

# Energy: No Such Thing as a Free Lunch

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Eric Prebys

# Motivation for This Lecture

- The basic facts:
  - The energy consumption of the human race is increasing.
  - Soon, the developing world will pass the US and Western Europe in energy usage.
  - Our reliance on fossil fuels is impacting our environment, perhaps catastrophically.
  - Fossil fuels will run out – maybe in 10 years, maybe in 100, but they will run out.
- The current emphasis on “going green” has raised the stakes for alternative energy sources:
  - Scientifically, this is very exciting, but...
  - It will also not be lost on the con men.

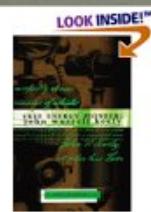
# Is this lecture necessary?



Unfortunately, Homer's conceptual understanding is well above average!

# Evidence: Amazon search "free energy"

## Top 5:



**Free Energy Pioneer: John Worrell Keely** by Theo Pajmans (**Paperback** - Sep 2004)

Buy new: \$19.95 **\$14.96** 26 Used & new from \$9.26

Get it by **Monday, April 21** if you order in the next **11 minutes** and choose one-day shipping.  
Eligible for **FREE** Super Saver Shipping.

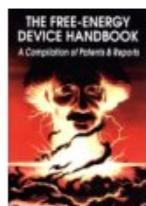
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Other Editions: **Paperback**



**Free Energy Generation Circuits & Schematics** by Tom Bearden and John Bedini (**Paperback** - 2006)

1 Used & new from \$59.99

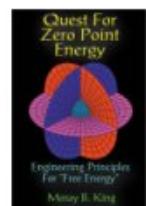


**The Free-Energy Device Handbook: A Compilation of Patents & Reports (Lost Science Series)** by David Hatcher Childress (**Paperback** - Nov 1994)

Buy new: \$46.95 **\$13.22** 31 Used & new from \$6.45

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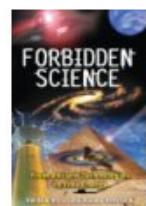


**Quest for Zero Point Energy Engineering Principles for Free Energy** by Moray B. King (**Paperback** - Jan 30, 2002)

Buy new: \$14.95 **\$10.17** 39 Used & new from \$9.06

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**Forbidden Science: From Ancient Technologies to Free Energy** by J. Douglas Kenyon (**Paperback** - Feb 22, 2008)

Buy new: \$18.00 **\$12.24** 22 Used & new from \$9.75

Get it by **Tuesday, April 22** if you order in the next **51 hours** and choose one-day shipping.  
Eligible for **FREE** Super Saver Shipping.

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# Working definition: How free is "free"?

- For the purposes of this discussion, “free energy” refers to transformative technologies that:
  - Can be implemented on an individual basis
    - i.e. non-centralized
  - Will enable dramatic reduction in domestic and/or transportation energy expenses
    - say, a factor of four or more
  - Do not require a lifestyle change
  - Involve only modest capital costs
    - Pay for themselves in less than a year or so
- Some examples which do NOT qualify:
  - Trading in your Hummer for a motorcycle
    - Lifestyle change
  - Converting your home to 100% solar
    - Takes several years to recover the cost

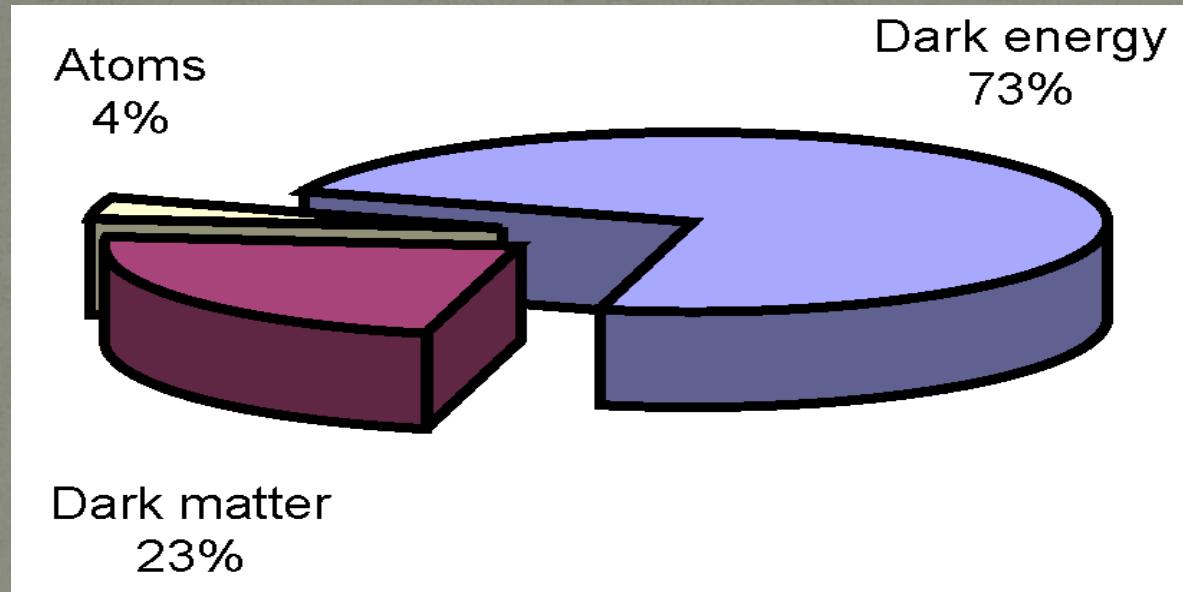
# Types of “free energy”

- Perpetual Motion: A device which produces useable output energy with no input energy or fuel.
  - To the extent science declares anything “impossible”, this is impossible.
- Dramatically improved efficiency in utilizing an existing power source.
  - A legitimate idea, but there limits
- A new source of energy or radically different way of tapping an established source of energy
  - Examples: cold fusion, zero-point energy, hydrinos, etc.

In many cases, claims of the second two types really imply the first

# How can we be so sure of ourselves?

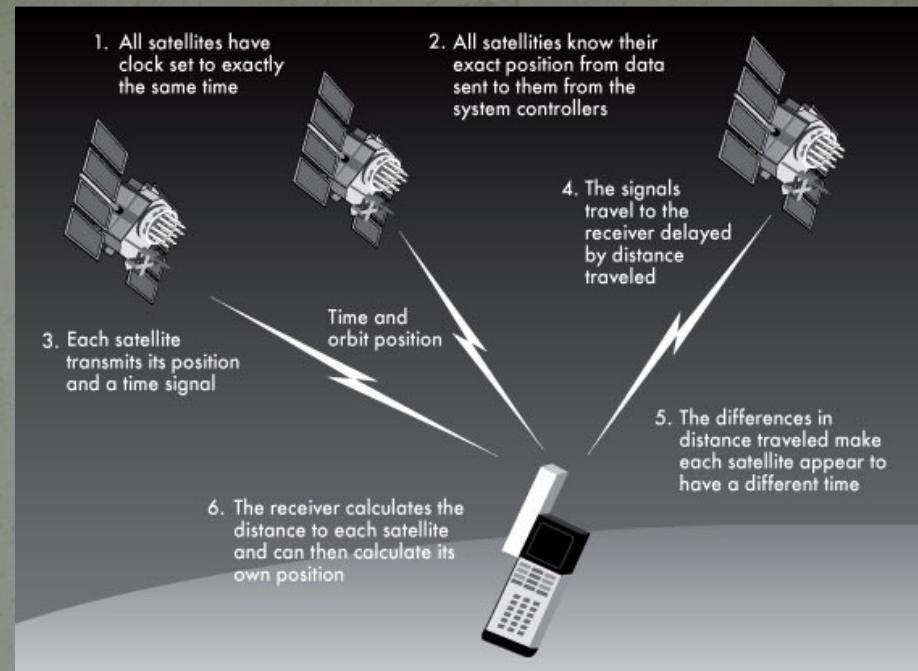
- After all, we only know what 4% of the universe is made of.



- Can't there be some sort of energy source in the other 96%?
- Maybe, but even if we don't know what 96% is, we know a lot about what it *isn't*.

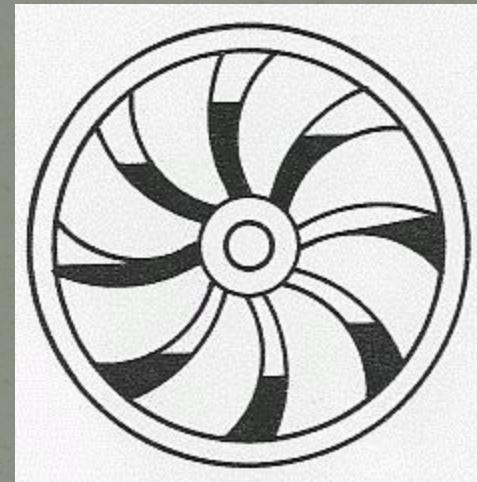
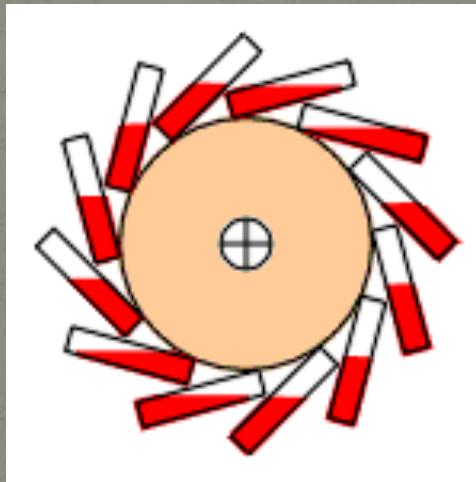
# Consider the GPS

- For a GPS to work, we have to understand
  - The chemistry of the fuel
  - The dynamics of the launch and orbit
  - The physics of the onboard atomic clocks
  - The E&M involved in generating and transmitting the signal
  - The Special and General Relativity corrections required
    - $38 \mu\text{sec} = 11.4 \text{ km/day}$  error without them!
  - And then there's all the physics needed to put that much computing in your hand.
- None* of this would work if unknown particles and forces interacted significantly with ordinary matter.



