nuclear reactions of several types
  - A rich collection of explanations is now being actively explored
- Lists 70 institutions and organizations that are involved in research in the subject
- "Experimental evidence for claiming a novel phenomenon based on nuclear interaction has three sources
  - Energy production is measured using a calorimeter; this energy is frequently much too large to be produced by normal chemical processes
  - Elements are detected after the process that were not detected initially, and cannot be explained by some sort of contamination and/or local enrichment
  - Radiation of various kinds is emitted when none should be found
- Provides a detailed discussion of each of the three

- For calorimetry, addresses three basic challenges
  - Prove that claimed anomalous (excess) heat energy is not generated by a prosaic reaction
  - Prove that this energy is not merely released after it has been previously stored during the course of the experiment
  - Prove that the Calorimeter is sufficiently accurate and sensitive to reliably measure the claimed energy
- For anomalous element production, addresses three kinds of production: 1) 4He; 2) tritium; and 3) transmutation products
- For radiation and particle emission, covers alpha, proton, triton, and neutron emissions – none are associated with energy production
- Asserts that the Nuclear Active Environment (NAE) is not within the bulk of the palladium, but at the surface, and is much more complex than pure metallic palladium
  - High D/Pd loading is still required on the substrate to prevent deuterium leakage out of the NAE and into the underlying Pd
  - Difficult in replication is because NAE creation is difficult and depends on variables not understood, let alone controlled
- Use of normal water as a blank is risky because it might be involved in cold fusion reaction
- Refutes the assertion that researchers ignore negative results
- Emphasizes the importance of understanding the nature of the NAE: "…reasons for negative results are now much better understood. One logical reason is because the required, unique environment was not made. The anomalous effects become reproducible and robust, as observed, once this nuclear active material is present. The major unknown at this point is the nature of this material and how it can be created more predictably""
  - "…present understanding places the nuclear activity in a thin deposit on the surface. This deposit is presently made over a period of time by a random process. Examination of surface of an operating electrode by an infrared camera shows random hot spots, indicating that only a small fraction of the surface is active. Nevertheless, power generation at levels in excess of 5 watts are occasionally measured. This means that power density of the active region is very high. In fact, it is high enough to cause local melting of palladium on occasion.
  - "Once the nature of this active region is understood and can be made in large amounts, presumably power density can be increased to any level that is required for an application."
- "The issue is not whether each and every paper is perfect or that every experiment is without flaw. The issue is whether the weight of the evidence shows anomalous and important behavior."
- "The generation of anomalous energy is now much more reproducible than in the past and has been shown to be associated with helium generation in some cases. Evidence is accumulating showing element production by transmutation…"
- Suggests four major issues as being important for further study
  - What is the nature of the NAE and how can it be created?
  - What mechanism(s) initiates 4He production and under what conditions?
  - What mechanism(s) initiates transmutation?
  - What mechanism(s) produces energetic particles and how are they related to fusion and transmutation?
- Brings up the important issue of the implications for the U.S. if other countries develop the cold fusion phenomenon first due to this country's inactivity

Taubes, Gary. *Bad Science – the Short Life and Weird Times of Cold Fusion*. New York, Random House, 1993

Contents

- A relatively early post-closure work that contributed to the closure and is still widely referenced, though quite out of date
- Written not by a scientist (like Huizenga), but by an informed journalist, who contributed to Science magazine; well written and very "readable"
- Contains enormous, rich detail of the sequence of events, written in a style similar to a novel, and with well-researched background on individuals and events
- The author makes clear his viewpoint early against cold fusion and proceeds to develop his case accordingly
- An excellent work for grasping the cold fusion "story", if enough effort is put into filtering for the explicit bias against cold fusion
- Work is perhaps most noted for its accusation of fraud at Bockris' lab at Texas A&M regarding tritium measurements
- Most explanations of individuals and background appear to be quite negative in tone, particularly for cold fusion advocates, but for others as well

U.S. Department of Energy. "Report of the Review of Low Energy Nuclear Reactions". Unpublished U.S. DOE Report, 5 p. December 1, 2004.

