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From LENR-Effects Towards a Product

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Abstract

A prototype for heating a single-family home based on Low-Energy Nuclear Reactions (LENR) was implemented in Austria in 2012 and operated for approximately two months. It achieved a thermal output of up to 20 kW with a reported coefficient of performance (COP) between 20 and 50. The inventor, Hans Peter Bierbaumer—an engineer whose career began at CERN and who received an honorary doctorate for his achievements—died in 2012 before he could publish any scientific papers. According to his investors, the related documents and materials have been lost. The author, a former executive manager for R&D, supported and monitored the develop¬ment at a high level. The measurements were performed using standard energy measurement equipment. The radiation was monitored. Helium was detected. The professional research-oriented methodology and demonstrations of the test setups and the prototype were convincing. The effect of excess energy was discovered in experiments for hydrogen production using pulsed electrolysis. The underlying physical principle of operation remained unclear during development. Many details regarding the generation of excess heat were deliberately omitted from the relevant patents. Current theoretical analyses suggest a LENR effect due to resonances. This is a point of ongoing research. This paper describes the demonstrator and derives product-relevant system requirements for LENR heating systems. It outlines Transmutation Energy's research program for clarifying the theoretical basis of the effect. This should enable the development of a maintenance-friendly and certifiable LENR heating system.

Keywords: : LENR, Commercial Power Measurements, Pulsed Electrolysis, Hydrogen/Oxygen Recombination, Super Heat Pump, Prototype Replication, Heating System Product Requirements.

Introduction

Low-energy nuclear reactions (LENRs) exhibit physical phenomena under specific excitation conditions, materials, and electrochemical environments, resulting in the creation of atomic nuclei that did not exist before and the release of heat. Early inventions are not taken seriously [1]. These physical reactions are not "hot fusion at room temperature." A key engineering challenge for the research community is the transition from laboratory observations of these effects to controllable, operational, and certifiable systems that perform predictably over time, which is difficult [2,3].

In 2012, a LENR heating system was installed in a single-family home in Austria. This prototype heated the house for two months before the cathode was exhausted. The prototype achieved a thermal output of up to 20 kW and generated 20 to 50 times the electrical power input as heat output, according to a writing from the inventor. Therefore, the system can be described as a "Super Heat Pump" (SHP). The LENR Energy Source receives a mixture of high-frequency electrical pulses from the SHP Control. Thanks to LENR, this yields significantly more H2 and O2 than electrolysis alone. The H_2 and O_2 recombine in the primary fluid circuit, partly in the SHP and partly in a small hydrolyzer. The electrical input power also includes the power for the primary circulation pump. A heat exchanger thermally connects the radiator circuit to the primary fluid circuit, which contains the LENR energy source for the heating system. The heating system includes pumps, degassing, heat measurement, and pulse- and control- electronics, see Fig. 1.

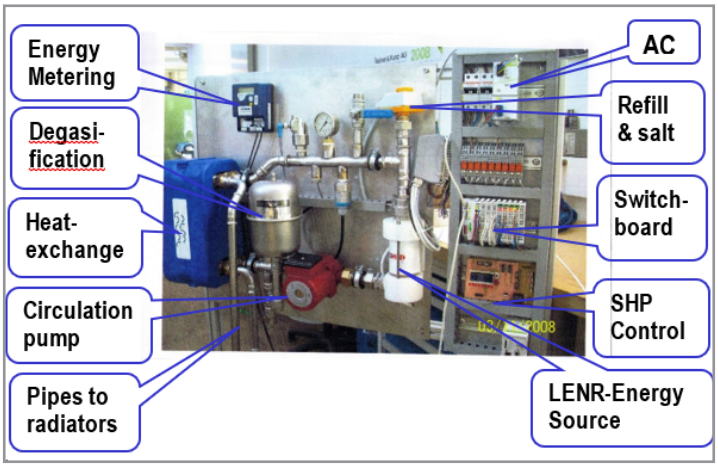

Figure 1: Demonstrator in the Laboratory of Hydrogen Research from Mr. Bierbaumer

The inventor, Hans Peter Bierbaumer (career start at CERN, magnet work; later awarded an honorary doctorate for his achievements), passed away in August 2012 before publishing the decisive practical details, and the relevant documents and materials are reported lost.