# Early perpetual motion machines

- Some of the oldest perpetual motion machines were documented by the Indian author Bhaskara (c. 1159), who made sketches of something called the “Persian Wheel”



- This device used flowing water (or sand) to create a “perpetual imbalance”
- Still find people claiming to build these on FaceBook

# Perpetual motion and physics

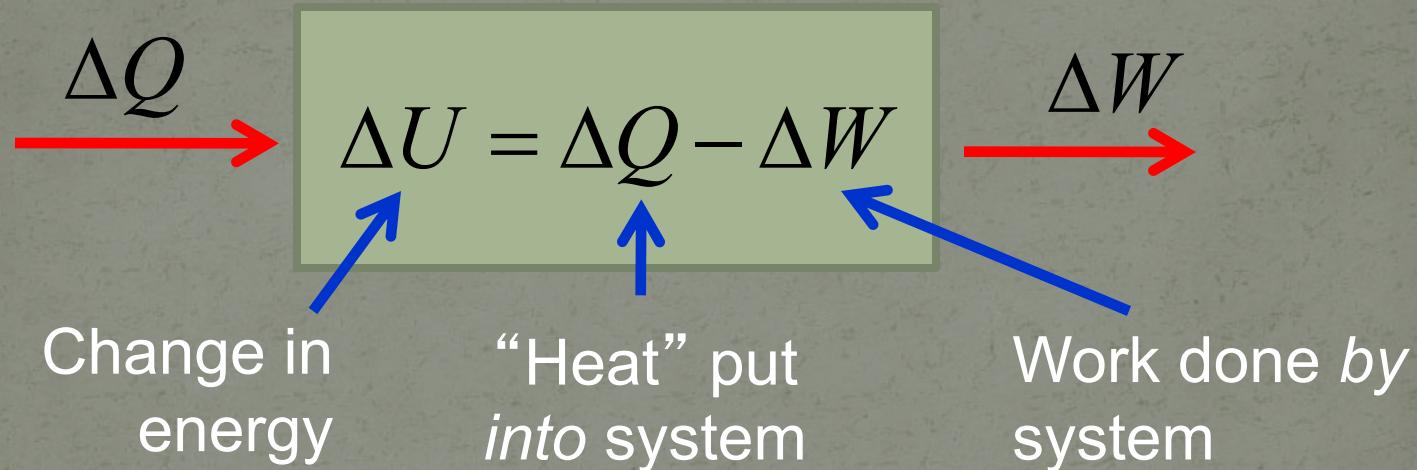
- We need to examine these early claims in the context of the time.
- Because there was no theoretical framework to rule out these machines, these people were behaving as good scientists.
  - The fact they didn't work was an important piece of experimental evidence.
- All of this changed with Newton
  - $F=ma$  and the “universal law of gravitation” held the mathematical key to ruling out all of these “imbalance” type perpetual motion machines in one fell swoop.

# Physics and energy

- In the 18<sup>th</sup> and 19<sup>th</sup> centuries, a great deal of physics was done to formalize the concepts of work, energy, and conservation laws.
  - The non-observation of perpetual motion was taken as *input* to these theories.
- The 19<sup>th</sup> century saw the development of thermodynamics
  - Term originally coined by James Joule to describe the science of heat and power
  - Generalized to cover all physical systems
  - Lays out the specifics of the relationship between physical systems and usable energy
- As new types of physics were discovered, they still fit into this paradigm
  - Electricity and Magnetism
  - Relativity
  - Nuclear energy
  - Quantum Mechanics

# First Law of Thermodynamics

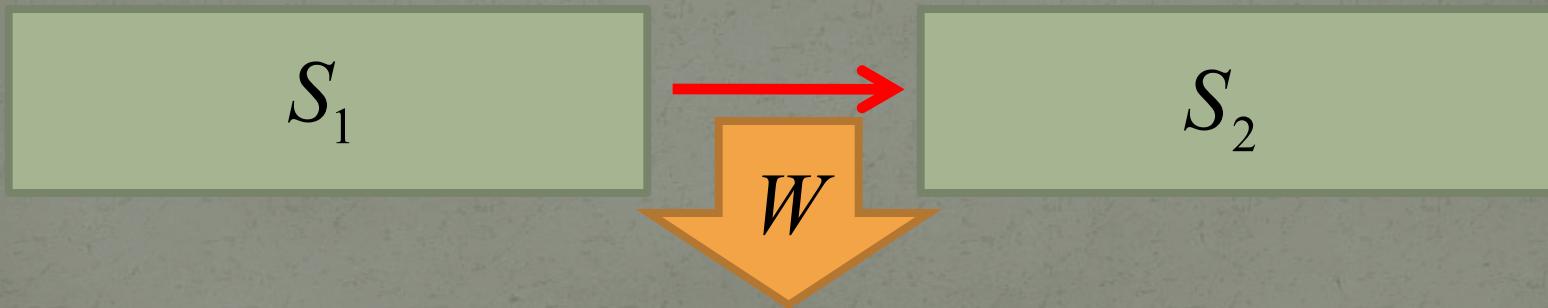
- Every system is characterized by an energy ( $U$ )



- This law is also known as “Conservation of Energy”

# Second Law of Thermodynamics

- Not all energy is useable!!
- Every system is characterized by an “entropy” ( $S$ )
  - A measure of energy and degree of order
    - Generally “Low entropy” = high energy and high order
- The entropy of a “closed” system can *never* decrease.
- Can only get work out of system in *a transition to a higher entropy state*. ( $S_2 > S_1$ )



# Second Law and Heat

- Entropy increases as heat flows from high to low temperature
  - We can *extract work* when heat flows from *high temperature* to low temperature

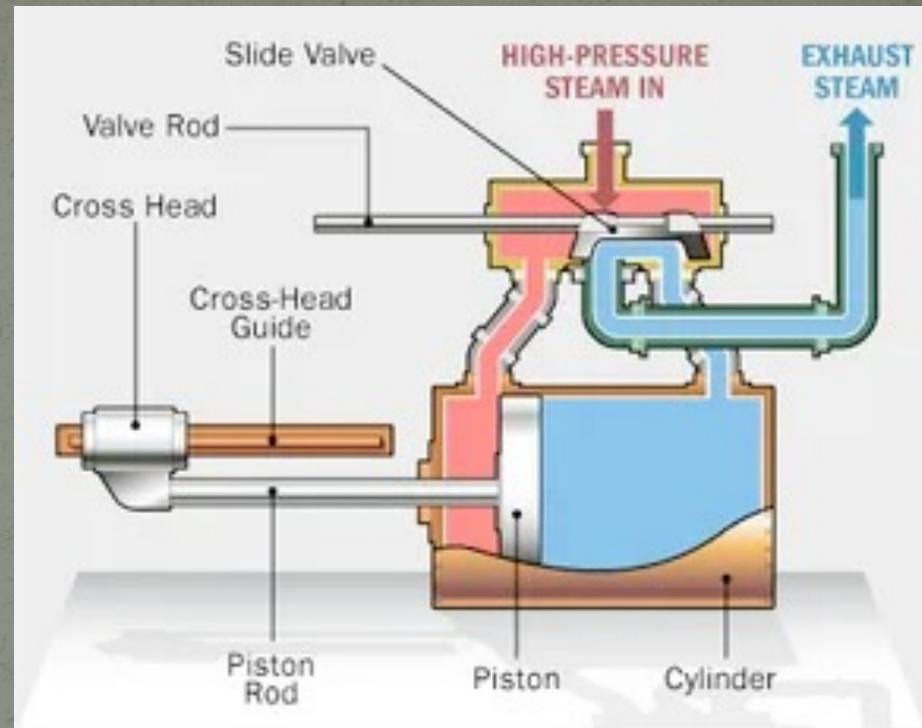
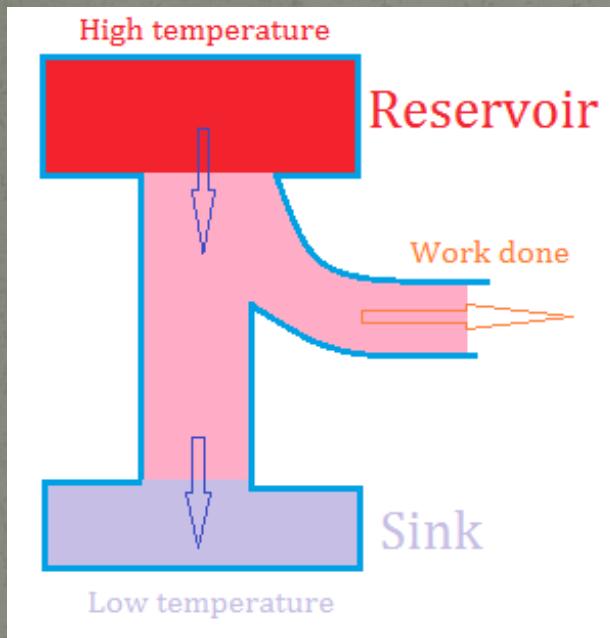


- We have to *do work* to move heat from *low temperature* to *high temperature*.