Contents

- Review conducted by DOE Office of Science
- References the earlier 1989 ERAB review: "…peer review of the experimental data and supporting theory since the 1989 ERAB review"
- Includes the Hagelstein et al. 2004 paper prepared for the review as Attachment 1
- Review conducted in two parts
  - Nine scientists reviewed Hagelstein et al. 2004 paper and submitted comments
  - Nine additional scientist convened on August 23, 2004 for one-day review of presentations
- Review Criteria (3) [See Charge Elements below]
- Review paper (Hagelstein et al. 2004) focused on "a subset of research from two areas"
  - "selected issues associated with excess heat production in deuterated metals"
  - "some aspects of nuclear emissions from deuterated metals."
- Detailed summaries of reviewer responses presented were prepared by DOE program managers – based on the 18 sets of reviewer comments
- Charge Element 1: Examine and evaluate the experimental evidence for the occurrences of nuclear reactions in condensed matter at low energies (less than a few electron volts).
  - Focused on production of excess heat and "expected fusion products such as 4He
  - Regarding excess heat, the reviewers were split on its existence being documented
    - Effects not repeatable
    - Magnitude of effect not increased in over a decade of work
    - Many experiments not well documented
  - regarding 4He production, 5 of 16 cases in cells whose excess heat was produced claimed 4He
    - At or close to background concentrations
    - Contamination cited as one possible cause of false positive results
  - "Two-thirds of the reviewers commenting on Charge Element 1 did not feel the evidence was conclusive for low energy nuclear reactions, nor found the evidence convincing, and the remainder indicated they were somewhat convinced."
  - "Many reviewers noted that poor experiment design, documentation, background control and other similar issues hampered the understanding and interpretation of the results presented.

- Charge Element 2: Determine whether the evidence is sufficiently conclusive to demonstrate that such nuclear reactions occur
  - "Reviewers expert in nuclear physics noted that the cold fusion mechanism put forward by proponents is not in accord with presently accepted knowledge of D+D fusion.
  - "The preponderance of the reviewers' evaluations indicated that charge Element 2, the occurrence of low energy nuclear reactions, is not conclusively demonstrated by the evidence presented. One reviewer believed that the occurrence was demonstrated, and several reviewers did not address the question."
- Charge Element 3: Determine whether there is a scientific case for continued efforts in these studies and, if so, to identify the most promising areas to be pursued.
  - "The nearly unanimous opinion of the reviewers was that funding agencies should entertain individual, well-designed proposals for experiments that address specific scientific issues relevant to the question of whether not there is anomalous energy production in Pd/D systems, or whether or not D-D fusion reactions occur at energies on the order of a few eV. These proposals should meet accepted scientific standards, and undergo the rigors of peer review."
  - "No reviewer recommended a focused federally funded program for low energy nuclear reactions."
- Conclusion
  - "While significant progress has been made in the sophistication of calorimeters since the review of this subject in 1989, the conclusions reached by the reviewers today are similar to those found in the 2989 review."
  - "The current reviewers identified a number of basic science research areas that could be helpful in resolving some of the controversies in the field, two of which were: 1) material science aspects of deuterated metals using modern characterization techniques, and 2) the study of particles reportedly emitted from deuterated foils suing state-of-the-art apparatus and methods."
  - "The reviewers believed that this field would benefit from the peer-review processes associated with proposal submission to agencies and paper submission to archival journals."

U.S. Department of Energy. "Report of the Review of Low Energy Nuclear Reactions – Reviewers' Comments". Unpublished U.S. DOE Report, 45 p. December 2004. Online. Available http://www.lenr-canr.org. Accessed October 2005.

Contents

Separate section for each of 18 reviews

- Each review has a highly variable format and content, apparently because no guidance was provided beyond listing the three Charge Elements
- Generally highly technical and not addressed to lay audiences
- Very narrow in the scope of the evaluations – only strictly technical (as was the intent of DOE)
- Therefore not very useful for policy analysis for cold fusion as written, but the outcome in the DOE report that is based on these reviews was extremely important
- The identities of the reviewers are not disclosed
- The variety of opinions expressed reflect the continued non-definitive status of cold fusion, which means it is still of great interest for continued consideration and development

2.2 References Reviewed But Not Annotated

Many references were reviewed that were deemed not to be sufficiently relevant to a cold fusion policy analysis for the preparation of annotations. In the interest of completeness, and in the event that the initial determination of non-relevancy needs to be revised, the list of references reviewed but not annotated is provided below.

Chubb, Scott. "The 2005 MIT Cold Fusion Colloquium, Honoring Eugene Mallote." Infinite Energy Magazine, issue 62. 11 p. Online. Available www.infinite-energy.com/iemagazine. Accessed November 2005.

Jones, Steven E., Franco Scaramuzzi, and David Worledge, eds., *Anomalous Nuclear Effects in Deuterium/Solid Systems*: publisher TBD, 2001.

Kevles, Bettann H. "When Fraud Wriggles Itself into Science." *Austin American-Statesman* (January 15, 2006), p. H1, H4.

