

Context & Thoughts on LANR/LENR

March 24, 2019

Carl Page

Anthropocene Institute





Anthropocene Institute

M | **ENERGY INSTITUTE**
UNIVERSITY OF MICHIGAN

ecoAmerica
building climate leadership

The logo for eGroups, featuring a stylized flower or sunburst made of seven colored petals (blue, green, yellow, orange, red, brown, and light blue) above the word "eGroups" in a bold, italicized, black sans-serif font.
eGroups



CalCars
THE CALIFORNIA
CARS INITIATIVE

Organization

Founded by Barbara and Carl Page

Ocean Conservation for Resilience.

Dispel Roadblocks to Long Term Success

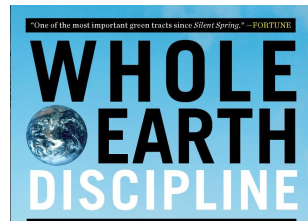
- Enable Good Long Term Corporate Decision Making.
- Inspire Public to Take Action in Self Defense on Climate, Energy, Health.

Cheap Clean Energy Research and Development.

- Small companies.
- University research groups.

Slides Will Be on
web AnthInst.org

No Hand Wringing!



*We are as gods, we **HAVE** to get good at it.
--Stewart Brand.*

Being Less Bad
is Not Being Good.
--William McDonough.



Agenda:

Establish the Objective- Great minds on emerging condensed matter physics

who

ultimate goal. context.

Modest Proposal: Stop All Pollution Now...

H+ Ocean Acidification

COO Greenhouse Gases

N Nitrogen

P Phosphorous

Mud Run-off - Enhanced erosion

Germs Disease agents, PM2.5

Sprawl Footprint Pollution - Habitat

Garbage Trash

Clean
Up
After
Yourself

...And Make Money Doing It!

While Respecting Human Rights Better All The Time

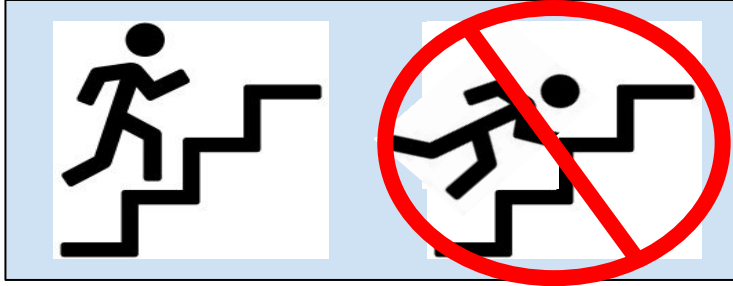
How many people can the Earth Support?

All the people who support Earth!

**There's room for everyone who makes Earth better than
they found it.**

***Bad things happen
to Fatalistic people!***

Greatest danger- Half Steps.



If all the ineffective ideas for solving the energy crisis were laid end to end, they would reach to the moon and back

--David J. C. MacKay

If you're going through Hell... Keep going!

Never Waste a Good Disaster.