# 2<sup>nd</sup> law: getting energy out...

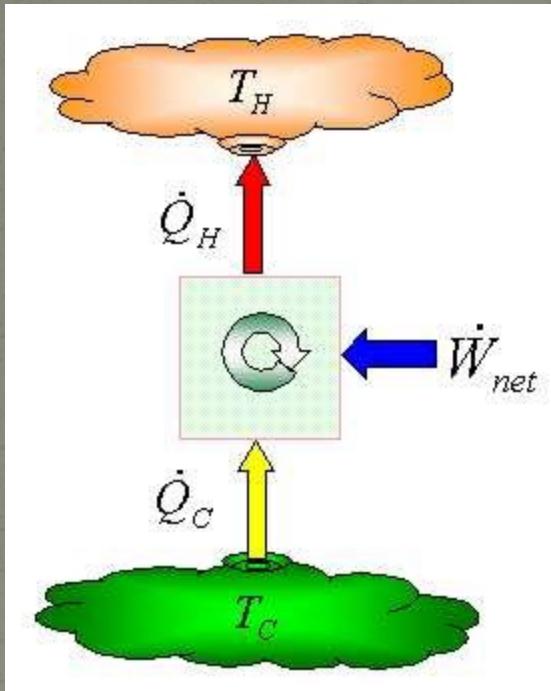
- Steam engine:



- A source of heat makes stream
- The steam pushes a piston, cooling in the process.
- The steam is then exhausted to a cooler reservoir

# 2<sup>nd</sup> Law: doing work to move heat

- Air conditioning



Work is done to move heat from inside the house to the radiator unit outside the house.

The heat radiated outside the house is equal to the heat removed from the house *plus* the work it took to move it.

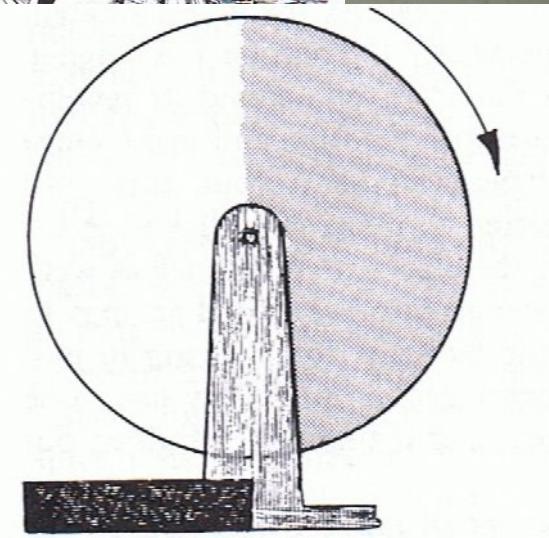
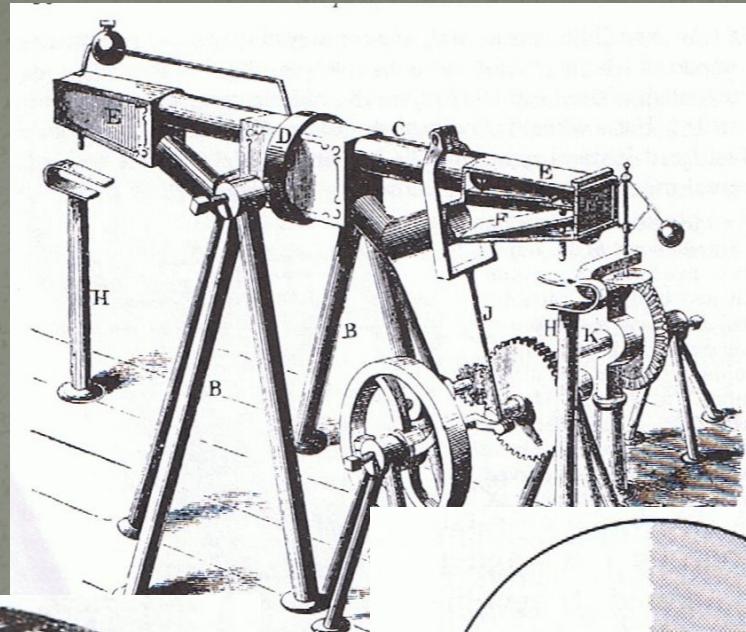
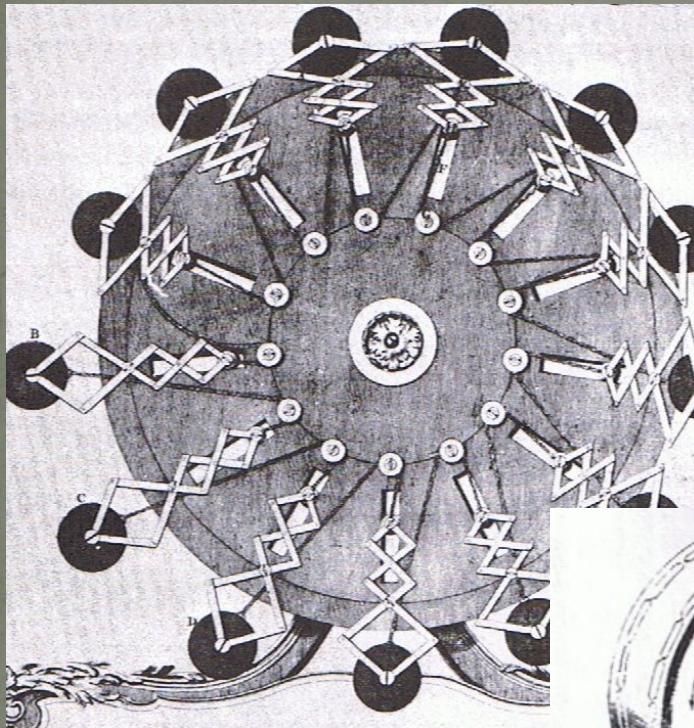
- This is why you can't use your refrigerator to cool your house!

# The Bottom Line

- To date, no violation of the Laws of Thermodynamics has ever been observed
  - Period.
  - Exclamation point!
  - Red box around it

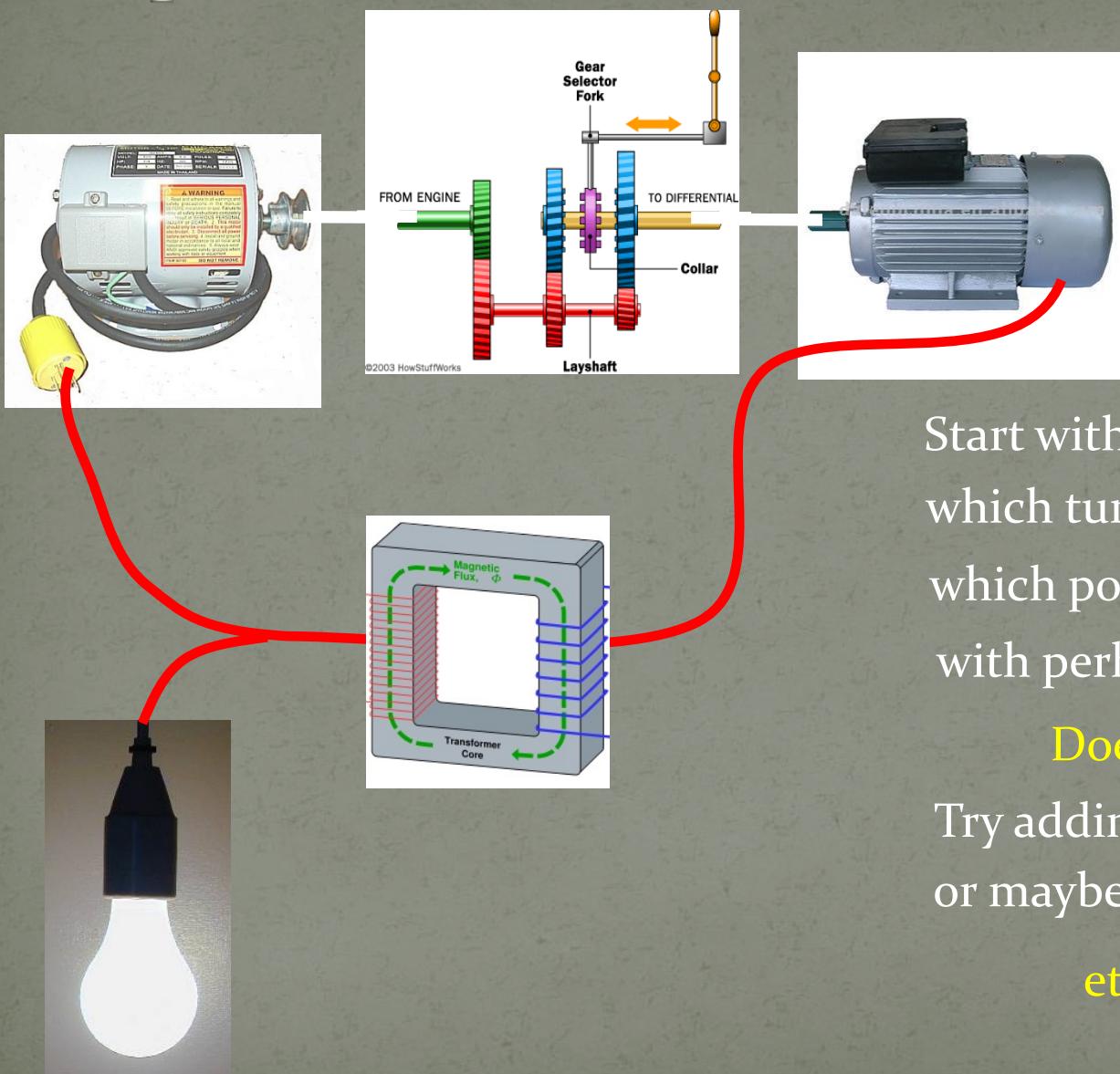
# Interest continued, undaunted by facts\*

Gravitational imbalance...