Simon, Bart. "Public Science: Media Configuration and Closure in the Cold Fusion Controversy". *Public Understanding of Science*, v. 10 (2001), p. 383-402

Toumey, Christopher P. "Conjuring Science in the Case of Cold Fusion". *Public Understanding of Science*, v. 5 (1996), p. 121-133.

U.S. Department of Energy, Energy Research Advisory Board. "Final Report of the Cold Fusion Panel of the Energy Research Advisory Board." Unpublished U.S. DOE Report, 61 p. November, 1989.

3 Website Reviews

One of the salient characteristics of cold fusion as a highly marginalized science is the denial of access to normal scientific publication channels for reporting research results. The availability of the Internet has consequently proven to be a powerful communications tool both for exchange of technical information and as a forum for mutual support among researchers and other interested parties.

Approximately 20 websites have been reviewed that are at least partly dedicated to cold fusion promotion and information dissemination. The most significant websites as information sources for cold fusion policy analysis are reviewed below. Other websites of secondary interest (and not annotated) are listed further down in this section (subsection 3.2).

3.1 Primary Cold Fusion Websites, with Annotations

A total of about a dozen websites were annotated after being selected during the initial review. They are provided below in three parts: 1) name and website address (URL); 2) contents (primary webpages, including homepage); 3) annotations of principal contents in "bullet" form; and 4) significance of contained information for cold fusion policy analysis, generally as the last one to three bullets.

Copes of the homepages of the selected websites are included in Appendix A.

Author Unknown. *Weird Science: Cold Fusion Links*.. Online. Available: http://www.amasci.com/weird/wcf.html. Accessed: January 2006.

Contents

Webpage of "Weird Research, Anomalous Physics"
Has "Links to Articles", "Books" and "CF Websites" on the page

- "Cold Fusion is not normal fusion, so a more appropriate name for it is 'Low Energy Nuclear Reactions'" LENR, or 'Chemically-Assisted Nuclear Reactions,' CANR... or CMNS 'Condensed Matter Nuclear Science'"
- The links are particularly helpful; among the best collection available
- Links to other sites may be useful for cold fusion policy analysis

Biberian, Jean Paul, Editor-in-Chief. *International Society for Condensed Matter Nuclear Science*. Online. Available: http://www.iscmns.org. Accessed: January 2006.

Contents

Homepage
Membership
Search/Site Map
FAQ
News
Siena
ICCF12

- Motto: **Ardet nec consumitur** – "It burns but is not consumed"
- Recently formed (March 2004) professional organization to advance the cause of cold fusion (now named *Condensed Matter Nuclear Science)*
- Incorporated in England; has a Memorandum of Association and a full set of Articles of Organization
- The "FAQ" section is about the Society (ISCMNS) rather than about cold fusion
- The "News" section is embryonic and promises to be more significant with time
- "Siena" is a brief webpage on the "6th International Workshop on Anomalies in Hydrogen / Deuterium loaded Metals", which took place in Siena, Italy in May 2005
- "ICCF 12 " is on the "12th International Conference on Condensed Matter Nuclear Science", which occurred in Yokohama, Japan in November and December 2005; little of the substance of the conference is included, but an agenda and a link to the conference website are provided
- Overall the site appears to be embryonic and may be more useful in the future as the Society catches on and gains momentum
- Not a particularly useful site (at this time) for a policy analysis study of cold fusion

Britz, Dieter. *Dieter Britz's Cold Fusion Bibliography*. Online. Available: http://www.chem.au.dk/~db/fusion/. Accessed: January 2006.

Contents

Homepage: Chemistry Department, Aarhus University
General Information
FAQ
Remarks on recent additions
New stuff of the last 3 months or so
Bibliographies
Conferences
Unpublished collections (Vince Cate, Terry Bollinger)
Submission/Publication statistics
Related site links

- Britz is at Kemisk Institute, Aarhus University
- Cold fusion bibliography has several parts:
  * Books.
  * Articles published in journals; no patents, preprints or conferences here. This appears in the full form, including abstracts, and an abbreviated form with references and titles only. This rather large file is also provided, broken up alphabetically into 26 smaller files, to make downloading easier.
  * A bibliography, in a slightly different format, of Russian CNF literature, supplied by Dr. V. Filimonov of Belorussia. This largely overlaps the main journal articles bibliography, but I have not yet determined how much, and how many papers in it I have missed.
  * Patents
  * News, reports, comments in scientific magazine/journals (Nature, Science...)
  * Published articles peripheral to cold fusion (background facts etc)
  * Unpublished writings, preprints, supplied by Vincent Cate, and available from him and (18-Jul-91) a collection of palladium hydride references plus abstracts and annotations supplied by Terry Bollinger, and copyrighted by him.
- Extensive collection – "Current item counts, 28-Oct-05":

Books	28
Papers	1352
Comments	282
Patents	250
Peripherals	137
Conf-Procs	27

- A good starting point for cold fusion references; excellent collection, but mostly very technical articles
- Shows a sharp decline in the number of cold fusion publications in recent years
- Only one article in "New Stuff" webpage
- "Related Site Links" are few in number and not very useful
- Likely to be a useful resource for cold fusion policy analysis for surveys of published works

Cravens, Dennis, and Dennis Letts. *Clean Energy Research Group*. Online. Available: http://www.cerg.org. Accessed: January 2006.

