Lattice Energy LLC

Commercializing a Next-Generation Source of Safe Nuclear Energy

Low Energy Nuclear Reactions (LENRs):

Not fusion (hot, cold, warm, or otherwise)

Not heavy element fission

Uses clean, safe, low cost

weak interactions

"Energy, broadly defined, has become the most important geostrategic and geoeconomic challenge of our time."

Thomas Friedman
New York Times, April 28, 2006

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Company specifically created to commercialize LENRs

- Lattice Energy LLC is a privately-held limited liability company started in 2001; only private sector funding so far
- Headquarters in Chicago, Illinois, USA
- Commercializing LENR technology, initially for small portable and kW-scale backup power generation applications
- With additional funding to be raised in 2009, plans to establish independent laboratory facilities and develop integrated proof-of-concept prototypes within 2 – 3 years
- Plans to ship first commercial products within 3 – 5 years, with assistance of strategic partners and additional funding

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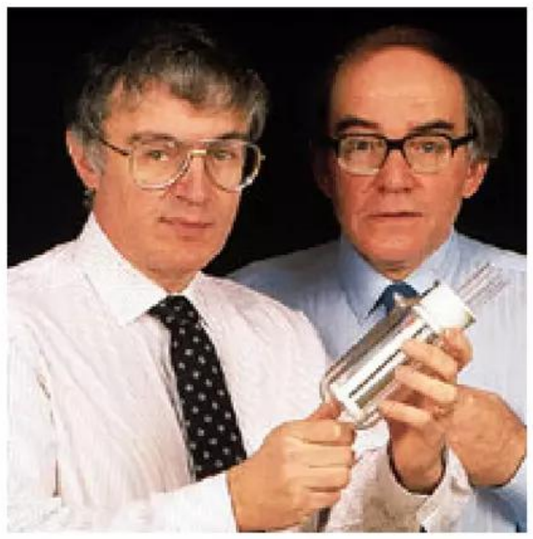
Does 'green' nuclear energy exist?

- Yes, it does exist and is called Low Energy Nuclear Reactions or LENRs
- LENRs are a truly 'green' next generation source of safe, low cost nuclear energy
- Controversial field of physical science - little current coverage in popular media, scientific press, and majority of mainstream scientific journals

So-called "star in a jar"

- LENRs mistakenly thought to be "cold fusion" after notorious news conference at Univ. of Utah in 1989
- Major 20-year scientific controversy began there …
- And ends here – Lattice believes that it has the answers to key theoretical and technical questions
- Using known physics, Widom-Larsen developed a new theory of LENRs that shows how non-fusion nuclear processes can occur in ordinary chemical cells



Profs. Pons and Fleischmann holding a "cold fusion" cell – Univ. of Utah ca. 1989

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Commercializing LENRs for use in many applications

Company's business goal is to commercialize LENR-based integrated power generation systems for a broad range of market applications:

- **Lattice's unique understanding of LENRs should enable the development of safe, revolutionary nuclear power sources, initially for use in distributed power generation applications, including small battery-like devices for portable electronics**

- **Lattice's proprietary breakthroughs should result in a radically new nuclear power generation technology, based on environmentally friendly weak interactions, not strong interaction fission or fusion**

- **LENR-based power sources could potentially have substantial competitive advantages in energy density, longevity, and cost/kWh over system duty cycle compared to chemically-based batteries, fuel cells, and fossil fuel microgenerators**

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LENRs potentially much less expensive than fission/fusion

- If successfully commercialized, LENR-based integrated power generation systems could potentially have vastly lower intrinsic costs than current fission or future fusion power technologies because they:
  - Also produce large, controllable quantities of heat for long periods
  - Have no risk of runaway chain reactions as in some fission reactor designs; no need for expensive control systems
  - Need little or no shielding – no 'hard' gamma or neutron radiation issues
  - Have no major costs associated with removal and processing of long-lived radioactive waste products (unlike fission, LENRs do not produce any)
  - Use fuels comprising stable elements (e.g. Nickel, Titanium, Lithium) and ordinary hydrogen or deuterium – do not use expensive radioactive fuels
  - Can be integrated with a variety of scalable, off-the-shelf energy conversion technologies (e.g. thermoelectrics, thermionics, Stirling engines, small steam engines) to create safe, low cost, compact nuclear power reactors