\*Illustrations taken from  
A.W.J.G Ord-Hume,  
“Perpetual Motion: The  
History of an Obsession”

# Perpetual Motion 101 (electricity example)



Start with a motor...  
which turns a generator...  
which powers the motor...  
with perhaps some left over!

Doesn't work??

Try adding some gears...  
or maybe a transformer

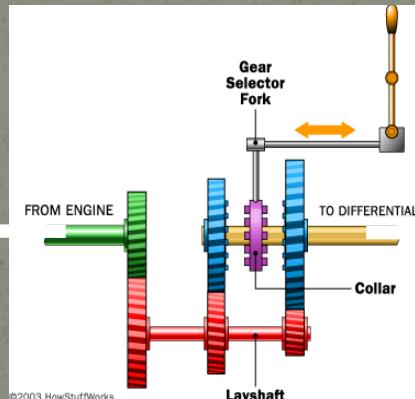
etc, etc, etc...

# Redefining the problem

- Instead of talking about “perpetual motion”, talk about “over-unity”; that is, gearboxes, transformers, etc, in which the power out is greater than the power in

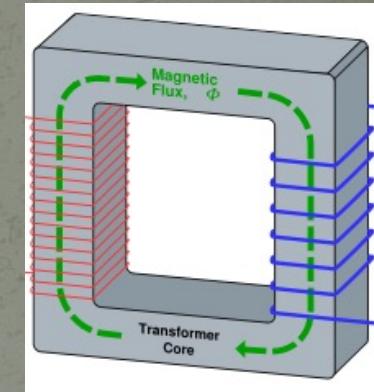
$$P_{in} \equiv \tau_{in} \omega_{in}$$

in torque  
angular frequency



$$P_{in} \equiv I_{in} V_{in}$$

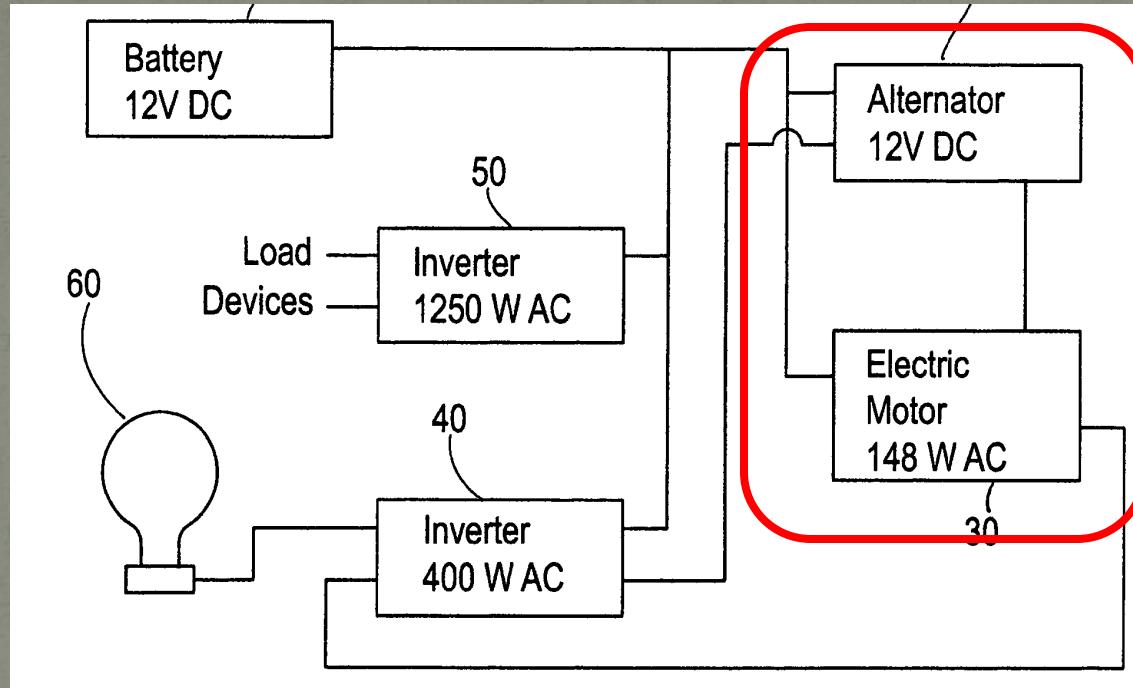
current  
voltage



- Physically,  $P_{out} \leq P_{in}$  - ALWAYS
- “Over-unity” = “perpetual motion” - PERIOD

# In case you thought my example was silly

US Patent #7,095,126: "Internal Energy Generating Power Source" (2006)



## ABSTRACT

An external power source such as a battery is used to initially supply power to start an alternator and generator. *Once the system has started it is not necessary for the battery to supply power to the system. The battery can then be disconnected.* The alternator and electric motor work in combination to generate (sic) electrical power.

# Speaking of patents

- A *partial* list of US patents purported to support perpetual motion:
  - 2,006,676: “Electrolytic Carburetor” (Garrett Carburetor)
    - Launched a whole kook industry
  - 4,074,153: “Magnetic propulsion device”
  - 4,151,431: “Permanent magnet motor”
  - 4,215,330: “Permanent magnet propulsion system”
  - 6,246,561: “Methods for controlling the path of magnet flux...”
  - 6,362,718: “Motionless electromagnetic generator”
  - 6,523,646: “Spring driven apparatus”
  - 6,526,925: “Piston driven rotary engine”
  - 6,962,052: “Energy generation mechanism, device and system”
  - 7,095,126: “Internal energy generating power source”
    - The one we just talked about

# Patents and perpetual motion

- The Patent Office has had so much trouble with perpetual motion machine patents that it's developed special rules:

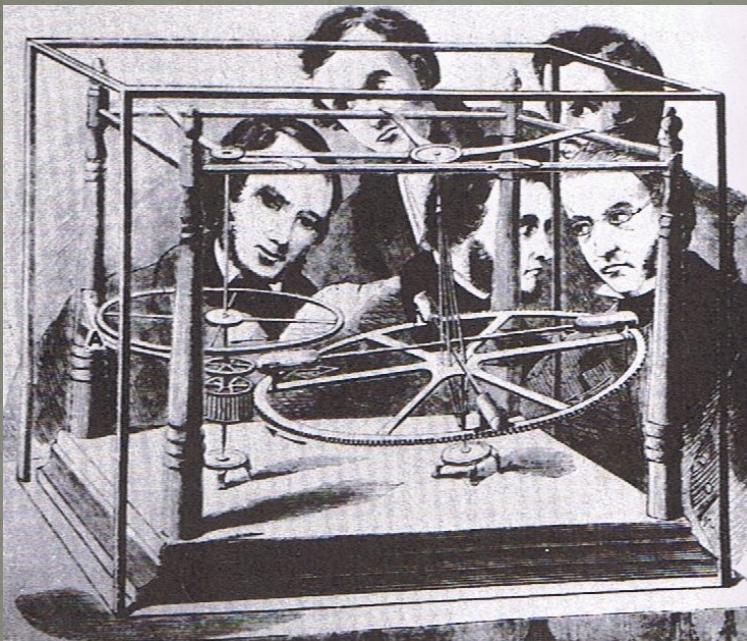
*“With the exception of cases involving perpetual motion, a model is not ordinarily required by the Office to demonstrate the operability of a device. If operability of a device is questioned, the applicant must establish it to the satisfaction of the examiner”*

- 35 U.S.C 101 (Examiners' Handbook)

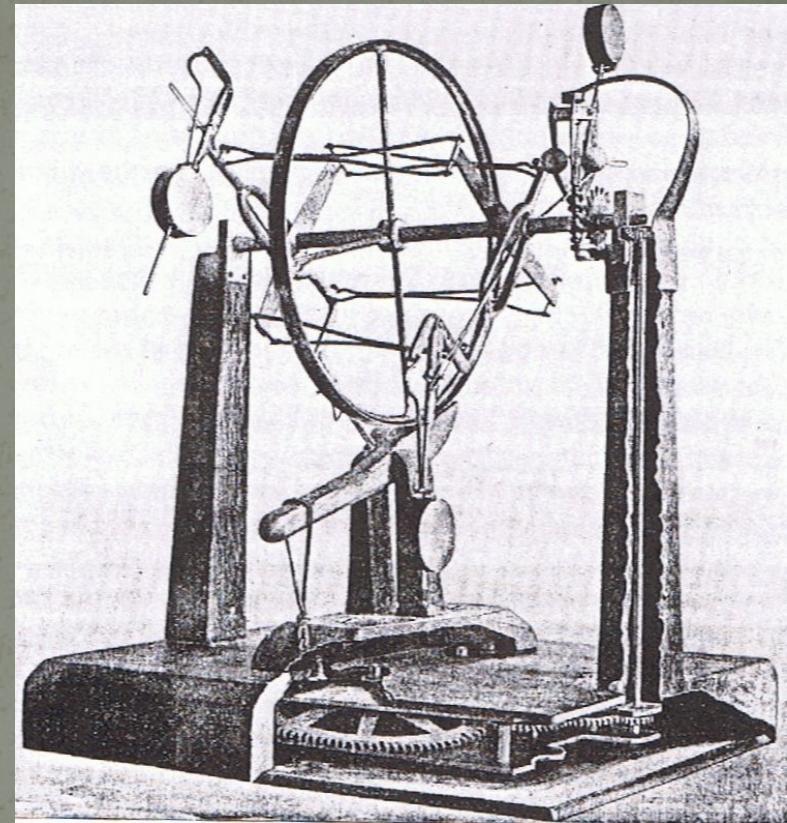
Translation: “If the Patent Office didn't ask for a working model, they didn't believe it was a perpetual motion machine”.