Contents

Homepage
Experimental Approach
Facilities
Discussion and FAQ
Publications
Links
Contact Us

- Experimental Approach: "The primary methodologies we have focused on includes a materials stimulation environment and a nanotechnology related focus using:"
  - Improved Isoperibolic & Calorimetric Approaches
  - Investigation of low power Laser based stimulation of LENR
  - Investigation of Lightwater Plasma based LENR
  - Investigation of Electro-Magnetic stimulation of LENR
  - Investigation of RF Stimulation of LENR
  - Investigation of Chemically Assisted Stimulation of LENR
  - Spectroscopic Surface Studies
- Facilities in Cloudcroft, NM and Austin, TX
- "Discussion" only has links to LENR-CANR and Hagelsteins's "Cold Fusion" on-line journal
- "Publications" has articles by Letts and Cravens, and other articles as well, generally quite technical in nature
- "Links" has only a few, generally the most common, linkages
- See the following webpage for info on Letts: http://www.newenergytimes.com/Conversations/Letts.htm
- Website seems not to have been updated much in 2005; mostly 2004 and before material
- Mission:

  Clean Energy Research Group (CERG) is a private energy research and nanotechnology cooperative conducting basic research in the physics, chemistry and material science of LENR (Low Energy Nuclear Reactions), cold fusion(CF) and condensed matter nuclear science (CMNS). We are a group of academic, retired government & independent industry researchers who believe that LENR/CF in its variety of forms along with the theoretical science of CMNS can also provide important clues and new approaches in energy and materials science related nanotechnology research & development. We believe that someday harnessing LENR/CF will provide a source of reliable energy.
- Not (yet) particularly useful to policy analysis for cold fusion; seems to be generally dated and does not live up to potential

George, Russ. *D2Fusion, Inc*. Online. Available: http:// www.d2fusion.com. Accessed: January 2006.

Contents

Homepage
Mission
Science
Finance
In the Media
Team
Positions
Newsletters
Educational Site

- Appears to be the website of a commercial applications firm headed by Russ George
- Is a wholly-owned subsidiary of Solar Energy Limited of Vancouver, BC
- Mission:
  "In the firm belief that understanding and practically exploiting the mechanisms of solid-state fusion will benefit all humanity, D2Fusion, Inc. is committed to developing and delivering practical solid-state fusion energy applications that will both help rescue the planet and provide premier investment opportunities."
- Vision: To fulfill this mission, D2Fusion Inc. is designed and determined:
  - To become the most effective champion of solid state fusion physics, pioneer its rapid exploitation in practical technologies, and engineer marketable applications to immediately benefit society and the environment;
  - To closely cooperate with leading international science and engineering organizations to accelerate methodological insights, technical breakthroughs and commercialized technologies in the field;
  - To grow and maintain a highly committed, collaborative and diversely talented professional team to support our global goals and activities;
  - To craft market strategies for our prototypes, technologies, expertise and intellectual property that maximize their societal diffusion, ecological benefits and return on investment.
- Seems not to have been kept very up to date
- “Educational Site” contains useful information
- “Team” describes the apparently highly credentialed members of the company
- Otherwise not a very useful site for cold fusion policy analysis

Hagelstein, Peter, Editor-in-Chief. *Condensed Matter Nuclear Science*. Online. Available: http://www.rle.mit.edu/phagelstein/. Accessed: January 2006

Contents (all on one page)