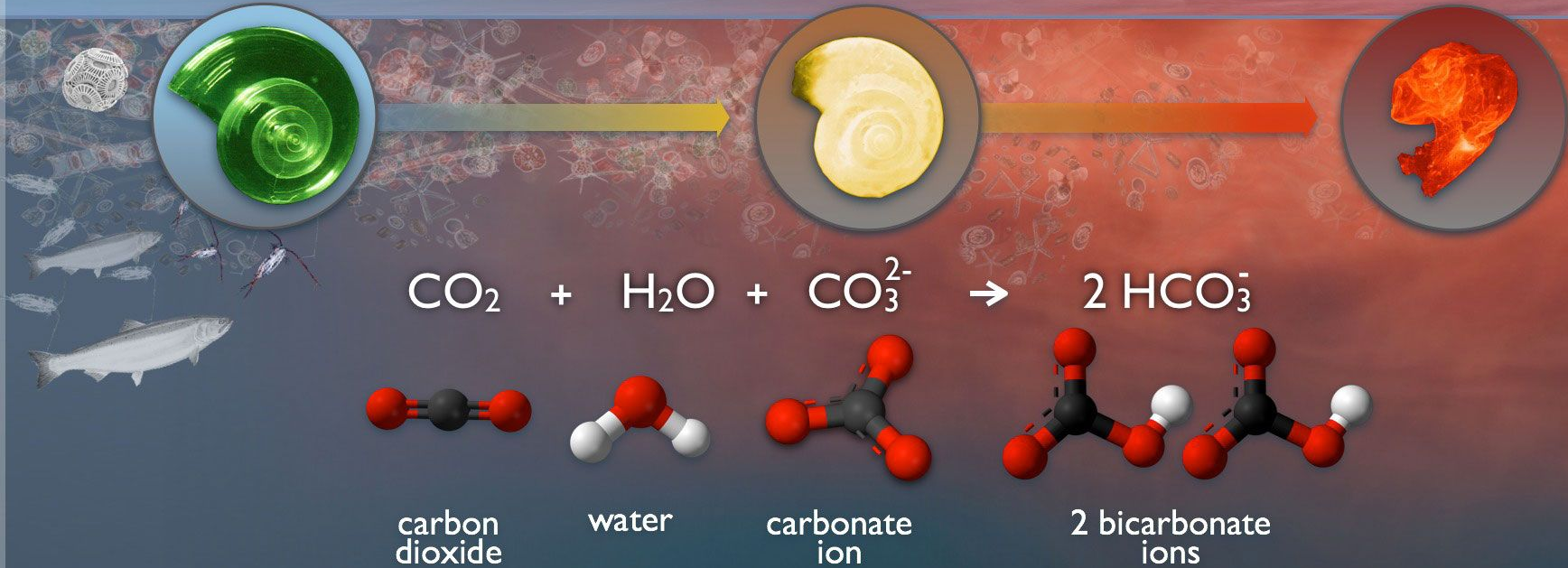
--Winston Churchill



Ocean Acidification- A simpler, sooner, Tipping Point

HOW WILL CHANGES IN OCEAN
CHEMISTRY AFFECT MARINE LIFE?

CO₂ absorbed from the atmosphere

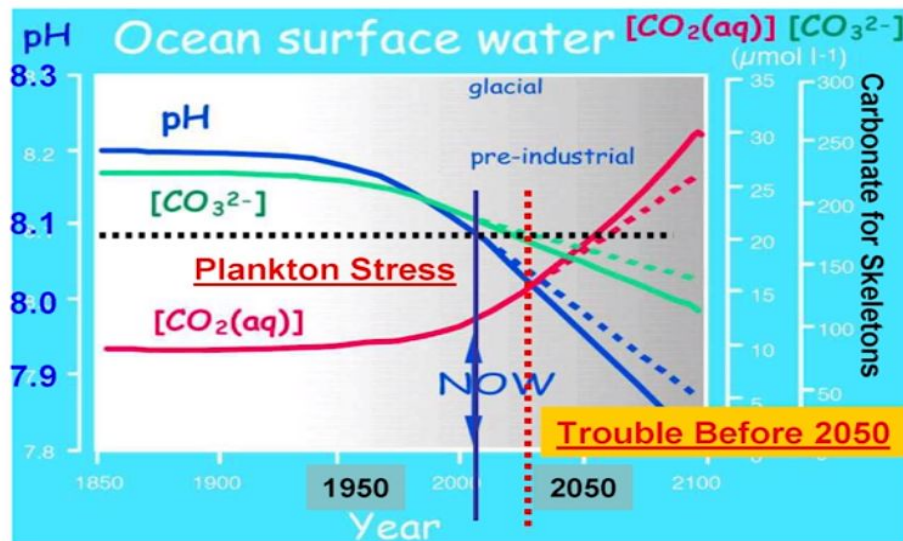


consumption of carbonate ions impedes calcification

Acidification & Extinctions

~30% of all ~1.5 trillion tons of CO₂ emissions are now in oceans creating less alkaline seawater, affecting entire sea food chains -- sea life provides ~20% of all human food protein – “The Sixth Extinction” by Kolbert 2014