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New funding can leverage unique technical breakthroughs

- **Widom-Larsen developed initial body of breakthrough theoretical work that for the first time explains all major features of LENR-related phenomena**

- **Related unpublished proprietary technical breakthroughs and insights should enable Lattice to solve enormous experimental reproducibility and device fabrication problems that plagued R&D in LENRs for 20 years**

- **Thanks to its unique proprietary understanding of LENRs, and unlike other competitors currently in the field, Lattice is now ready to begin preliminary engineering work aimed toward creating 'breadboard' prototype systems**

- **Competitors still struggling to understand basic science issues**

- **Will use proceeds of next round of funding to aggressively leverage proprietary technical insights and accelerate internal R&D&E programs**

- **Given adequate financial resources, planned time-to-market for company's first commercial products might be much less than any competitor's**

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Major theoretical breakthroughs in understanding LENRs

- Lattice achieved series of major theoretical breakthroughs which provide clear understanding of mechanisms underlying a large body of previously unexplained experimental anomalies dating back to 1880s

- These breakthroughs have become known as the Widom-Larsen theory of LENRs - now expanding its scope beyond chemical cells and exploding wires into other related areas of physics, including astrophysics and high energies

- First publicly released theoretical paper published in highly respected, peer reviewed scientific journal – *European Physical Journal C*

- W-L discovered weak interactions are key mechanism in condensed matter LENRs, not strong interaction fusion or heavy element fission

- Showed that LENRs are not "cold fusion" and never were; unlike "cold fusion" theories, W-L theory does not violate accepted laws of physics

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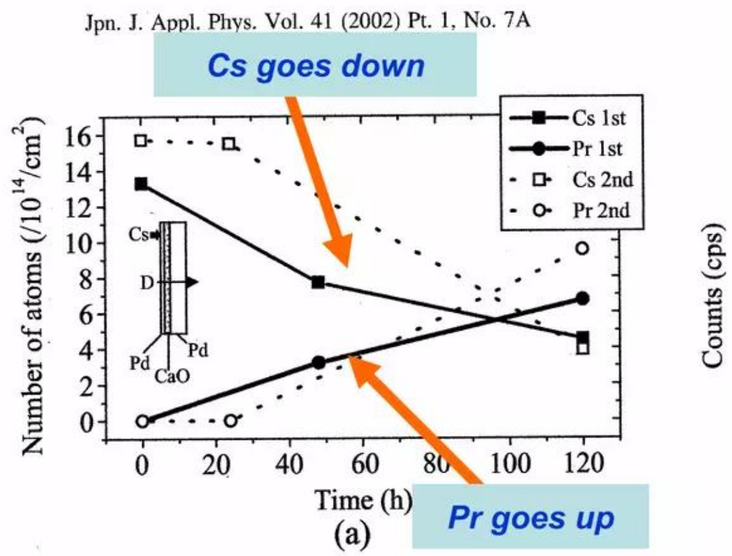
Widom-Larsen initially studied previous work on LENRS

- After carefully studying hundreds of conference papers, it was clear that many LENR researchers were essentially correct about certain types of frequently observed anomalies seen in well-executed experiments conducted since 1989 (e.g., Helium-4, nuclear transmutations, heat)
- Unfortunately, LENR researchers' strong interaction D-D fusion paradigm appeared to be incorrect, misguiding experiments --- Lattice-supported experimental work did not suggest that any fusion was taking place in such systems; quite the opposite, neutron captures implicated
- Other theoretical work used questionable physics, could not calculate anything experimentally significant, and was clearly wrong about D-D fusion being dominant process
- Widom-Larsen determined that the proper theoretical framework for understanding LENRs involved weak interactions and collective effects in condensed matter
- W-L also found that LENR phenomena did not just begin with Pons & Fleischmann in 1989; uncovered evidence that LENR effects seen experimentally far back as 1880s

