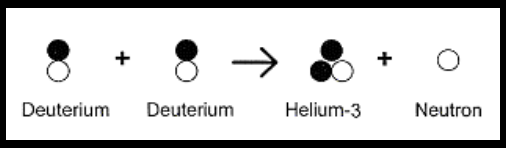
Cold Fusion and It's Development into a New Science: LENR
(Low-Energy Nuclear Reactions)

Steven B. Krivit
Editor, *New Energy Times*
Executive Director, New Energy Institute
New Energy Movement Canada
Simon Fraser University, Vancouver, CA, September 8, 2008

Thermonuclear Fusion



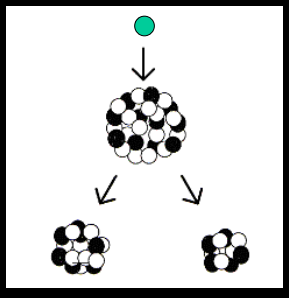
Three Types of Nuclear Processes

1. **Fission**
2. **Thermonuclear Fusion**
3. **LENR**
   (Low-Energy Nuclear Reactions)

Fundamental Energy Factors

1. **Cost**
2. **Location**
3. **Size**

Nuclear Fission



"Green" Energy

Micro-hydro

"Green" Energy

Energy Devices - Size Comparison (Real Applications)

Chemical

Nuclear Fission

Energy Density – Raw Fuel (Real Applications)

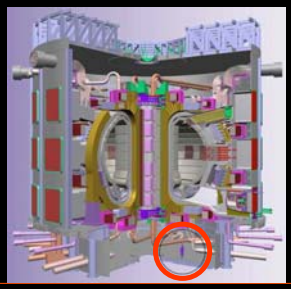
Chemical

Nuclear Fission

3.5 barrels of oil
17,000 cubic feet of NG
1,780 pounds of coal

www.cameco.com

Energy Devices - Size Comparison (Science Research)



Thermonuclear Fusion

Energy Density – Raw Fuel (Science Research)

Thermonuclear Fusion

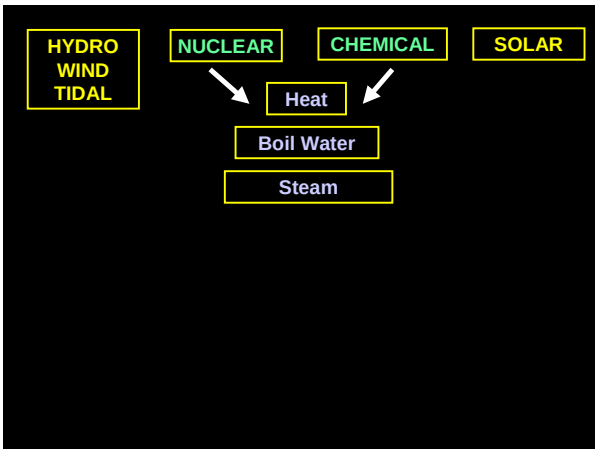
LENRs
Low-Energy
Nuclear Reactions

Energy Devices - Size Comparison (Science Research)