www.kqed.org/a/forum/R201405260900

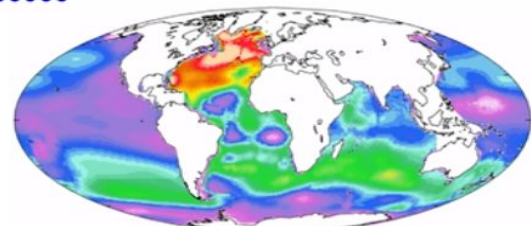


www.ocean-acidification.net/

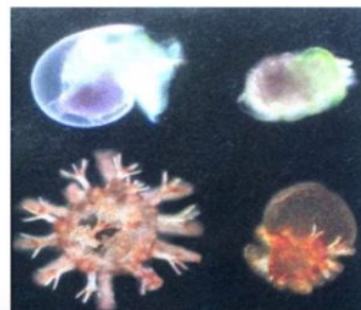
<http://tinyurl.com/6mtd8db>

www.noaa.gov/video/administrator/acidification/index.html

www.bbc.co.uk/news/science-environment-18938002



Anthropogenic CO₂ In Seawater



Deformed Larvae

Warmer, acidifying North Atlantic

The Uninhabitable Earth

Life After Warming

David
Wallace-Wells

Anthropocene Institute

Copyrighted Material

"THE MOST IMPORTANT BOOK ABOUT
CLIMATE CHANGE SINCE *AN INCONVENIENT TRUTH*."

—from the foreword by **STEVEN PINKER**

A B R I G H T F U T U R E



How Some Countries
Have **Solved Climate Change**
and the Rest Can Follow

JOSHUA S. GOLDSTEIN

STAFFAN A. QVIST

Subgoal:

Vast Abundant Ubiquitous Cheap Clean Safe
Energy. Zero Pollution.

Energy consumption should increase dramatically.
Industry revenues can increase reducing opposition.

Anthropocene Institute is trying to make a difference
developing new relevant energy technologies and
re-evaluating safety from a whole-system perspective.



is committed to giving our children a healthy climate and a thriving planet. It is an education, networking and advocacy program of the [Foundation for Climate Restoration](#). Giving future generations a healthy climate like our grandparents had. HCA serves as a bridge between the public, policy-makers and tech/business experts.

A Goal is where we WANT to Go.

Up Till Now Climate Goals have been focused on Avoiding or Delaying Catastrophe. With the Center for Climate Restoration, Generating Roadmaps to restore the climate.

See also : [Climate Mobilization](#), [Extinction Rebellion](#), and the [Sunrise Movement](#). Bi-partisan support for the [Green New Deal](#).

One-Cent Clean Energy

Coming Soon.

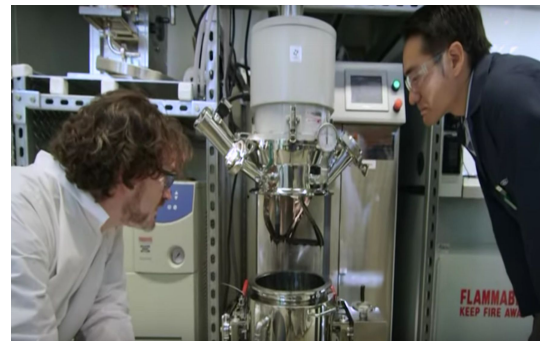
A milestone to Anticipate.

New Wind selling at 2 cents around the world.

Dam-free micro-hydropower growth potential.

Electrical Storage to firm up the above.

- ★ Innovative atomic energy.
- ★ MSR?
- ★ LENR?



Michigan Battery Lab

Missing
the Target



Alphabet's
Makani energy
kite system



Sustainable abundance and prosperity.

Minimum ethical economy.

Carbon Free!

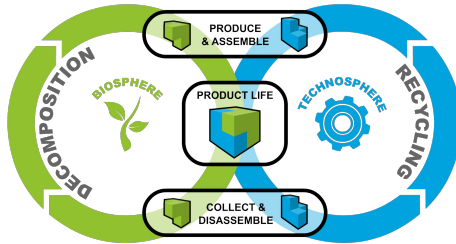
Intentional Design For Sustainable Industrial and Natural Ecosystems.



