



***Public Interest and Level-of-Evidence
Considerations in
Cold Fusion Public Policy***

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Prior to coming to the LBJ School

Enjoyed a long & enjoyable career in the environmental field

Don't propose to be presenting much (if anything) new to give this morning

Rather, assemble information in a way that might (just maybe) provide an avenue out of the wilderness for CF

This presentation is different from others on the agenda

Nevertheless a topic of much potential interest among CF researchers



Public Policy toward Cold Fusion: Approach

1. Focus on the Public Interest in Cold Fusion
2. Assess CF policy in Evidence-Based framework
3. Delineate 5 Levels of Evidence in rational framework
4. Consider evidence of CF specifically

Self explanatory slide



Public Policy toward Cold Fusion: Approach

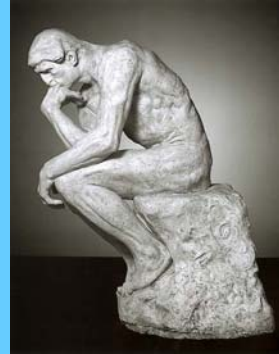
6. Propose 2 policy response scenarios – conservative & moderate
7. Conclude risk not a major consideration in relation to reward – public benefit
8. Postulate Level of Evidence for CF existence and associated public policy response

Self explanatory slide



Policy Toward Cold Fusion: What Should It Be?

- Private Sector
 - \$ incentives
 - Market forces
 - Intellectual property considerations
- Public Sector
 - The **Public Interest**



What should the policy for development of CF be?

Private sector has its set of answers

Public sector, on the other hand, has a different answer: the
PUBLIC INTEREST

I will be referring back to this concept or value frequently in
this talk



The Public Interest in CF Is Well Established...

- Excess heat: energy source
- Transmutation of elements?
- New area of science (physics): unknown future benefits

Self explanatory slide



How Should Public Policy Be Determined?

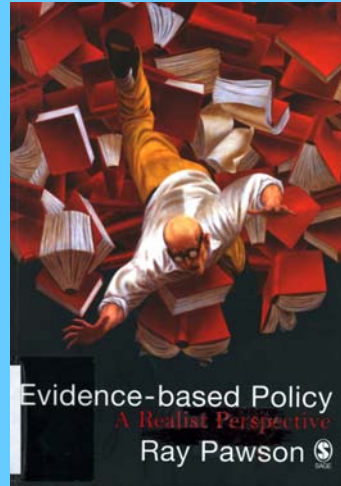
- Grounded in the Public Interest
- Set in rational policy making framework
- Based on level of evidence of CF existence
- Balancing risk and reward of CF support

Self explanatory slide



Evidence-Based Policy Making Framework

- Not ideological
- Return to rational basis of public policy
- Reaction to Post-Modern trend?
- Pragmatic: what works!
- Started in medicine
- Extended to other fields
 - Education
 - Management
 - Social welfare
 - Public policy making



Evidence-based Policy Making represents a resurgence of the rational (Modern) point of view and value system for the Public Interest



Levels of Evidence

- Lesser levels of evidence...
 - Low probability <10%
 - Medium probability 10-50%
- Borrowing from the legal field...
 - Preponderance of evidence 50-70%
 - Clear and convincing evidence 70-90%
 - Beyond a reasonable doubt >90%

Levels of Evidence postulated for this investigation



Evidence for CF Existence

- Scientific Evidence
 - Early Confirmations (Beaudette, 2002)
 - Affirmations, 1989-2004 (Storms, 2007)
 - Most Convincing Experiments (WIP)
- Probabilistic Evidence (Melich, 2007)
 - $P(A|BC)$
 - A: Low-Temperature Nuclear Reactions
 - B: Excess Heat
 - C: Radiation

That is, what is the Evidence of CF Reality?

Start with Scientific evidence.

Looked at from 3 angles

Early corroborations...

Affirmations since then...