# Early frauds

- Perpetual motion was mostly an intellectual curiosity, until the Industrial Revolution convinced people of its “value”



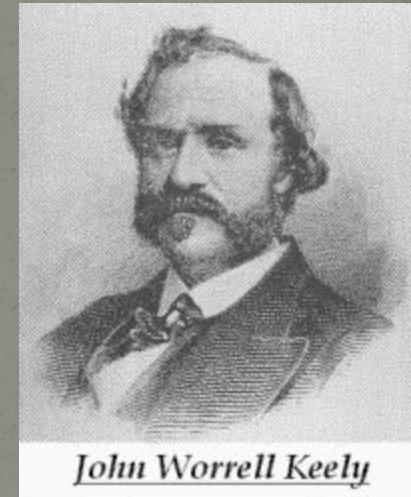
- E.P. Willis' “overbalanced wheel” ran on hidden compressed air.  
(1850's)



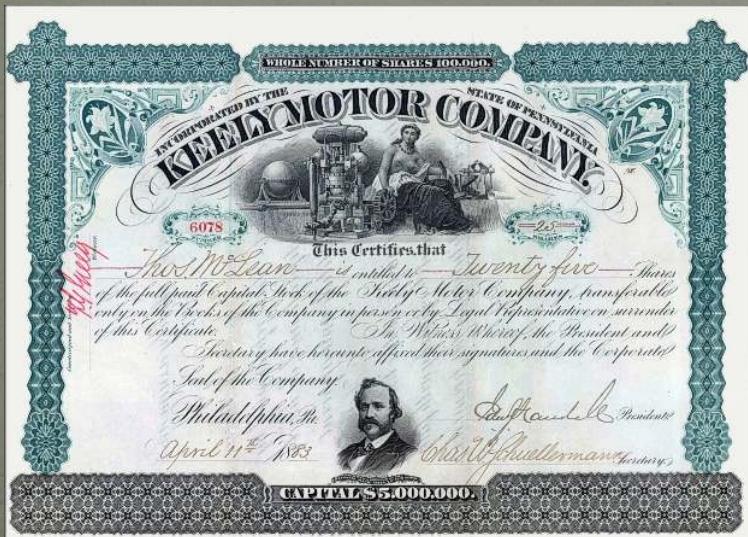
- J.M. Aldrich's machine ran on hidden springs (1899)

# John Keely: the father of the free energy scam

- There were numerous perpetual motion frauds in the 19<sup>th</sup> century, but most were pretty small scale
- In 1872, John E. Worrel Keely claimed to have discovered a new type of motor, which used some sort of musical resonance to extract energy from the “luminiferous ether”.



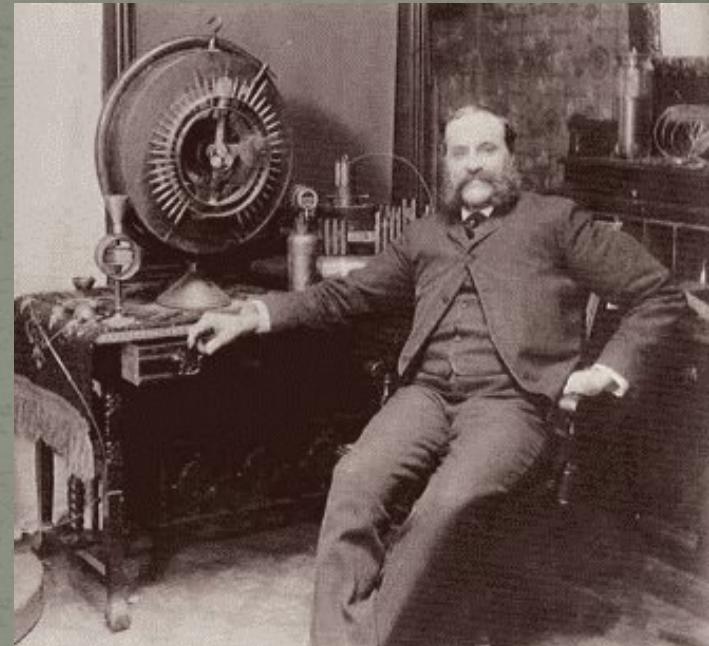
John Worrell Keely



- He formed the “Keely Motor Company”, began giving public demonstrations and selling stock.

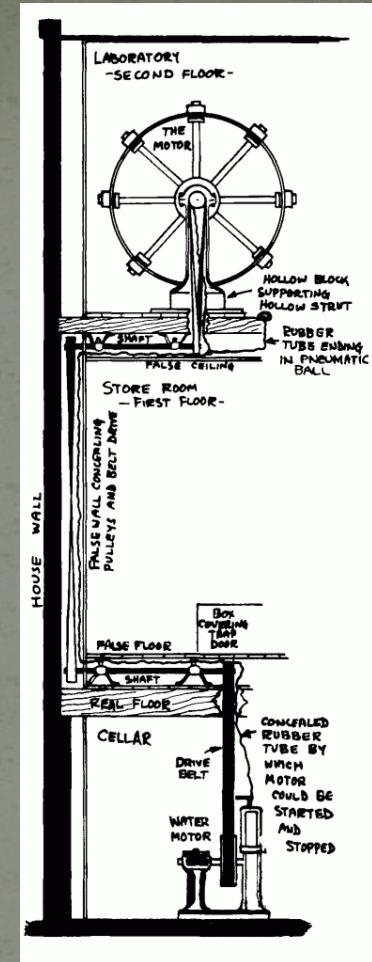
# Keely and his times

- In the context of the times, Keely's claims were not all that unbelievable:
  - This was before Special Relativity, and “Luminiferous Ether” was the hypothetical fluid through which electromagnetic waves, including light, propagated.
  - This was the golden age of empirical physics, and finding a way to extract energy from this medium was not yet experimentally ruled out.
- Keely's *behavior*, on other hand, should have raised some alarm bells
  - He never published any data regarding the mode of operation of his machine in scientific journals.
  - He never allowed any independent test or even inspection of his machine.



# Keely: postmortem

- “Scientific American” had always been skeptical of Keely. Following his death, they inspected his home.
- They discovered an elaborate system of pipes and hoses, connected to his machines through hollowed out legs on the furniture!



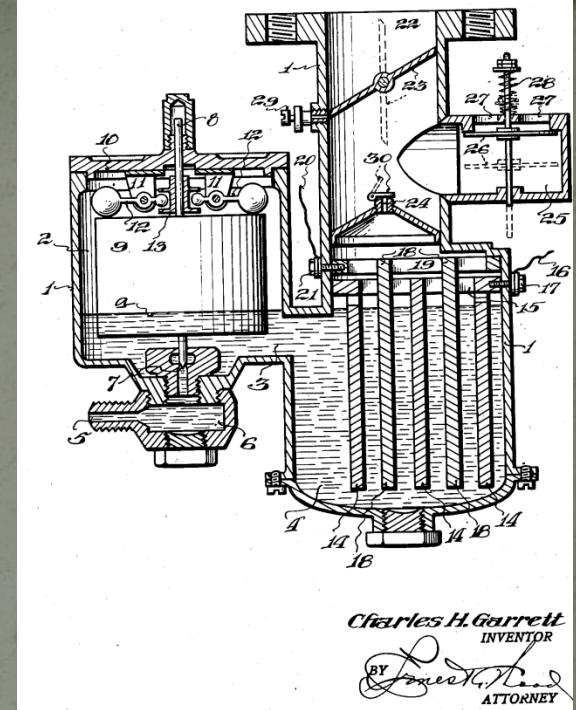
- The entire system was powered by a compressed air tank in the basement.

# Major classes of modern free energy devices

- Motors that run on permanent magnets
  - Usually find excuses to connect them to batteries
- “Over-unity” transformers that put out more electrical power than they take in.
  - Rather than admit they are selling a perpetual motion machine, they will usually claim to be tapping the “Zero Point Energy” (ZPE)
- Engines that run on water
  - Generally deny being “perpetual motion machines”
  - Instead claim to split water into H and O with “very high efficiency”
- Fancy jars of goo
  - Cold fusion
  - Self-charging batteries
  - Yet more ZPE devices

# Motors that run on water

- Tapping the energy of water is to the “free energy community” what the Philosopher's Stone was to alchemists.
- Even Keely himself claimed to have a motor which ran on water in 1890.
- A patent was issued in 1935 for the “Garrett Carburetor”, which set the standard for countless water schemes to follow. The principle is quite simple:
  - Invent an “efficient” way to use electricity to separate water into Hydrogen and Oxygen.
  - Burn the Hydrogen.
  - Use a small amount of the energy to generate electricity to produce more Hydrogen.