- Journal Scope: "The journal *Condensed Matter Nuclear Science* accepts scientific papers of high quality that are concerned with subjects including and relating to nuclear processes in a condensed matter environment. Papers may focus on the results of experimental studies, theoretical studies, or a combination of experiment and theory."
- "Topics that are of particular interest at present to the community to which the journal is addressed include:"
  - Temperature increases, power and energy production in metal hydrides and deuterides; calorimetry relevant to such experiments
  - Correlations, or lack of correlations, between energy production and possible nuclear products
  - Materials science issues that are important for the development of nuclear effects in condensed matter
  - Electrochemical issues concerning loading, surface chemistry, resistance diagnostics and other issues concerning metal hydrides and metal deuterides that relate to anomalies
  - Observations of low-level dd-fusion reaction products in metal deuterides
  - Charged-particle emission from metal hydrides and deuterides
  - X-ray and gamma emission from metal hydrides and deuterides
  - Tritium production in metal hydride and metal deuterides
  - Production of new elements or isotopes in metal hydrides and metal deuterides; and modification of the associated isotopic distributions
  - Induced radioactivity in metal deuterides and metal hydrides
  - Accelerator experiments on metal deuterides and metal hydrides that pertain to screening and the anomalies
  - Screening between nuclei in the condensed matter environment
  - Models for nuclear processes in the condensed matter environment
  - Other topics considered to be of interest to the community
- Associate Editors
  - North America: Dr. Michael McKubre, Director, Energy Research Center, SRI, Menlo Park, CA; Professor George Miley, Nuclear Engineering Department, University of Illinois at Urbana-Champaign, Urbana, IL; Dr. Edmund Storms, retired. Former of Los Alamos National Laboratory
  - Europe: Dr. Francesco Scaramuzzi, retired. Formerly of Centro Ricerche Frascati, Italy; Professor Jean Paul Biberian, Physics Department, University Aix-Marsielle, France
  - Asia: Professor Akito Takahashi, Nuclear Engineering Department, Osaka University, Osaka, Japan; Professor Xing Zhong Li, Physics Department, Tsinghua University, Beijing, China
- Appears to be a recently formed journal, with pro-cold-fusion editors
- Guidance on preparing professional papers is provided
- Papers are posted on a secure webpage requiring logon (papers@journal.site.)
- Without membership, it cannot be determined the content of the papers or their usefulness to a policy analysis on cold fusion; the topics described appear to be very technical

Kowalski, Ludwik. *Ludwik Kowalski's Cold Fusion Project*. Online. Available: http://blake.montclair.edu/~kowalskil/cf/00_project.html. Accessed: January 2006.

Contents

"About My 'Learn Cold Fusion' Project"
"Links to Cold Fusion Items"

- Kowalski is with the Montclair State University, Upper Montclair, N.J.
- The introductory page ("About….") provides background on the purpose and motivation for the website

  What follows is a set of items posted, more or less regularly, on that web site since October of 2002. The items reflect my own process of learning, mostly from articles published by cold fusion researchers. I am still not convinced that excess heat, discovered by Fleischmann and Pons, is real or that nuclear transmutations can occur at ordinary temperatures. But I do think that time is right for the second evaluation of the entire field. I do not believe that extraordinary findings of hundreds of researchers are products of their imagination or fraud. Our scientific establishment should treat cold fusion in the same way in which any other area is treated. Those who study cold fusion do not appear to be pseudo-scientists or con artists. The items on my list are arranged in the order in which they were posted on my web site.
- Includes 274 "items" related to cold fusion and associated phenomena. Sampling:

  1) Introducing Cold Fusion to students.
  2) A typical "cold-fusion" setup.
  3) Three kinds of Cold fusion.
  4) Short biographies of three Cold Fusion Scientists.
  5) Aberration of the scientific methology.
  6) On dangers of "second hand" publishing.
  7) On Pathological Science (N-rays story).
  8) On Burden of Proof in Science.
  9) Scientific Method in Cold Fusion.
  10) A Russian connection.
  11) Bottom Line.
  12) What do physics teachers think about CF?
  13) More about the Russian Connection.
  14) What is pseudo-scientific in this?
  15) Or what is pseudo-scientific in this?
  16) Here is an example of real pseudo-science.
  17) An Italian connection.
  18) Nobel Prize for "cold fusion?"
  19) A French connection.
- A thorough search of all 274 items may turn up information that is useful for a cold fusion policy analysis

Krivit, Mark. *New Energy Times*. Online. Available: http://www.newenergytimes.com. Accessed: January 2006