The demonstrator was built from standardized industrial components, except for the LENR energy source (white) and the SHP Control-specific electronics. The fluid in the primary heating circle is alkaline with a pH of approximately 8. The recombination unit for H2 and O2 is small and not explicitly shown. The required recombination molar flow for 20 kW equals 0.07 mol/s of H2. This corresponds to a rather small device.

The most interesting component is the LENR-Energy-Source. How that apparatus was designed is described in Bierbaumer's patents [4]. (i) Energy Converting Device; EP1685276A1 and (ii) Device for Heating Fluid; WO2011/082441A2 together with K.Ph. Michaylowich. Phrases like "Over Unity" were avoided to ensure patent application acceptance, even though a COP of 33 is mentioned in the text. The patent intentionally omits details necessary for proper functioning, such as pulse frequencies. It consists of a cylindrical anode made of a metal and a round cathode made of a specific metal-ceramic. By experimenting with electric pulsing for the Condensed Plasmoid (CP), cathode material, and fluid doping, the best operating conditions will be analysed. The fluid moves from the bottom along a rotating path.

The Demonstrator was Designed to Fulfil the Following Requirements

First: the most important requirement is the ability to control the heat output from the LENR heating source. This eliminates a dedicated mixing valve in conventional oil or gas heating systems and is more energy-efficient.

Secondly: the service interval for a heating system must be more than one year. The system design must allow for easy maintenance and servicing, i.e., for replacing the cathodes and changing the fluid in the primary heating circle.

Thirdly: water is ideally suited for heat transfer due to its high heat capacity. That circulating through the radiators must be separate from the fluid in the primary heating circuit, but ther-mally coupled via a heat exchanger.

Fourthly: an effective control system requires comprehensive sensor technology: temperature sensors at the inlet and outlet of the primary and radiator circles, flow sensors for the primary circle, and pressure sensors for safe operating conditions.

Fifth: the materials for the cathode, anode, and primary liquid doping must be carefully selected: (i) to optimize electrode lifetime; (ii) to avoid neutron production and intense gamma radiation; (iii) to minimize chemical risks. This ensures an official type approval.

Sixth: the SHP control regulates the primary and secondary fluid circuits, the 3-way diverter valve with actuator for the boiler, and the LENR energy source.

Seventh: a system with remote monitoring offers advantages from a business perspective. This paves the way for a new type of regional energy supply operators or utility companies. This results in a triple win-win-win situation:

- Utilities for heat, gas, or electricity remain relevant in the evolving energy landscape.
- Homeowners benefit from continued trust in a known service provider.
- Manufacturers reduce sales overhead costs and achieve a strong sales channel with the service model

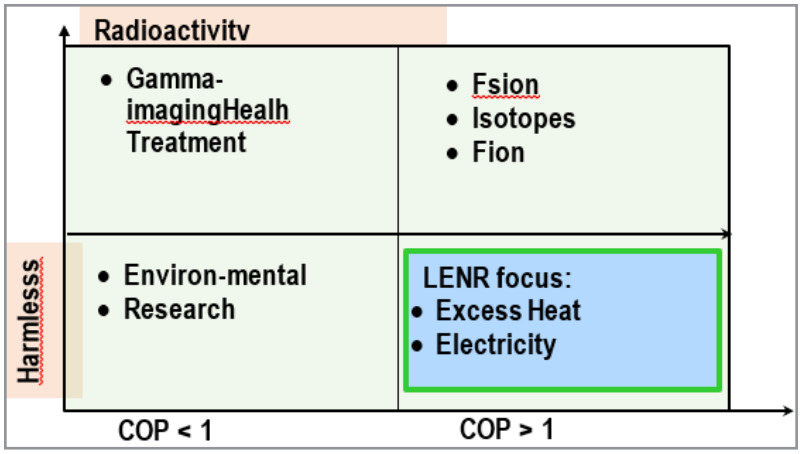

Figure 2: Classification of radioactivity and COP

These requirements can serve as a general guideline for any LENR-based product development, but they will vary depending on the purpose and market.