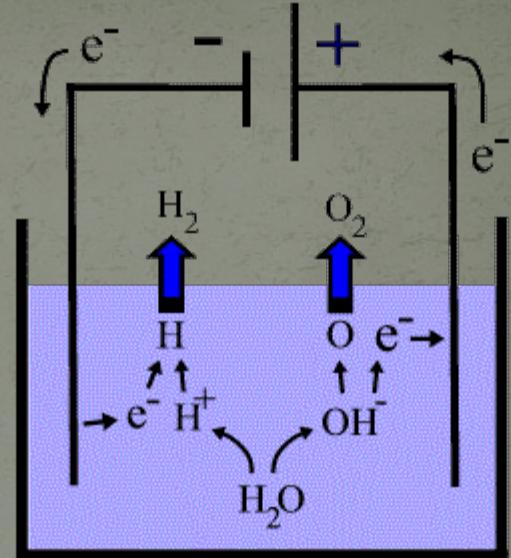
# The problem

- Burning Hydrogen and Oxygen produces water.
- Remember the First Law of Thermodynamics
  - An engine that runs on water
    - Starts with water
    - Ends with water (i.e. in the same state)
    - Extracts useable energy

**Cars that run on water violate the laws of physics as we know them**

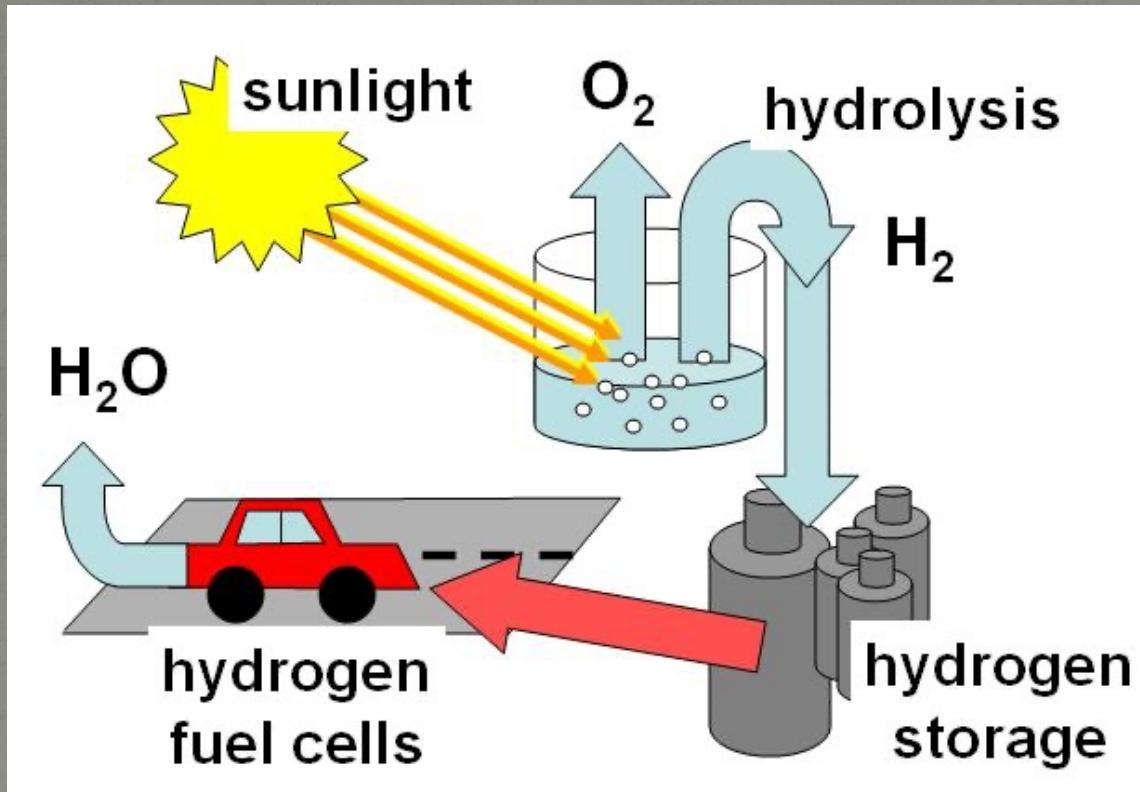
# Electrolysis: in the real world

- Electrolysis is the process by which electricity is used to break water into Hydrogen and Oxygen
- Energy is released when the Hydrogen and Oxygen are recombined , which again produces water
- The energy released in recombining the Hydrogen and Oxygen *is always less than the energy used in electrolysis.*



# Application of Hydrogen cycle

- Hydrogen can be used to store energy from inherently intermittent sources like wind and solar



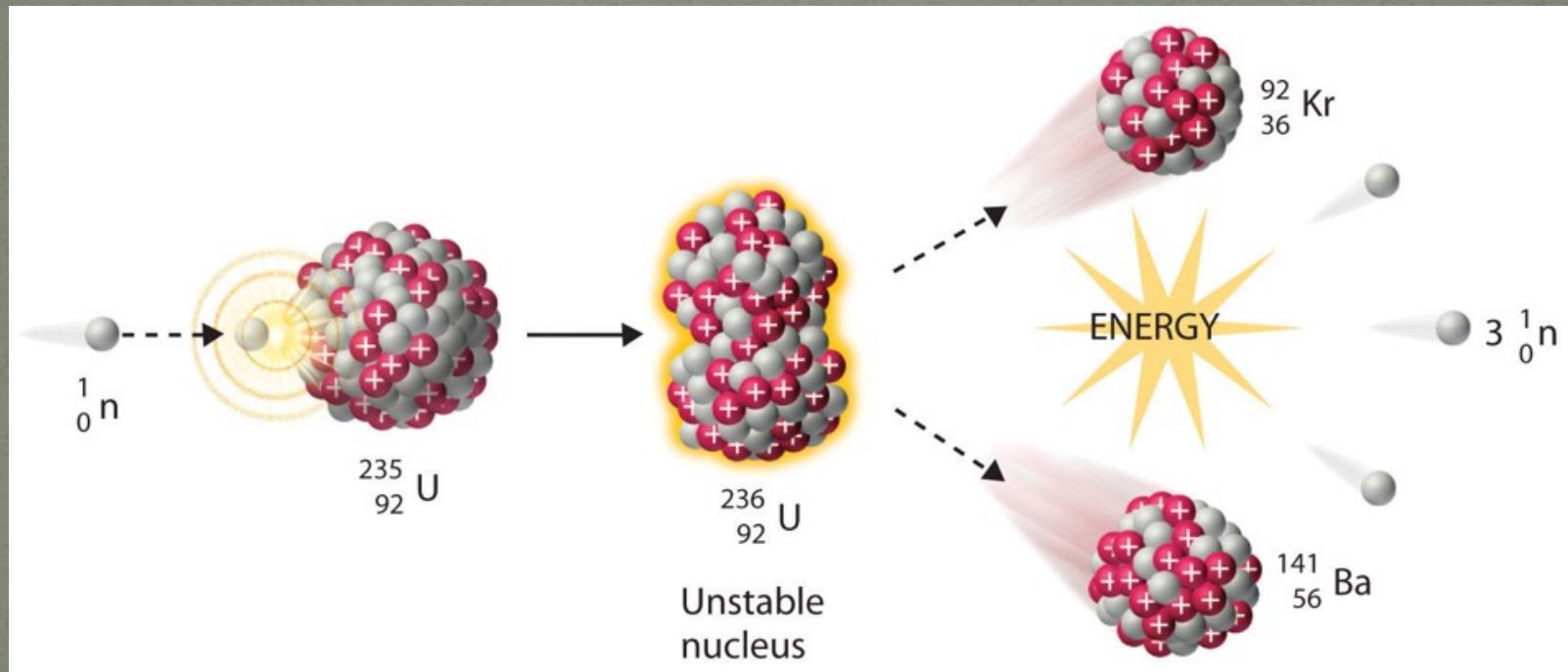
- Lots of practical problems to solve, but no problem with the laws of physics

# A Few Examples of Energy from Water Claims

- Stanley Meyer
  - Claimed to have a dune buggy that ran on water in the 1980s.
  - Never let anyone inspect it.
  - Patented everything before his death in 1986, but no one can make it work.
- Dennis Klein
  - In 2002, developed “Aquxygen”, which he claimed could extract energy from water.
  - Started me on this obsession.
  - I’ve moved this to my “Media” lecture, because they were very complicit.
- Genesis World Energy
  - Major investment scam started in 2002.
  - Promised cars and home generators running on only water.
  - The owner, Patrick Kelly, was sentenced to five years in jail in 2006.

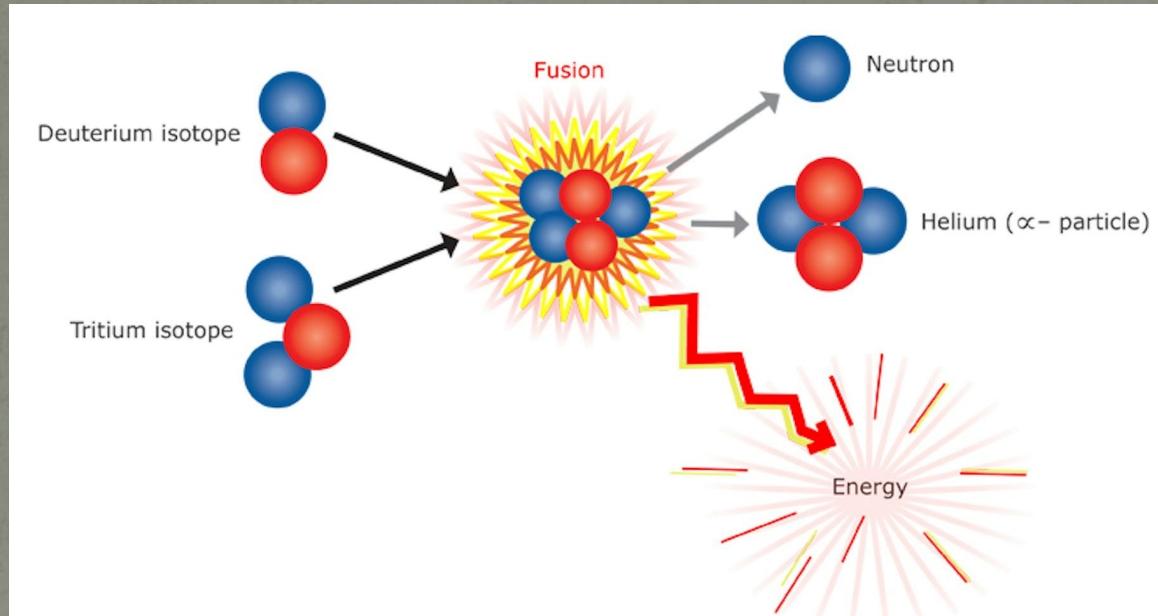
# Digression: Nuclear Fission

- All existing nuclear plants extract energy from nuclear fission; that is, breaking about heavy nuclei in a chain reaction.