LENR - Low-Energy Nuclear Reactions

Two Energy Forms

1. **Liquid Fuels**
2. **Electricity**

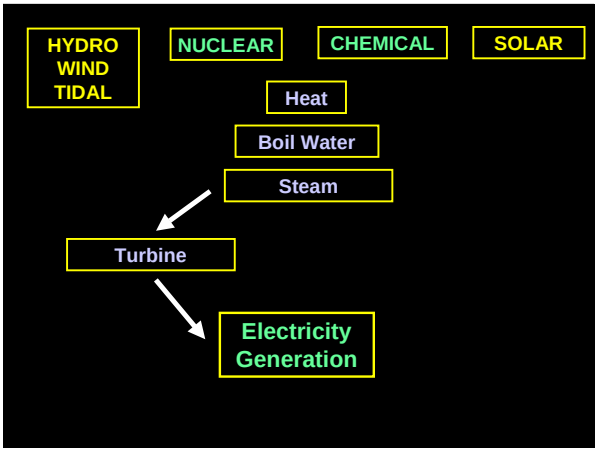


Liquid Fuels

Petroleum - Ethanol

Primary Use:
TRANSPORTATION

WHY?
Dense, Portable, Independent



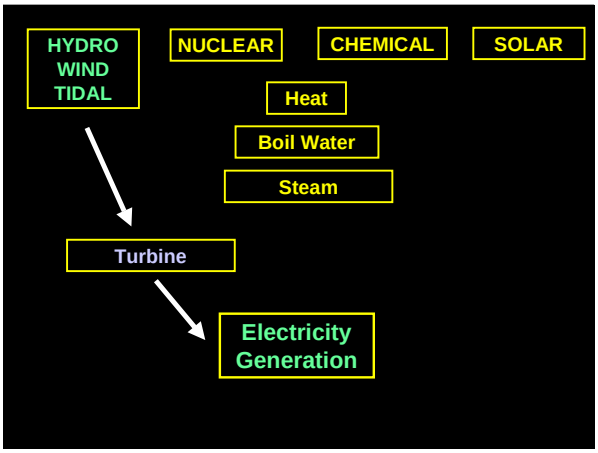
Sources of Electricity

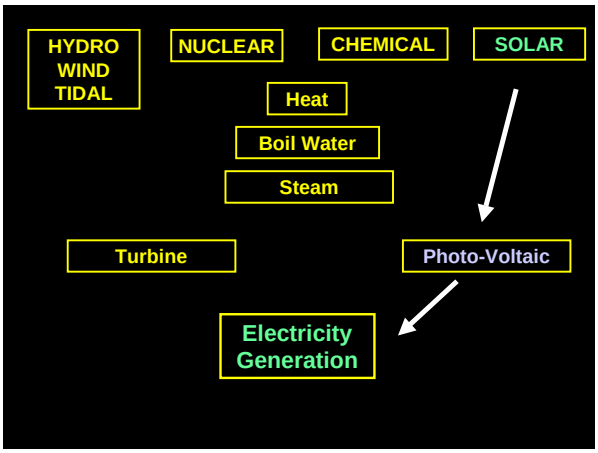
HYDRO
WIND
TIDAL

NUCLEAR

CHEMICAL

SOLAR

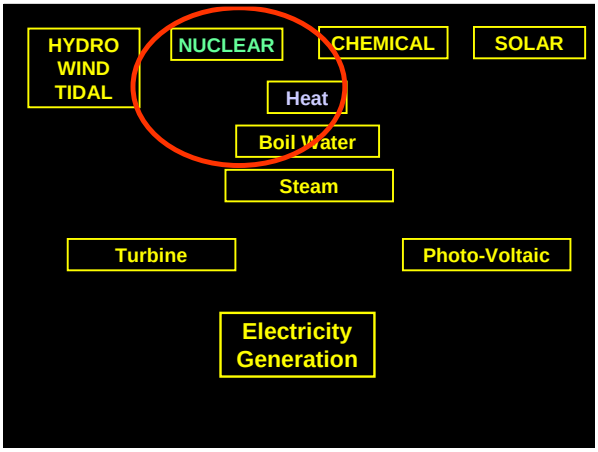




A New Source of Energy?

The cell produced unexplained heat

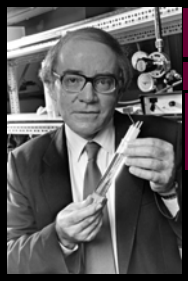
Milliwatts of electrical input
4 Watts heat output?



Surprise!

Excitement!

Utah Fusion Announcement



Martin Fleischmann
University of Southampton

University of Utah
Press Conference

March 23, 1989

"… established a sustained nuclear fusion reaction … "

Stanley Pons
University of Utah

U.S. Nationwide Cover Stories

May 8, 1989

What Was (and Still is) the Hope?