Contents

Homepage
News
Conferences
Conversations
Links
Donate
About

- Probably the ”premier” website on cold fusion, set up and managed by Steven Krivit, trial attorney (very articulate in film clip of cold fusion presentation)
- “Original reporting on research in the field of leading-edge energy and power technologies, with an emphasis on cold fusion.”
- Homepage has five (5) major sections, each with linked subcategories
  - Cold Fusion Information. For the: General Public; Those with a Science Background; General Media; Science Journalists; Science Students and Teachers (quite a bit of overlap of articles, etc. in the categories)
  - Special Collections. Lectures, Interviews and Commentary; News and Past Newsletters; Conferences and Cold Fusion Sessions; Myths and Reviews Misunderstandings; U.S. Department of Energy Cold Fusion
  - Upcoming Events (see “Conferences” webpage)
  - Free “New Energy Times” newsletter
  - Advertisement for Stephen Krivit’s “The Rebirth of Cold Fusion”
- “News” webpage has back issues of “New Energy Times”
- “Conferences” has about a dozen past and upcoming conferences, with links.
- “Conversations” has about 20 documentations of interviews with and presentations by Steven Krivit
- “Links” has one of the best guides to other websites anywhere
- “Donate” gives information on where to send contributions to the New Energy Institute, Steven Krivit, Executive Director
- “About” has the following mission statement, as well as a biography of Krivit, a listing of the Board of Advisors, list of projects, brief intro on cold fusion, and “Appearances.”

  The mission of New Energy Institute is to provide accurate and responsible news and analysis through the New Energy Times[tm] Web site and newsletter and provide the public with educational resources to facilitate the progress of new, sustainable and environmentally friendly energy sources.

  Its primary focus is the field of new energy, including cold fusion, also known as condensed matter nuclear science. New Energy Institute seeks to advance the development and application of clean energy, accessible and affordable for everyone.

  In order to remain a neutral, unbiased and impartial source of news and analysis, New Energy Times[tm] and New Energy Institute Inc. do not conduct their own scientific research, do not invest in or maintain ownership in any of the companies or technologies they report on, and do not try to acquire any intellectual property rights in the field.
- One of the primary websites for cold fusion policy analysis; is openly favorable in it’s approach to the phenomenon. Krivit is one of the foremost cold fusion “champions”

Mallove, Eugene. *Infinite Energy Magazine*. Online. Available: http://www.infinite-energy.com. Accessed: January 2006.

Contents

- One of the leading websites for promotion of cold fusion and related phenomena
- Apparently started by Eugene Mallove, who was murdered in 2004, and continued by others
- Includes other alternative energy source material, but main focus is on cold fusion
- Self-description of New Energy Foundation, Inc.

  New Energy Foundation, Inc. (NEF) is a non-profit corporation based in the State of New Hampshire. It is approved by the IRS as a 501c3 public charity corporation, therefore contributions to it are tax deductible. NEF publishes *Infinite Energy*: The Magazine of New Energy Technology, which has been in operation since early 1995. NEF also runs a testing laboratory, New Energy Research Laboratory (NERL), to verify or reject claims of anomalous performance in particular energy-producing devices brought to its attention. New Energy is the term applied to new sources of energy that are currently not recognized as feasible by the "scientific establishment," but for which overwhelming and compelling evidence exists in at least three categories:

  1. New hydrogen physics (a.k.a. "cold fusion," more generally Low-Energy Nuclear Reactions or LENR, "hydrino" physics, and other water-based energy sources).

  2. Vacuum energy, Zero Point Energy or "ZPE," Aether energy, or Space energy— descriptions of vast energy sources from the vacuum state.

  3. Environmental energy, *i.e.* energy from sensible thermal energy (in particular, energy of molecular motion), through significant extensions to the Second Law of Thermodynamics.

  NEF also has a grant-awarding function. It dispenses to outside researchers and developers carefully targeted research and development funding grants from NEF's reserves of charitable contributions.
- Primary activity is publication of “New Energy Magazine”, which is available free by subscription

  Infinite Energy Magazine has been in publication since March 1995. It is a technical magazine with editorial outreach to the general public as well. To maintain the highest editorial standards, it is written and edited by scientists, engineers, and expert journalists. It is aimed at pioneering scientists, engineers, industrialists, environmentalists, and investors who are concerned about an exciting R&D area that we believe will change the world dramatically. Infinite Energy is circulated around the world to over 40 countries. And, Infinite Energy is distributed to newsstands in the U.S. and Canada
- Although having a “New Age” component, an extremely valuable source of information of cold fusion and related phenomena
- A very important source of information to support a cold fusion policy analysis

O'Leary, Brian, et al. *New Energy Movement*. Online. Available: http://www.newenergymovement.org. Accessed: January 2006.