Perhaps also most convincing experiments (a Work in Progress)

We can also look at other kinds of evidence

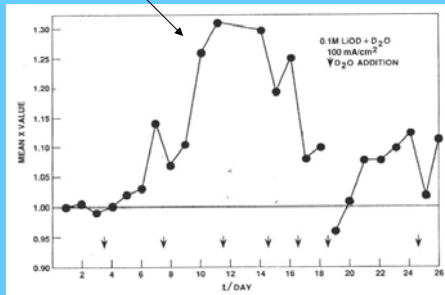
For example, the very interesting probabilistic analysis presented by Michael Melich at Catania in 2007

Reached a conclusion of 97% probability

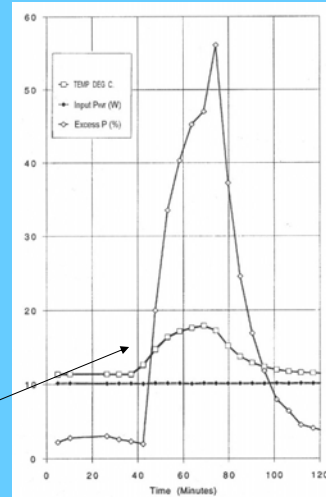


Early Confirmation (Excess Heat) Miles, Huggins

Excess heat indicated



Excess heat indicated



Beaudette, "Excess Heat", 2002

Miles

Plot of ratio of output power to input power

Excess power began on Day 4

Reached a maximum of 1.3 (30% excess) on Day 11

Continued to end of experiment

Huggins

Excess power (% over input power) began at ~45 min

Reached a maximum of 55% excess power at 55 min

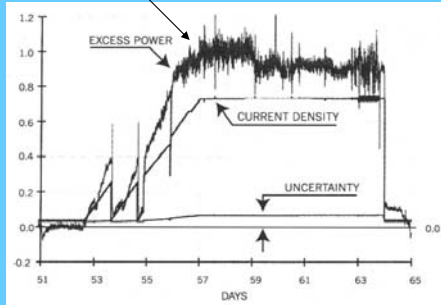
Continued until 95 min

Temperature rise noted in same timeframe

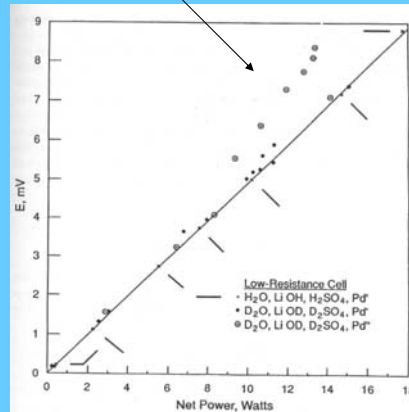


Early Confirmation (Excess Heat) McKubre, Oriani

Excess heat indicated



Excess heat indicated



Beaudette, "Excess Heat", 2002

McKubre

Excess power initiated on Day 53 of experiment and continued through Day 65

Experimentally initiated by increasing current on Day 53

Excess power of about 0.9 watts observed

Oriani

Plot of power in vs power out

Input and output balance indicated by diagonal line

Total of eight points (six more definitive) above the line

Strong indication of excess heat where heat output exceeds input



Under most circumstances...

Early confirmations would have been sufficient for scientific acceptance.

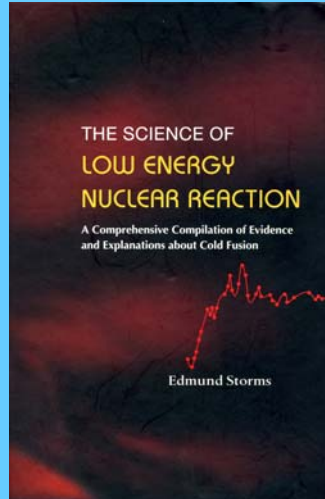
But not for CF...

What about since then?

Self explanatory slide



Confirmations, 1989-2004 *Excess Heat*



Storms, 2007

1989	2	1998	17
1990	15	1999	1
1991	8	2000	12
1992	21	2001	1
1993	20	2002	16
1994	8	2003	11
1995	17	<u>2004</u>	<u>8</u>
1996	20		
1997	7	Total	184

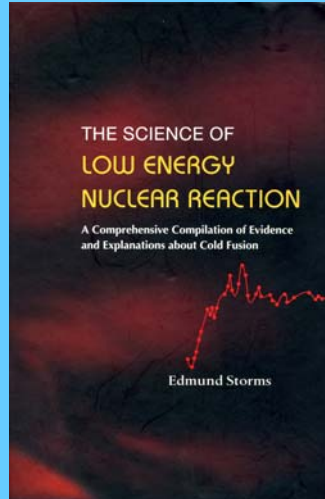
Assembled from Table 2, p. 53-61

Remarkable 184 corroborations of excess heat since early confirmations.