Iwamura et al, Advanced Technology Research Center, Mitsubishi Heavy Industries, "Elemental Analyses of Pd Complexes: Effects of D2 Gas Permeation" , Japanese Journal of Applied Physics 41 (July 2002) pp. 4642

Widom-Larsen theory of LENRs can easily explain these experimental results



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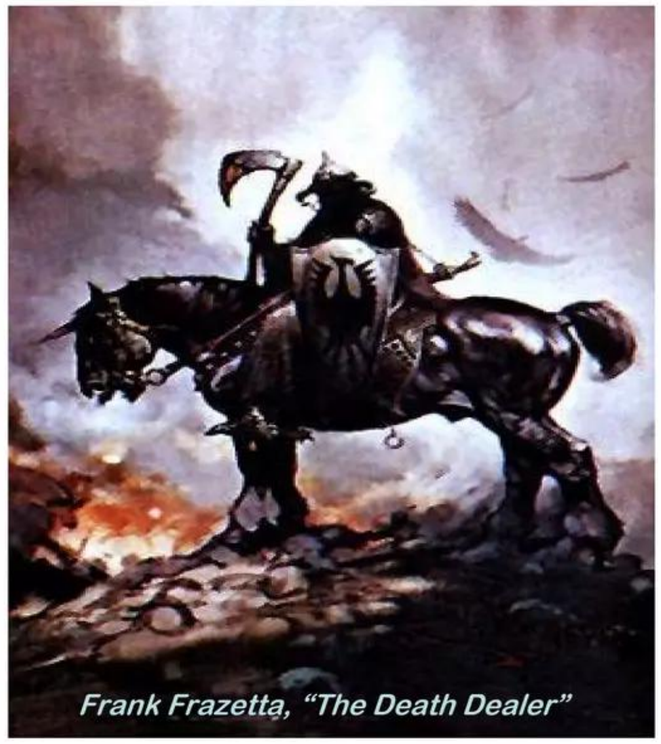
W-L weak interactions can explain unique features of LENRs

- **Since 1989, most previously proposed theories of LENRs presumed that Coulomb barrier-penetrating D-D fusion was taking place in LENRs. However, these earlier theories incorporated many ad hoc assumptions, invoked questionable "new physics," and were readily dismissed by mainstream physicists**

- **Prior to work of Widom-Larsen, no comprehensive theory of LENRs existed that was: consistent with known physics and could explain results of heavy and light water experiments and identify the cause of complex transmutations and able to calculate observed reaction rates; only theory able to explain Prof. John Huizenga's "three miracles" in highly critical 1993 book**

- **Our theoretical work involves Standard Model weak interactions and collective effects - explains all good experimental data on LENRs, esp. absence of hard gamma radiation and long-lived radioactive waste; predicts new experimentally verifiable phenomena**

According to accepted knowledge about nuclear fusion processes, many LENR researchers should have been killed by large fluxes of energetic neutrons and hard radiation that should have been commensurate with the excess heat that they observed. Yet they live!



Frank Frazetta, "The Death Dealer"

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Widom-Larsen theory – seven papers publicly released

- **Beginning in May 2005, Lattice has publicly released seven papers on selected non-proprietary basic science aspects of our theory of LENRs:**
  - ✓ "*Ultra Low Momentum Neutron Catalyzed Nuclear Reactions on Metallic Hydride Surfaces*", Eur. Phys. J. C 46, 107 (2006 – arXiv in May 2005) Widom and Larsen
  - ✓ "*Absorption of Nuclear Gamma Radiation by Heavy Electrons on Metallic Hydride Surfaces*" arXiv:cond-mat/0509269 *(Sept 2005)* Widom and Larsen
  - ✓ "*Nuclear Abundances in Metallic Hydride Electrodes of Electrolytic Chemical Cells*" arXiv:cond-mat/0602472 *(Feb 2006)* Widom and Larsen
  - ✓ "*Theoretical Standard Model Rates of Proton to Neutron Conversions Near Metallic Hydride Surfaces*" arXiv:nucl-th/0608059v2 (Sep 2007) Widom and Larsen
  - ✓ "*Energetic Electrons and Nuclear Transmutations in Exploding Wires*" arXiv:nucl-th/0709.1222 (Sept 2007) Widom, Srivastava, and Larsen
  - ✓ "*High Energy Particles in the Solar Corona*" arXiv:nucl-th/0804.2647 (April 2008) Widom, Srivastava, and Larsen
  - ✓ "*A Primer for Electro-Weak Induced Low Energy Nuclear Reactions*" arXiv:gen-ph/0810.0159v1 (Oct 2008) Srivastava, Widom, and Larsen