Contents

Homepage
The Movement
New Energy
Our Team
Conferences
Knowledge
Resources

- Concept (from Homepage):

  New Energy Movement is the public face of a growing scientific and ethical renaissance that represents the end of unsustainable energy practices. We are an outgrowth of the now century-old insight that energy is not the limited quantity much of orthodox physics assumes it to be. Our efforts are geared toward educating the public and governments alike as to the nature and practical application of new energy principles and technology. New Energy Movement envisions itself being a clearing-house and repository of leading-edge research, as well as a hub for social activism necessary to the introduction of new energy innovations.
- Initiated August 31, 2005
- Interests represented go far beyond cold fusion
- Not a great deal is present on cold fusion specifically
- Has a strong New Age overtone
- "Knowledge" is primarily statements of O'Leary (former astronaut) and other Directors
- Similarly for "Conferences"
- Appears to have little content of substance that would be useful to a cold fusion policy analysis

Rothwell, Jed. *LENR-CANR (for Low Energy Nuclear Reactions – Chemically Assisted Low Energy Nuclear Reactions)*. Online. Available: http://www.lenr-canr.org. Accessed: January 2006.

Contents

Homepage
Introduction to LENR-CANR
News, Links, Download Tally
A Look at Experiments
Special Collections
Library Guide, Downloadable indexes
Library

- Primary feature is the extensive online library of cold fusion technical papers and other resources – over 3000 entries in the database – the best available anywhere.

  This site features a library of papers on LENR, Low Energy Nuclear Reactions, also known as Cold Fusion. (CANR, Chemically Assisted Nuclear Reactions, is another term for this phenomenon.) It features a library of more than 400 original scientific papers in Acrobat format, reprinted with permission from the authors and publishers. The papers are linked to a bibliography of over 3,000 journal papers, news articles and books about LENR.
- Homepage also provides three free books and short articles
  - A Student's Guide to Cold Fusion
  - Cold Fusion for Dummies
  - Cold Fusion and The Future
- "Introduction to LENR-CANR" has sections as follows:
  - A Student's Guide to Cold Fusion (start of text), by Ed Storms
  - "It Started in 1989….", by Peter Hagelstein
  - Cold Fusion: What Is It?
  - A Science Tutorial
  - Technical Introduction to LENR-CANR
- "News, Links, Download Tally" includes articles from the press (most unfavorable) and associated responses. Most recently an article by Bethann Kevles
- "A Look at Experiments" provides a number of photos, including cold fusion cells, related to the topic
- "Special Collections" includes materials related to the 2004 U.S. DOE review of cold fusion, proceedings of ICCF conferences up to ICC
- "Library Guide, Downloadable Indexes":

  This section contains a guide to the library, and some simple, downloadable indexes — copies of our bibliography that you can store on your disk and consult anytime, even when you are not connected to the Internet. These are single, stand alone HTML documents, without attachments or graphic images.
- Library Example (more than 3000 entries)

  Adamenko, S. and V. Vysotskii. *Experimental Observation And A Possible Way To The Creation Of Anomalous Isotopes And Stable Superheavy Nuclei Via The Electron-Nucleus Collapse*. In *Tenth International Conference on Cold Fusion*. 2003. Cambridge, MA: LENR-CANR.org.
- Primary significance to a cold fusion policy analysis study is the extensive database of online references – readily available for download at no cost

Storms, Edmund. *Edmund Storms' Cold Fusion Website*.. Online. Available: http://home.netcom.com/~storms2. Accessed: January 2006.

Contents

Homepage
Photo Page
Papers by Storms
An Editorial
E-Mail Me At
A Modern Fairy Tale (dead page)

- Website has excellent information on cold fusion in general from a proponent's viewpoint
  This site is designed to keep you informed about the latest research done on Cold Fusion (CANR) by Dr. Edmund Storms.
- Storms Biography
  Edmund Storms obtained a Ph.D. in radiochemistry from Washington University (St. Louis) and is retired from the Los Alamos National Laboratory after thirty-four years of service. His work there involved basic research in the field of high temperature chemistry as applied to materials used in nuclear power and propulsion reactors, including studies of the "cold fusion" effect. Over seventy reviewed publications and monographs resulted from this work as well as several books, all describing an assortment of material properties. He presently lives in Santa Fe where he is investigating the "cold fusion" effect in his own laboratory. These studies have resulted in sixteen presentations to various conferences including the ACS and APS. In addition, twenty-one papers have been published including three complete scientific reviews of the field, one published in 1991, another in 1996 and the latest one in 1998. A critical evaluation of the Pons-Fleichmann Effect was published in 2000. In May 1993, he was invited to testify before a congressional committee about the "cold fusion" effect. In 1998, Wired magazine honored him as one of 25 people who are making significant contributions to new ideas.
- "Articles" on Homepage has many links to other papers and websites with cold fusion information
- "Photo Page" has excellent pictures of cold fusion electrochemical cells – best seen anywhere
- "Papers by Storms" includes many prior to his interest in cold fusion
- "An Editorial" is an excellent summary of the point of view of cold fusion proponents in the face of the marginalization of their field – "When Will We Learn to Listen?"
- Overall, a good source for policy analysis of cold fusion for beginners in the field, with good links to more advanced sources

3.2 Cold Fusion Websites of Secondary Interest (without Annotations)

Cravens, Dennis. *Dennis Cravens' Homepage*. Online. Available: http://www.netmdc.com/%7Ephysics/. Accessed: January 2006.