Confirmations, 1989-2004

Radiation



Storms, 2007

1989	3	1998	27
1990	6	1999	0
1991	6	2000	6
1992	10	2001	1
1993	1	2002	5
1994	3	2003	7
1995	7	<u>2004</u>	<u>5</u>
1996	6		
1997	0	Total	68

Assembled from Table 11, p. 101-104

Similarly remarkable 68 corroborations of radiation since early confirmations.



Most Convincing Experiments

(Work in Progress)

- The list of candidates is long...
 - McKubre?
 - Mizuno?
 - Storms?
 - SPAWAR?
 - Oriani?
 - Others?
- Criterion: Clearest evidence to support *rational policy making*

Selection of Most Convincing Experiments for Policy Makers still needs to be accomplished.



Probabilistic Analysis of CF Reality

- Computed conditional probability of A, given observation of B and C: $P(A|BC)$
 - A: Nuclear reactions at low temperatures
 - B: Excess heat (B)
 - C: Emission of energetic particles (C)
 - Conducted analysis using Bayes' Theorem and Bayesian network
 - Made **reasonable** estimates of probability of the nodes of the Bayesian network
- Result: $P(A|BC) = 0.971 \sim 97\%$
 - Qualifier: demonstration of approach only
 - Melich not ready to “stand behind” the probability estimates

Melich, et al., 2007 presentation in Catania conference.
Self explanatory slide



CF Evidence: Summary

- Four excellent examples of early confirmation
- Numerous confirmations since
- Many excellent candidates for highly convincing experiments
- Early probabilistic analysis very positive

Self explanatory slide



Taking the analysis to the
next step...

*What should the policy
responses toward CF be?*

1. Conservative Scenario
2. Moderate Scenario

Two scenarios set forth....



Policy Responses to Levels of Evidence *Conservative Policy Scenario*

Five responses for five levels of evidence...

Low	<10%	Discontinue Research
Medium	10-50%	Business as Usual
PoE	50-70%	Reinstate
CCE	70-90%	Hot Fusion Support
BRD	>90%	Manhattan Project

Five Policy Responses postulated for first time in this investigation – Conservative scenario



Policy Responses to Levels of Evidence

Moderate Policy Scenario

Move responses up by one level...

Low	<10%	Business as Usual
Medium	10-50%	Reinstate
PoE	50-70%	Hot Fusion Support
CCE	70-90%	Manhattan Project
BRD	>90%	Manhattan Project+

Similar Policy Responses – Moderate Scenario

Responses move up one level.



Conclusion: What is the Level of Evidence for CF?

- Based on:
 - Scientific evidence (3 lines)
 - Preliminary probabilistic analysis
- ***LoE is at least PoE (50-70%)***
- Strong case can be made for CCE (70-90%)
- Perhaps not (yet) for BRD (>90%)

Bold Assertion! Preponderance of Evidence for existence (reality) of CF phenomenon



Summary: What Is the Policy Response to CF Evidence?

Policy Scenario

Conservative

Moderate

Medium: 10-50% *Business as Usual* *Reinstate*

PoE: 50-70% *Reinstate* *Hot Fusion*

CCE: 70-90% *Hot Fusion* *Manhattan Project*

Given the high level of public interest in the success of CF...

Self explanatory review slide – conclusions presented another way.



Finally, What About Reward vs Risk?

- Reward (CF real): Public Interest well established!
- Risk (CF real): Any?
- Risk (CF not real): Not much...
 - Possible wasted public funds
 - Diversion of support from competing areas?
- Conclusion: risk not a major consideration
- Risk greatly outweighed by potential rewards



Many argue that CF is a low-risk investigation area. This slide shows why.

Risk of CF reality not shown: reputation of antagonists and how CF treatment did not follow scientific method



Summary

- Assert CF Level of Evidence...

- **At least PoE (50-70%)**
- Maybe even CCE (70-90%)

- Conclude policy response...

Conservative

Moderate

- PoE: **Reinstate**

Hot fusion level

- CCE: Hot fusion level

Manhattan Project

Self explanatory slide – the bottom line

CF must be at least reinstated, even supported on a par with hot fusion



Next Steps

- “Full-blown” Policy Analysis: path forward (Fall 2008)
 - Focus on Public Interest, rational policy making
 - Also on *reconciliation and recovery* (in the Public Interest)
- Initiate process for comprehensive, integrated research plan
- Begin consideration of secondary impacts (technology assessment?)

Self explanatory slide



The “Policy Angle” on Cold Fusion

www.coldfusionpolicy.org

Self explanatory slide