"When a new truth enters the world, the first stage of reaction to it is ridicule, the second stage is violent opposition, and in the third stage, that truth comes to be regarded as self-evident." - ***Arthur Schopenhauer, 1800s***

"[New] Theories have four stages of acceptance:
i) this is worthless nonsense;
ii) this is an interesting, but perverse, point of view.
iii) this is true but quite unimportant.
iv) I always said so."
- J.B.S. Haldane, 1963

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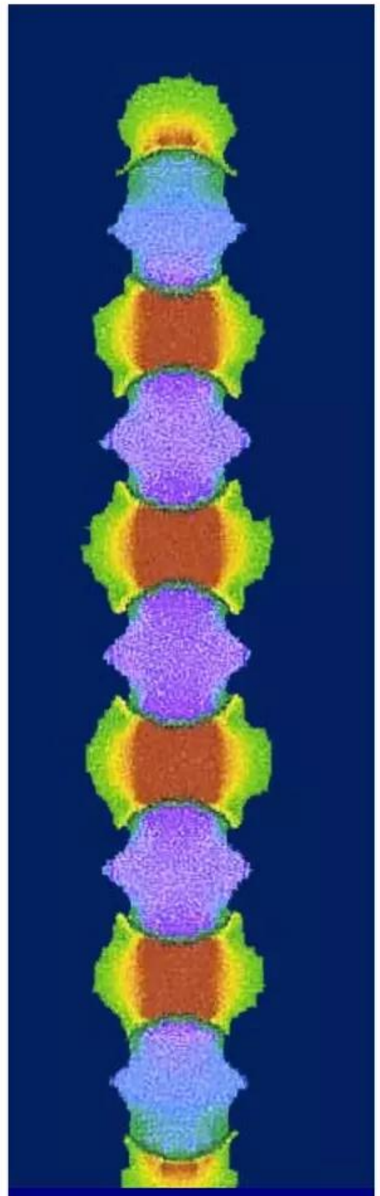
Major competitive advantage: unique proprietary knowledge

- Five issued patents and multiple patents pending on various aspects on LENR technology, including novel low-mass, high performance gamma shielding; plan to aggressively file additional patent applications to expand intellectual property

- Have incorporated and applied key knowledge derived from nanotechnology to develop proprietary device fabrication techniques that can help solve reproducibility issues

- Extended theory from LENRs in chemical cells to cover physical environments found in high-current exploding wires; large “wire” inductors and collective magnetic effects can easily scale upward with regard to device size

- LENRs are complex, multi-step phenomena; competing LENR researchers do not have broad multidisciplinary scientific knowledge and deep theoretical understanding required to solve key issues crucial to successful commercialization as a new power generation technology



Surface Plasmon E-M Fields Around Nanoparticles

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W-L theory: applicable from microcosm to macrocosm