Nuclear reactions are usually linked to radioactivity. Therefore, the impact of radioactivity has to be considered in the development of any solution based on LERN. As a result of decades of fear-mongering against nuclear energy, politicians followed this opinion without considering scien¬tific facts. Some EU member states called on the European Commission to ban the financing of nuclear energy projects, including fusion energy. Other EU member states have prohibited the use of nuclear technologies, including LENR. Those political hurdles must be killed before any product reaches the market. Policies are ignoring that: (i) LENR produces no nuclear waste; (ii) our food includes C14, (iii) in some geographic regions, natural radioactivity exceeds the legally allowed limit in nuclear power plants.

We categorize these LENR effects by their Coefficient of Productivity (COP), distinguishing those with a COP below 1 from those above 1. Additionally, we compare the level of radio-activity with other applications, as either harmless or high. Although LENR aims for harmlessness, the term "nuclear" is often reflexively equated with the perceived risks of nuclear fission in EU policy. The Fusion Industry Association (FIA) success¬fully advocates for fusion energy and against anti-nuclear regulations at the EU level. Whether this will be sufficiently effective for LENR is uncertain. Similar to the Low Energy Nuclear Reaction Industrial Association (LENRIA) in the USA, there is no corresponding lobbying organization in Europe, although such an organization would be desirable.

High levels of radiation can be generated during experiments for LENR research and develop-ment. The author observed this with a gamma-ray detector during Mr. Bierbaumer's laboratory demonstration [5]. The signal was strong. Subsequently, different materials were used, resulting in harmless radioactivity. Radioactive or toxic waste must be avoided for LENR products in the civilian market. This requires careful material selection, considering potential transmutations into account.

Metal hydrides are a research focus for LENR. Transmutation Energy's R&D does not address metal hydrides. Metal hydrides play a key role in hydrogen storage. Under certain conditions, such as during electrolysis, LENRs can occur. This can lead to transmutation elements, with or without excess energy. For safety reasons, this would be worth investigating.

Methodology to Evaluate the Findings

The author, an inventor himself (97 patents), former executive head of research and development (3.000 MY), board member of a tiny but successful VC fund, provided high-level support and guidance to the inventor of the LENR heating system.

First: it quickly became clear that Dr. h.c. Hans-Peter Bierbaumer is a trustworthy and competent person who understands the importance of professional measurements and further developments.

Second: the discussion of the theory behind his approach quickly revealed that it involves a nuclear mechanism. How this mechanism functions at the level of nuclear physics was an open challenge in 2012 and remains partly open [6].

Based on this assessment, the author trusted the inventor, and several presentations confirmed his statements. Due to a lack of theoretical foundations in 2012 for the underlying physics, it was not possible to involve a professional venture capital fund.

The measurements focused on energy gain and radiation. At the measured energy levels, calorimetric measurements are unnecessary. Mr. Bierbaumer also demonstrated a welding torch with a flame fueled by hydrogen and oxygen generated by his LENR device. Unfortunately, no data were recorded for this welding torch. The gas in the gas-separator was analyzed at the AIT (Austrian Institute of Technology) in Seibersdorf. It contained Helium. Mr. Bierbaumer also collaborated with the AIT on other topics.