# Nuclear Fusion

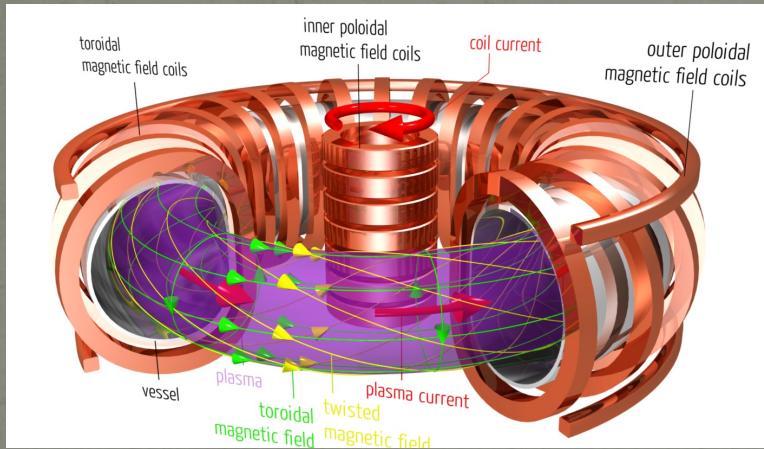
- We could in principle get more and cleaner energy by *fusing* lighter nuclei



- Unfortunately, it's *very* hard to do this.
  - We had a fission reactor before we had a fission bomb.
  - We've had nuclear fusion (thermonuclear) bombs for over 70 years, but we're still not even close to a reactor.

# Magnetic Confinement Fusion

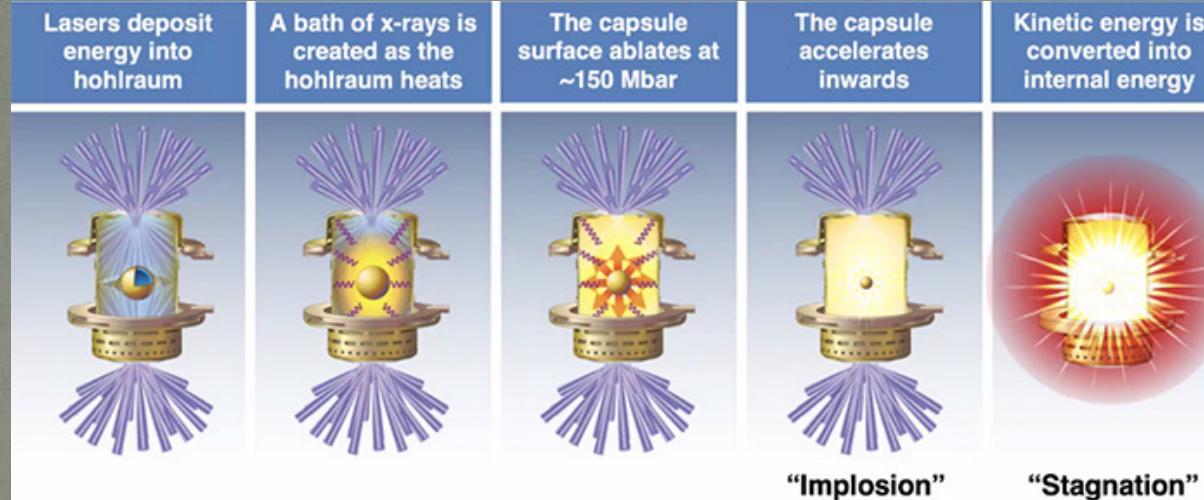
- Use magnetic fields to keep particles together long enough to fuse



- Example: ITER in France
  - Planning started in 1978
  - Construction started in 2007
  - Scheduled to demonstrate sustained fusion in 2039 (!!)
  - Demonstration machine only. Not a power reactor.

# Inertial Confinement Fusion

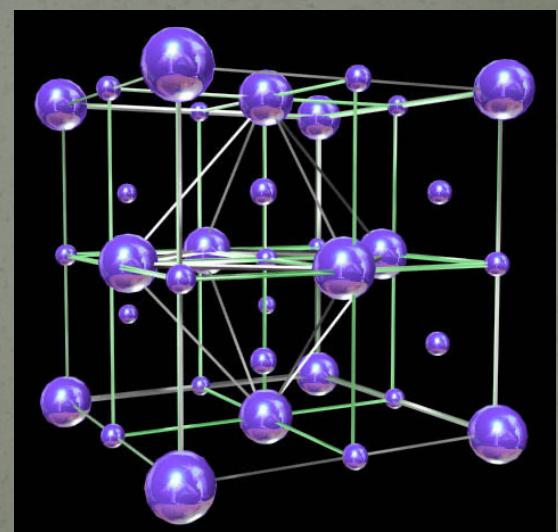
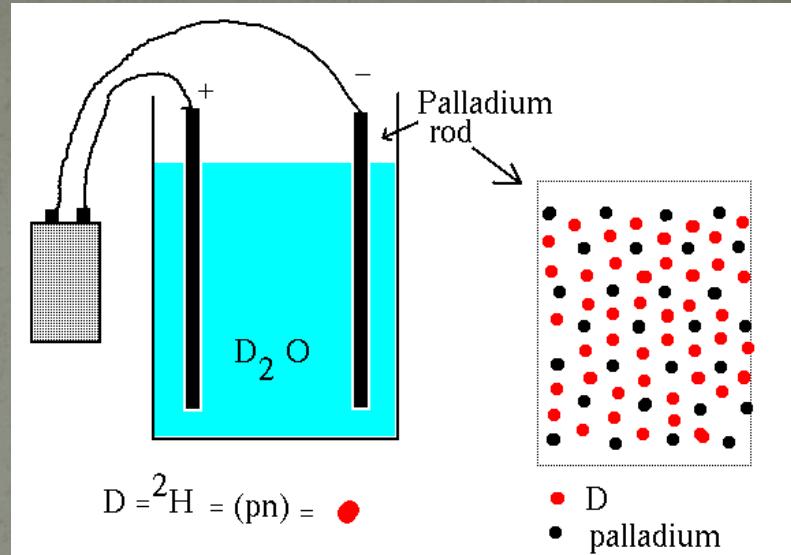
- Compress nuclei with powerful lasers.
  - Fusion happens before they can fly apart.



- Most successful facility is the National Ignition Facility at Lawrence Livermore National Lab.
  - 192 HUGE lasers
  - Some recent successes, but no clear path to a power plant
- But what if there were an easier way...

# Cold fusion: the revolution that wasn't

- In 1989, two teams announced they had seen evidence for nuclear fusion at room temperature taking place in a Palladium rod which had been loaded with Deuterium from heavy water.
- One team, Pons and Fleischmann, claimed energy release at a level which promised practical application.
  - The other, Rafelski and Jones, claimed much less energy and didn't make as much news.
- Although difficult to reconcile with solid state physics, there's nothing a priori impossible about the claim, and theorists struggle to accommodate the result.



# Problems Right Out of the Gate

- These are hard measurements, because palladium is very reactive
- Ordinary D-D fusion occurs through the reaction



- But the helium is excited and decays to

Should see  
neutrons



Should see helium  
and gamma rays

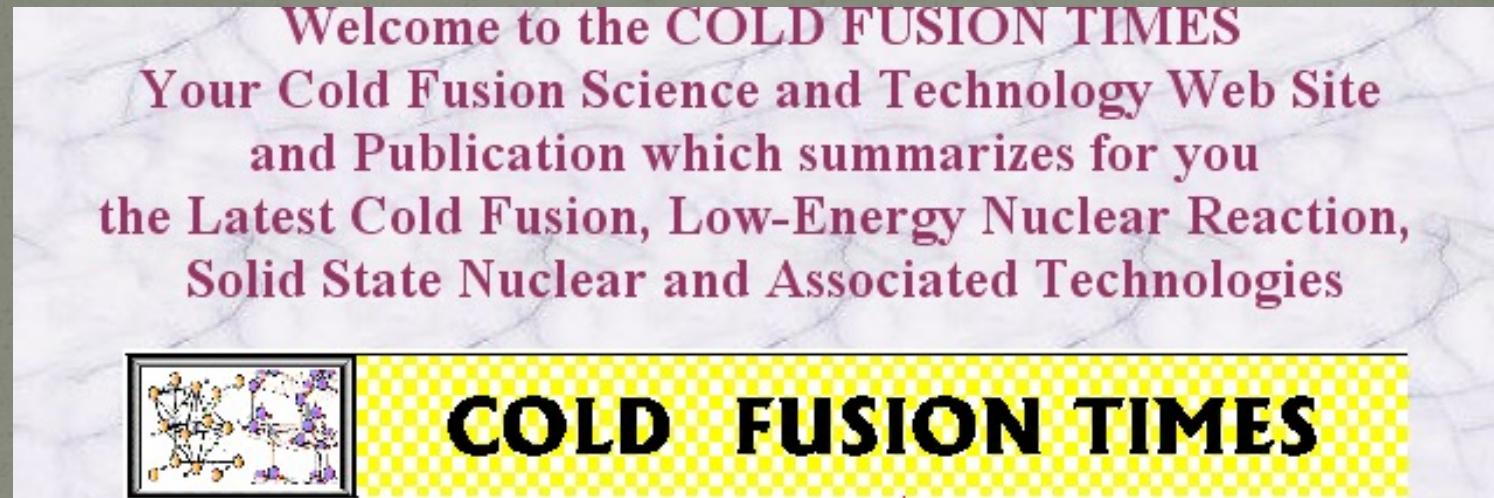
- P & F claimed they say 4000 neutrons/second, BUT
- Their claimed excess heat of 1 Watt should have produced  $10^{12}$  neutrons/second
  - Which would have been lethal!