Length Scale	Type of System	Electromagnetic Regime	Collective LENR Phenomena	Comment
Submicron	Certain earthly bacteria and fungi	Very short-range electric or magnetic fields	Transmutations, high level gamma shielding	Obtain unavailable trace elements; survive deadly gamma/X-ray radiation
Microns	Hydrogen isotopes on metallic surfaces	Very high, short-range electric fields on solid substrates	Transmutations, high level gamma shielding, heat, some energetic particles	This regime is useful for small-scale commercial power generation
Microns to Many Meters	Exploding wires, planetary lightning	Dusty plasmas: mixed high-current and high local magnetic fields	Transmutations, 'leakier' gamma shielding, heat; X-rays up to 10 keV, larger energetic particle fluxes	This regime is useful for large-scale commercial power generation
Many Meters to Kilometers	Outer layers and atmospheres of stars (flux tubes)	Dusty plasmas: high mega-currents and very large-scale, highly organized magnetic fields	Transmutations, large fluxes of energetic particles (to GeVs), limited gamma shielding, X-rays	Solves mysteries of heating of solar corona and radioactive isotopes in stellar atmospheres
Up to several AU (distance from earth to sun)	Active galactic nuclei in vicinity of compact, massive objects (black holes)		Energetic particles (GeVs), gamma-ray bursts (GRBs) and ultra-high energy cosmic rays (TeVs)	Solves several unexplained astronomical mysteries

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2007 - UK environmental group evaluates LENRs

- I-SIS is a small, influential London-based environmental group that made important contributions to the ongoing debate about proliferation of genetically modified (GM) crops in Europe
- In October 2007, I-SIS published three reports detailing their evaluation of ongoing work in LENRs by U.S. and foreign scientists
  - Acknowledged potential to develop LENRs as a new, green nuclear technology
  - Noted potential strength and importance of the W-L theory, although they mistakenly thought that it involved fusion
- See URLs:
  - ✓ http://www.i-sis.org.uk/alchemistsDream.php
  - ✓ http://www.i-sis.org.uk/coldFusionCondensedMatter.php
  - ✓ http://www.i-sis.org.uk/HowColdFusionWorks.php

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I-SiS then publishes six articles on LENRs by Larsen

- **Dr. Mae-wan Ho, Founder and Director of I-SiS, asked Lewis Larsen to write a series articles on LENRs for its publication, *Science in Society* (*SiS*), that would be suitable for a broad audience; published six articles from late 2008 to early 2009**

  - ✓ ***Low Energy Nuclear Reactions for Green Energy - How weak interactions can provide sustainable nuclear energy and revolutionize the energy industry***
    http://www.i-sis.org.uk/LENRGE.php

  - ✓ ***Widom-Larsen Theory Explains Low Energy Nuclear Reactions & Why They Are Safe and Green - All down to collective effects and weak interactions***
    http://www.i-sis.org.uk/Widom-Larsen.php

  - ✓ ***Portable and Distributed Power Generation from LENRs - Power output of LENR-based systems could be scaled up to address many different commercial applications***
    http://www.i-sis.org.uk/PortableDistributedPowerFromLENRs.php

  - ✓ ***LENRs for Nuclear Waste Disposal - How weak interactions can transform radioactive isotopes into more benign elements***
    http://www.i-sis.org.uk/LENR_Nuclear_Waste_Disposal.php

  - ✓ ***Safe, Less Costly Nuclear Reactor Decommissioning and More - How weak interaction LENRs can take us out of the nuclear safety and economic black hole***
    http://www.i-sis.org.uk/safeNuclearDecommissioning.php

  - ✓ ***LENRs Replacing Coal for Distributed Democratized Power - Low energy nuclear reactions have the potential to provide distributed power generation with zero carbon emission and cheaper than coal***
    http://www.i-sis.org.uk/LENRsReplacingCoal.php

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Basic science is done – now ready for engineering phase

- **Using its unique, unpublished proprietary understanding of LENRs, Lattice is now ready to begin device engineering programs**
- **With adequate private capital, strategic partnering, and government participation, LENR energy technologies can become a commercial reality within 3 – 5 years and globally deployed within 10 - 15 years**
- **For those still in doubt, please consider some famous 'last words':**

✓ ***"The energy produced by the atom is a very poor kind of thing. Anyone who expects a source of power from the transformation of these atoms is talking moonshine."*** ***Prof. Ernest Rutherford, 1933*** *[fission discovered by Hahn and Strassmann in 1938; Fermi's first reactor went critical in 1942; use of nuclear weapons,1945; first commercial reactor, 1957]*