1. **Energy from water**
2. **Virtually unlimited fuel**
3. **No dangerous radiation**
4. **Not harmful to environment**

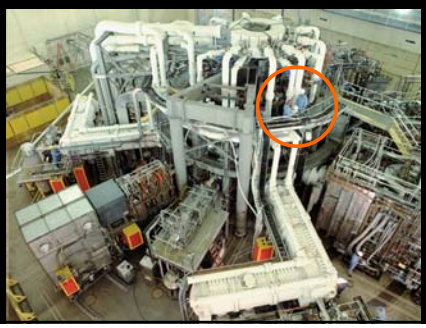
Hot Fusion

$20 Billion U.S.+

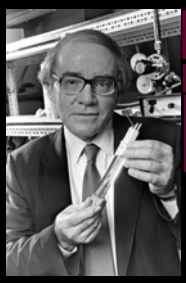
57 Years +

Princeton Plasma Physics Lab

Tokamak Reactor Exterior



Cold Fusion Is Announced



Martin Fleischmann
University of Southampton

University of Utah
Press Conference

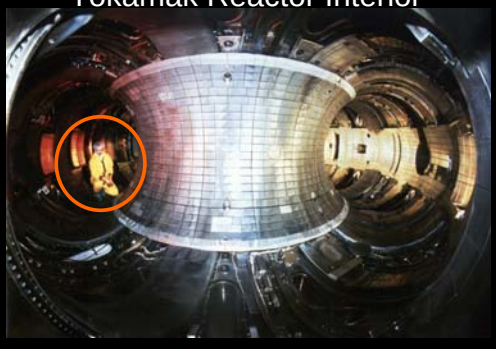
March 23, 1989

"… established a sustained nuclear fusion reaction … "

Stanley Pons
University of Utah

Princeton Plasma Physics Lab

Tokamak Reactor Interior



Failures to Replicate

Frustration

Secrecy

Fraud!

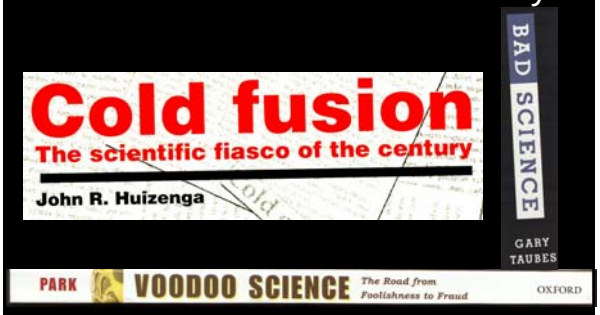
Mistake

Delusion

Steven Koonin - Caltech/BP

"Incompetence and delusions"

"Scientific Fiasco of the Century"



Ronald R. Parker

Director of MIT Hot Fusion

"It's Fraud"

Interview with Nick Tate, Boston Herald, April 29, 1989

Nathan Lewis - Caltech

"No Evidence" - Nothing There

Legitimate Science Questions…

It's not fusion as we currently know it…

Hey! Where's the Neutrons?

Six Months Earlier the President of the United States Was Told:

Cold fusion not real
Have DoE perform investigation
They will tell you it's not valid
That will resolve the problem for you

Why Was Cold Fusion So Controversial?

Didn't look like thermonuclear fusion

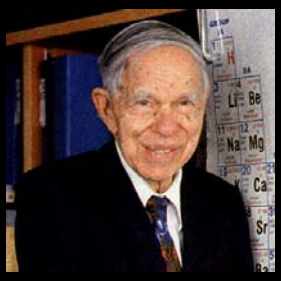
Apparent contradiction to laws of physics

Threat to thermonuclear fusion funding

Difficult science problem

"End of Science" attitude

Glenn T. Seaborg, Adviser to the President of the United States



November 1989 U.S. Department of Energy Cold Fusion Investigation

Implications:

Cold fusion not real
Nothing to see, move along…
We're not going to fund it

Nov. 2004 U.S. Dept. of Energy "Review of Low Energy Nuclear Reactions"

Was not a review
Was pushed on DoE
DoE deflected, did nothing
Sparked interest from commercial sector

1989: Who Succeeded, and Why?

Tadahiko Mizuno
Applied Physicist
Hokkaido University

"…performed similar experiments for 20 years prior….

…spent eight months preparing for my first cold fusion experiment.

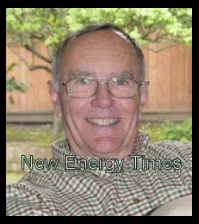
(*Nuclear Transmutation*, pg 59)

1989: Who Succeeded, and Why?