Kozima, Hideo. *Cold Fusion Research Laboratory*. Online. Available: http://web.pdx.edu/~pdx00210/. Accessed: January 2006.

Author. *Alternative Energy Institute*. Online. Available: http:// www.altenergy.org. Accessed: January 2006.

Author. *EarthTech International, Inc*. Online. Available: http:// www.earthtech.org. Accessed: January 2006.

4 Conclusion: A Re-evaluation of Cold Fusion Based on Sound Policy Analysis Is Needed

When considered in total and from a high-level viewpoint, the references and websites reviewed and annotated clearly indicate a strong need for re-evaluation of cold fusion both as a major new scientific research area and as a potential source of very low cost energy to meet society's needs. The following observations appear to be particularly relevant:

- Many mistakes were made by both proponents and skeptics in the 1989 announcement and the following weeks.
- These mistakes potentially (or likely) resulted in a premature negative judgment of cold fusion on the part of "mainstream science" (and, consequently, policymakers and the general public).
- Notwithstanding its highly marginalized state, cold fusion has continued to be the subject of high quality research by reputable scientists who disagree with the negative judgment.
- The continued research has resulted in findings of excess heat by many researchers working with a variety of materials and experimental approaches and in different laboratory settings.
- Excess or anomalous heat is the primary experimental finding of research to date, and this finding, by itself, warrants a high level of research to determine the mechanism of its generation and the development of a sound theoretical explanation.
- The primary mechanism of heat generation appears to be the fusion of two deuterons to form helium-4 plus heat that is transferred to the host material ($D + D \rightarrow {}^{4}He$ + heat)
- The above reaction is by far the least common among the three "branching ratios" seen in hot fusion, and the excess energy is released in hot fusion not as heat but as a gamma ray that is emitted without interacting with the host.
- The excess heat is apparently generated in cold fusion without the harmful radiation or nuclear products, that is seen in hot fusion.
- Cold fusion warrants research support not only for its potential as a new source of energy but also intrinsically as an exciting new area of scientific investigation
- Since becoming marginalized, cold fusion has become associated with or attracted other far less likely (or impossible, in violation of the laws of thermodynamics) low-cost or unlimited energy schemes.

- Because of the affiliation of cold fusion with even less legitimate areas of pseudo-science, it can be difficult, especially for non-technical persons, to "separate the wheat from the chaff" among articles and, especially, websites.

- Cold fusion marginalization is manifested in denial of funding from conventional energy research sources, failure to be recognized as a legitimate research area for graduate students (and resulting denial of research labor), and rejection of publications by mainstream peer-reviewed journals.

- Because it is neither "fully alive" and a part of mainstream science, nor "fully dead" in a way similar to fully discredited and inactive phenomena (e.g., N-rays, polywater), cold fusion is accurately portrayed as "undead science" in the sociology of science.

The principal conclusion of the bibliographic and website review is that a new evaluation is needed that both incorporates the most recent information and employs a broader, more effective method and set of evaluators. A policy analysis study is proposed as the best approach for the re-evaluation of cold fusion.

5 Library of Resources

Most of the resources reviewed in this paper have been collected in hard-copy form and, except for bound books, as electronic files. Approximately 15 to 20 bound volumes have been collected, and the remaining references are generally printed on 8.5 x 11 paper and filed in manila folders. Most of the latter references are also provided as PDF electronic files that are readily read by Adobe Reader, which is provided free to the public. A few of the references exist only as photocopies from the original book or paper (in part or in whole.)

The shorthand naming convention for both the bound books and the references in the manila folders is the lead author (or all authors) followed by the year of publication. In general, a second line on the manila folder tabs is included, with the first words of the title of the article to allow ready identification of the resource. Where an author has more than one publication in a year, the letters a, b, c, etc. are used after the year, in the order that they were discovered in the literature search.

Appendix A. Homepages of Annotated Websites

The homepages of websites selected for annotation in Section 3.1 of this report are provided in this appendix. These homepages are included to familiarize those conducting a cold fusion policy analysis in the future with the internet resources available to support the analysis. Approximately a dozen websites were selected for annotation and are included in this collection of homepages.