After Bierbaumer's death, the author reviewed the new literature on hydrogen production through electrolysis. A 2012 study published in India reported on water splitting using nanopulsed direct current [1]. In one instance, the released chemical energy exceeded the input electrical energy by an order of magnitude. Since a spark discharge between two electrodes acts like a short circuit, this finding was not perceived as suitable for large applications. Anyway, the effect used by Bierbaumer has at least one external reference.

Based on this evaluation, the author was convinced that a path forward for commercializing LENR is possible, although some theoretical challenges exist, and the results from Bierbaumer are correct.

Results

We compare the obtained results with the seven design requirements given in the introduction:

1. The fast control of the temperature in the primary fluid circle was demonstrated.
2. The Service Interval reached only 2 months. Thus, there was no readiness for the market entry.
3. The design separated the primary from the secondary fluid circle.
4. The SHP-control processed the input from the sensors and controlled the SHP-Energy-Source.
5. The chosen material avoided radioactivity, but was insufficient for the desired lifetime. Therefore, the chemical analysis of the primary fluid was not done.
6. The SHP-control operated as intended for the heat production.
7. The remote control and supervision of the LENR-Heating-System were demonstrated.

The second point proved to be a fatal flaw in an otherwise well-designed product. After Bierbaumer's death, his company, Hydrogen Research, went bankrupt. A devastating situation for his family and investors.

The author, accompanied by a close friend, visited the liquidator at the company headquarters to analyse the company's chances of survival. Hydrogen Research had prepared 14 heating systems for friends and investors who were awaiting an improved LENR-energy source. Its development was not yet complete, and the new concept had not been discussed with the author. The legal situation precluded collaboration with another investor. Unfortunately, further research, initiated by an initial investor and conducted with a Russian scientist, also failed.

Discussion

First and foremost, we owe our sincere thanks to Dr. h.c. Hans-Peter Bierbaumer for his courage and early commitment to an energy source that we now call LENR.

The Story Includes Several Lessons Learned for Successful Products in the Field of lenr

1. Team building is important for the survival of the company in case one of the key people drops out for whatever reason.
2. Before developing an excellent product, the most innovative core must be developed towards a long-life prototype. Otherwise, if the core has a fundamental defect, high fol¬low-up costs would become stranded costs.
3. The open research questions around LENR – there are still many – need strong

support at universities. There is no activity at any university in Germany, Austria, Switzerland, and some other countries in Europe. In contrast, the USA and Japan hold leading positions in research, followed by India and China. In Europe, France and Italy are at the forefront, followed by Poland.

In the last 100 years, several unexplained effects have been observed. An example in 1926 came from Friedrich Paneth, an Austrian chemist in Berlin. He observed Helium, generated by an exploding wire. He could not exclude a failure, and therefore, no further research was made. An important point brought up by Sakharov in 1948. If two deuterons form a molecule with Muons instead of electrons, they fuse. Alvarez conducted such an experiment in 1956 in Berkeley that confirmed Sakharov's calculation. The deuterons came as close to ≈ 256 fm in a muonized D2 molecule . The "cold" fusion of deuterons, however, is not the classic tunneling effect, which requires distances of less than 5 fm. Rather, it is a superposition of their matter waves, calculated using de Broglie and the Gamow factor for the superposition probability.

Pons and Fleischmann found a muon-free solution. This was difficult to reproduce. In the Indian neutron laboratory, only one of 2000 prepared palladium samples worked [5]. The reason for this is clear and not discussed herein. The term "cold fusion" contradicts the definition of hot nuclear fusion [11].

Instead of correcting the term and pursuing the correct question, main¬stream science suppressed these experiments and discredited the scientists. This blocked LENR research for a long time.

There is a Need for Further Analysis of the Theoretical Challenges

The principle of superpo¬sition of matter waves from atomic nuclei, as theoretically shown by Sakharov, applies to all LENRs. This raises the question of what effect brings the atomic nuclei so close together with¬out high energy? The author also received a hint long ago that what muons do could also happen with two electrons, only less frequently. Is this an effect of strong n-doping at the interface layers? If so, this could be important at the interface between metal surfaces and an ionized liquid, and between thin metal layers.