✓ ***"But what the hell is it good for?" Senior IBM Engineer Robert Lloyd, commenting on the microprocessor chip, 1968*** *[first Altair PC was sold in 1975 – near universal in computers today]*

✓ ***"There is no reason anyone would want a computer in their home." Ken Olson, CEO of Digital Equipment Corp. (DEC), 1977*** *[IBM sold the first IBM PC in 1981 – DEC is now gone]*

✓ ***"The idea of producing useful energy from room temperature nuclear reactions is an aberration." Prof. John Huizenga, chemist and physicist, 1993*** *[referring to "cold fusion" in his book]*

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Market entry strategy for commercial LENR systems

Early products – small, long-lived power generation systems:

- Initial products with custom form-factors will target high performance, mission critical applications in military and civilian markets that are not price-sensitive to cost of power source, e.g. military and police/emergency radios, small portable electronic devices, and small standalone, off-grid distributed stationary power generation systems --- low to medium unit volumes

- Power output of market-entry systems will probably be 10s of Watts for battery-like devices to several kilowatts for stationary systems, all having duty cycles of at least 500 – 1,000 hours at full output (>>10x performance of batteries)

- Over time, plan to ride down the manufacturing experience cost curve; similar to market strategies used in microprocessors, memory chips, PCs, cellphones

- Then enter huge unit volume, much more price-sensitive market applications (e.g., battery-like power sources for commodity cellphones) as the company's manufacturing experience accumulates and internal build costs drop – like Intel, aggressively price LENR-based power systems to maximize total market share

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Potential for major technological impact in the near future

- Commercial versions of LENR-based portable power sources could eventually be fabricated in high volume, capital intensive manufacturing facilities - very much like semiconductors, PCs, and commodity batteries
- LENR-based power systems would have revolutionary, orders-of-magnitude improvements in energy density/longevity compared to chemical power generation technologies such as batteries, fuel cells, and microgenerators
- High-volume market applications for LENR-based battery-like form factors could vastly reduce manufacturing costs of LENR power generation systems; ride experience/volume cost curve, displacing competing technologies
- As manufacturing costs drop and applications proliferate, total electrical power output of LENR-based power generation systems could be scaled-up dramatically, ultimately reaching 100s of kilowatts - enough to power some types of motor vehicles, aircraft (UAVs), and smaller commercial buildings
- Similar to PCs and cellphones, use of progressively less expensive, LENR-based distributed power systems could spread rapidly worldwide, especially to rural areas where an electrical power grid is either absent, uneconomic, or unreliable. Could also eventually displace internal combustion engines
- LENR technology could improve quality of life for billions of people

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'Green' LENR energy technology could change the world

- **In "Hot, Flat, and Crowded" (2008) Thomas Friedman says:**

"... we have not found that magic bullet – that form of energy production that will give us abundant, clean, reliable cheap electrons. All the advances we have made so far in wind, solar, geothermal, solar thermal, hydrogen, and cellulosic ethanol are incremental, and there has been no breakthrough in any other energy source. Incremental breakthroughs are all we've had, but exponential is what we desperately need."

"***No single solution will defuse more of the Energy-Climate Era's problems at once than the invention of a source of abundant, clean, reliable, and cheap electrons. Give me abundant clean, reliable, and cheap electrons, and I will give you a world that can continue to grow without triggering unmanageable climate change. Give me abundant clean, reliable, and cheap electrons, and I will give you water in the desert from a deep generator-powered well. Give me abundant clean, reliable, and cheap electrons, and I will put every petrodictator out of business. Give me abundant clean, reliable, and cheap electrons, and I will end deforestation from communities desperate for fuel and I will eliminate any reason to drill in Mother Nature's environmental cathedrals. Give me abundant clean, reliable, and cheap electrons, and I will enable millions of the earth's poor to get connected, to refrigerate their medicines, to educate their women, and to light up their nights."***