# The road from fallacy to fraud

- By the 1989 APS meeting in Baltimore, many groups had tried to replicated the results, and no one had succeeded.
  - They added a huge evening session, attended by the press
- Nathan Lewis, a chemist at Cal Tech, offered an explanation for all of their results in terms of sloppy experimental techniques:
  - Pons and Fleischmann did not attend, as they were busy soliciting funds.
- In addition, obvious cross-checks were not done
  - Control test with ordinary water
  - Assay for Helium, the product of fusion
- Cold fusion was dead – scientifically anyway.

# And yet...

- Cold fusion is alive and well in the minds of believers



- There are magazines, websites, books, products, and conferences.
- Still makes the news ~once/year
  - “60 Minutes” episode even did an episode on it.

# What Became of Pons and Fleischman?

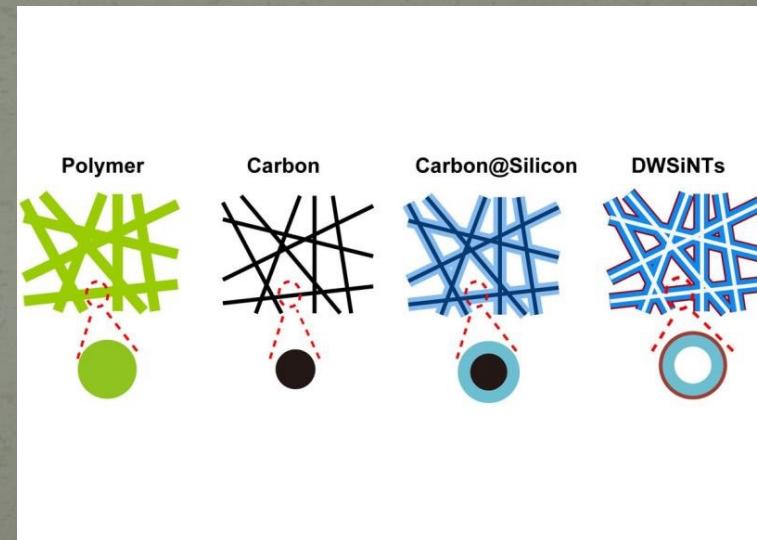
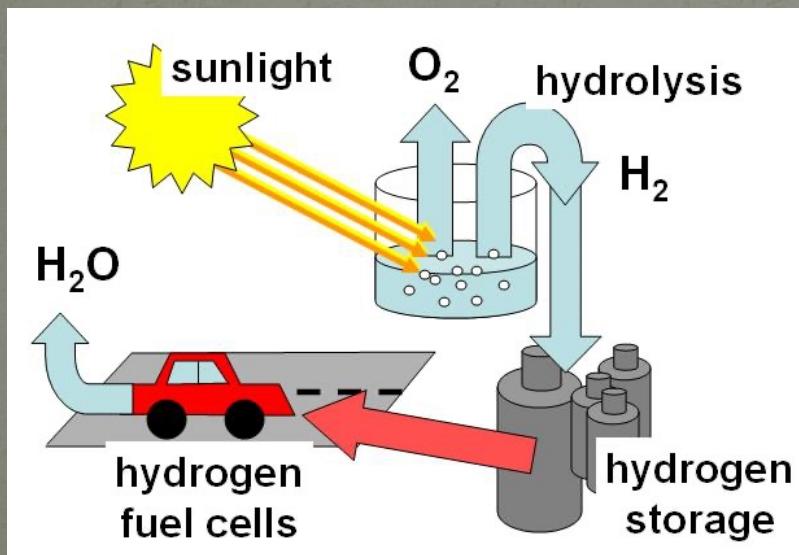
- They continued to solicit funding to do “research”, finally settling into a lavish “lab” in France.
- They moved to a lavish “lab” in France, funded by a subsidiary of Toyota.
  - They kept claiming positive results, but never published anything convincing.
- Eventually:
  - Fleischman retired to England, continuing to believe
    - Died in 2012 from complications from Parkinson’s Disease
  - Pons stayed in France, stopped doing research, and probably accepted the obvious.
- I recommend the documentary: “The Believers” (2012):
  - Available on Tubi and elsewhere

# Cold Fusion Research Today

- There are still a handful of people doing “serious research” in the cold fusion.
  - Even they admit that the vast majority of “researchers” are kooks and conmen
- They occasionally claim to see positive results, but they are not at all consistent with each other (very important)
- They’ve split into two groups:
  - Groups that claim to see the expected neutrons and therefore claim it’s ordinary D-D fusion
  - Groups that don’t see neutrons and claim it’s some sort of new “Low Energy Nuclear Reaction” (LENR)
  - These groups are very good at debunking *each other!*
  - None of them claim anything like the energy excesses Pons and Fleischman claimed.

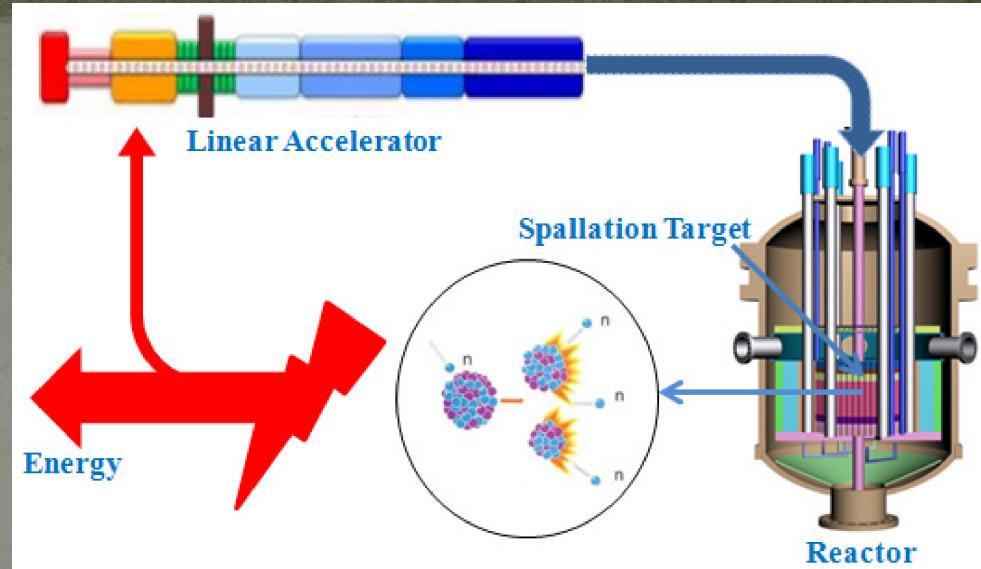
# Hope for the Future

- Solar and Wind?
  - “Free”, but intermittent
  - The science is in finding ways to store the energy
    - Hydrogen economy
    - Pumping water uphill
    - Compressed gas
    - Better batteries



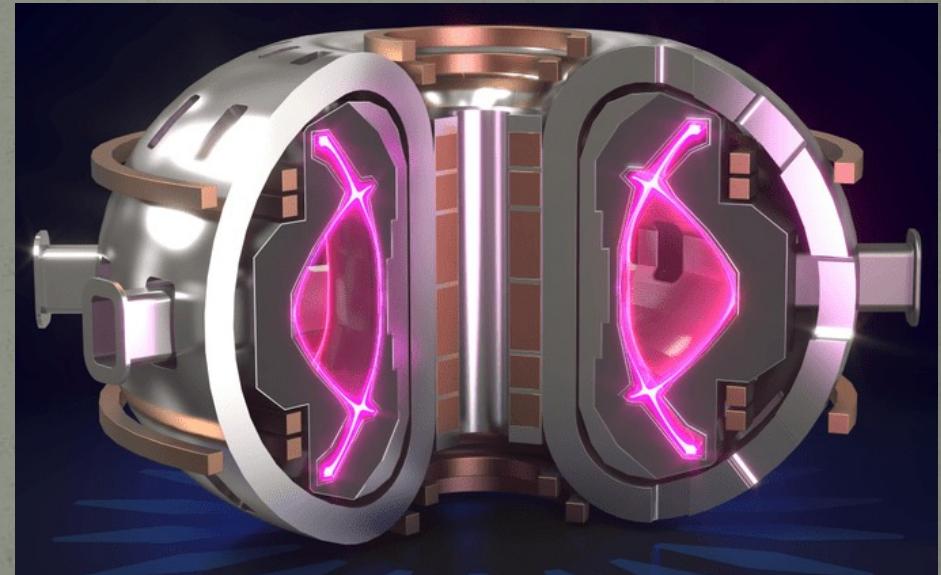
# Hope (cont'd)

- Accelerator-driven sub-critical systems
  - Use a particle beam to drive a sub-critical pile of fissionable material into criticality.
- Pros:
  - Beam goes off -> reaction stops (no danger of a melt-down)
  - Can burn thorium
  - Can burn non-enriched fuel (no-proliferation danger)
  - Burns up long-lived waste
- Cons:
  - Difficult and expensive.
  - This generating a lot of interest in India, which has a LOT of thorium.
  - Stay tuned...



# Compact Fusion Reactors?

- A number of companies are exploring compact fusion reactors as an alternative to ITER.
  - Some are straight up scams.
  - Others are sincere, but (IMHO) overly optimistic.
  - e.g. Commonwealth Fusion Systems, which spun off from MIT
- Time will tell.



# Some final comments

- This is just the tip of the iceberg
  - Just go to YouTube and search for
    - Tom Bearden
    - Joe Newman
    - Stan Meyer
    - Bedini Motor
    - Or just “free energy”
  - Watch the videos and *read the comments*
- Perpetual motion is just one facet of our society’s obsession with pseudo-science
  - Compare the Astrology section of bookstore with the Science section.
- We will never solve the daunting (and exciting) energy challenges facing us unless we first face reality.