The design of the LENR Energy Source needs a range of theories to understand the physics behind the observed LENR. First, there is the Barrier Zone (BZ) for streaming water along a surface, i.e., the interface between metal and liquid, according to research in the Pollack Labor¬atory (https://www.pollacklab.org/research); Second, there is a Condensed Plasmoid at any short electric pulse, according to the research of Lutz Jaitner [8].

Considering the barrier zone (BZ) is physically crucial, as the interface can be viewed as an active quantum reactor. The BZ, as a hydrophilic surface, causes water molecules to arrange themselves hexagonally. This results in the BZ being negatively charged, while protons or deu-terons accumulate in the adjacent liquid. The BZ's entrances act like a highly ordered insulator with a high dielectric constant.

According to Lutz Jaitner's theory, electron condensation occurs when strong electrical pulses are sent through this boundary layer: The pulses eject electrons from the metal or the BZ. At the extreme field strength at the peaks of the surface roughness (nano-peaks), these electrons no longer form individual particles, but rather a coherent quantum object (the plasmoid). This plasmoid possesses an extremely high charge density. When this object penetrates the metal lattice (or the boundary layer), it can

massively shield the Coulomb barrier of the deuterons.
At a pH of 8 (slightly alkaline) and in the presence of heavy water, the condensed plasmoid acts as an attractor for the positive deuterons, drawing them into its canter. Within the plasmoid, the distance between the nuclei is reduced so drastically that the zero-point vibration, as described in Sakharov's theory, allows the wave functions to overlap.

Instead of metals for the cathode, the prototype used metal ceramics. Unlike metals, ceramics are often solid-state electrolytes. In addition to deuterons, the ions of the metal within would also be mobile and subject to the wave functions. This means that the "reactants" are distributed not only on the surface but throughout the entire volume of the material.

The underlying theory involves resonant frequencies. One frequency is related to the BZ in the form of phonons. Quantum vibrations in a material are considered in some LENR theories as a coupling mechanism that can increase D-D fusion rates and thus overcome decoherence times, enabling observable fusion events.

Another frequency encompasses the electrical impulses to the cathode, as well as their shape and amplitude. There is a dependency on the materials and doping of the fluid, particularly regarding cathode lifetime. Can nuclear reactions within the fluid extend the cathode lifetime?
The underlying theory we see now as a possible explanation for the surprising performance of Bierbaum's invention was unknown in 2012. The range of possible theoretical explanations and their importance for COP and lifetime are subjects of further research at Transmutation Energy. An important overview [9]. and an AI-based analysis [10]. will support rapid problem-solving. The direct generation of electrical energy via LENR [11]. and [12]. is of great interest, but it remains unclear whether this is even possible.

Many more items are subject to further research, but outside the interest of Transmutation Energy. One example is in biology [13]. why some organisms, including the human body, contain elements that were not ingested through food or respiration. This requires a nuclear mech-anism that creates such elements in living organisms. A first finding was that the coenzyme ATP (adenosine triphosphate) could create elements not otherwise present, due to the extremely rapid rotation of its eight protons.

Conclusion

A household heating demonstrator based on LENR was reportedly implemented in Austria in 2012, operating for two months with up to ~20 kW output and CoP 20–50, reaching a level where most system requirements for a product were already addressed, except for a long service interval. The inventor's death and the reported loss of documentation make reestablishment the central task. This paper reframes the surviving information into product-relevant requirements and a constructive validation-and-development program. Understanding the range of theories behind the solution in 2012 seems possible today, although a few details need further analysis. Supported by the author's high-level involvement and professional R&D assessment that a working principle existed, Transmutation Energy positions the next phase as a focused replication and engineering effort aimed at controllability, maintainability, long service inter¬vals, and certification-compatible safety.

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