Robert Huggins,
Materials Scientist
Stanford

"We had all kinds of background relevant to this stuff. We had our own palladium which had a lot of lithium in it."

(Private Communications, 4/6/2006)



1989: Who Succeeded, and Why?

Edmund Storms, Radiochemist
Los Alamos National Lab. (ret.)

"I had worked with palladium previously…

…I had to learn electrochemistry.

…I also had a great deal of luck.."

(Private Communications, 3/25/2006)

1989: Who Succeeded, and Why?

Melvin Miles,
Electrochemist
U.S. Navy, China Lake

…used Johnson-Matthey palladium… nearly every experiment worked.

…never worked with Wesco palladium..

(Private Communications, 4/16/2006 and Dec. 4, 2003)

1989: Who Succeeded, and Why?

Michael McKubre,
Electrochemist
SRI International

"…four experts already working with the Pd/D system…

…spent three months planning and constructing … and spent two further mon hs performing it."

(Private Communications, 3/25/2006)

20 Years Later

All legitimate criticisms have been met

What has been learned?
What is known?

What goes in -

- **Hydrogen or deuterium**
- **Palladium, nickel, titanium**
- **Lithium**
- **A few watts of energy (electrical or mechanical)**

What *doesn't* come out -

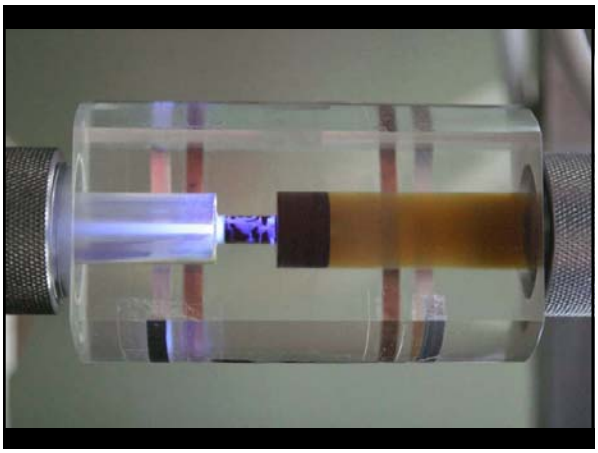
- **Greenhouse gases**
- **Strong prompt radiation**
- **Long-lived radioactive waste**

What comes out -

- **Energy, in the form of heat**
- **Helium**
- **Transmuted Elements**
- **Tritium**
- **Neutrons (tiny amount)**
- **Other weird stuff**

What is Excess Heat?

More energy coming out of the experiment than can be explained by known science



What's the Problem with LENR?
(Strategic Problems)

- **Stigma: Publications, Funding**
- **Disbelief: "It's not nuclear"**
- **Belief: "It's fusion"**

More likely: Neutron catalyzed, weak interactions (14 MeV per 4He atom - Widom-Larsen)

Not as Simple as It Looks

- **Difficult to achieve conditions**
- **Difficult material preparation**
- **Difficult instrumentation**

What's the Problem with LENR?
(Technical Problems)

- **Nature is being stubborn**
- **Research on a shoestring**
- **Competitiveness**

LENR Uncertainties

- **Will it be practical?**
- **When?**
- **Will it scale?**
- **At what cost?**
- **Will it replace liquid fuels?**
- **Will the knowledge die?**
- **Will it be used for destruction?**

New Energy Times Magazine
www.newenergytimes.com

steven1@newenergytimes.com

Who will Seek the Answers?

- **YOU!**
- **Universities**
  (students and professors)
- **Commercial enterprise**

EXTRA SLIDES

Please Get Back to Me ☺

- **Let me know what happens!**
- **Or doesn't happen!**

QUESTIONS?

Energy Density – Raw Fuel

(by Volume, Approx.)

Sources: Lattice Energy, Wikipedia, DoE EIA	Watt*hours/kg
Hydrogen	4,000
Wood	1,000
Ethanol	6,000
Gasoline	12,000
Coal	23,000
LENR	(theoretical) 57,000,000
Nuclear Fission	2,000,000,000
Nuclear Fusion	(theoretical) 3,000,000,000