50 Years



12 Billion Affluent City Dwellers
enjoy Clean Air & Water



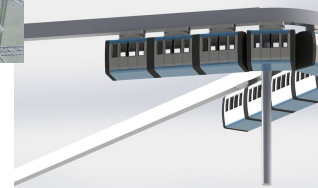
Cradle to Cradle

Upcycling the industrial food chain

Mostly Electrified Economy

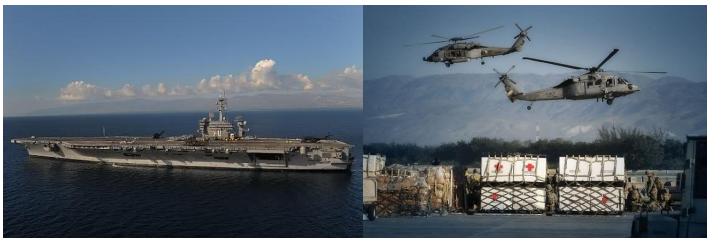


Great food using far
less cropland and
Fossil ag-chem



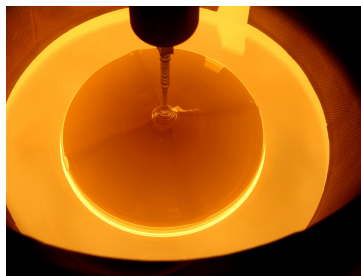
Cheap transportation and shipping

Let's Clean Up After Ourselves



Full Scale Disaster Recovery with Weatherproof Resilient Life Support & Energy Infrastructure

Large scale desalination for
people, farms and wild areas
facing drought.



Industrial Heat

More Wild Lands & Seas

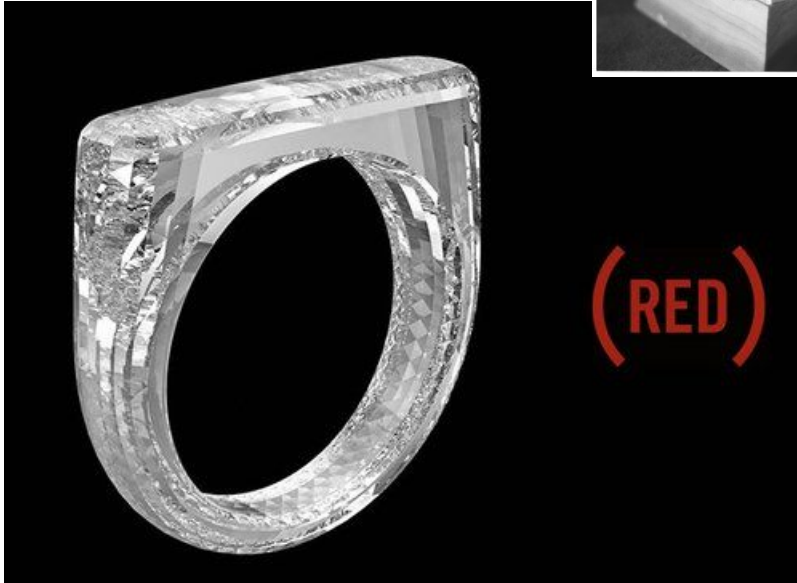


Carbon Neutral Fuel

Exponential Technology

Exponential Roadmap

Singularity
University



(RED)



NEW YORK TIMES BESTSELLER

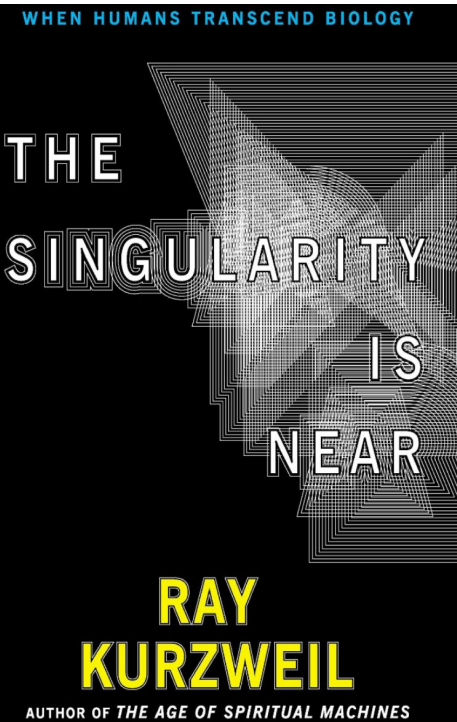
"A manifesto for the future that is grounded in practical solutions addressing the world's most pressing concerns." —*The Wall Street Journal*

Abundance

THE FUTURE IS
BETTER THAN YOU THINK

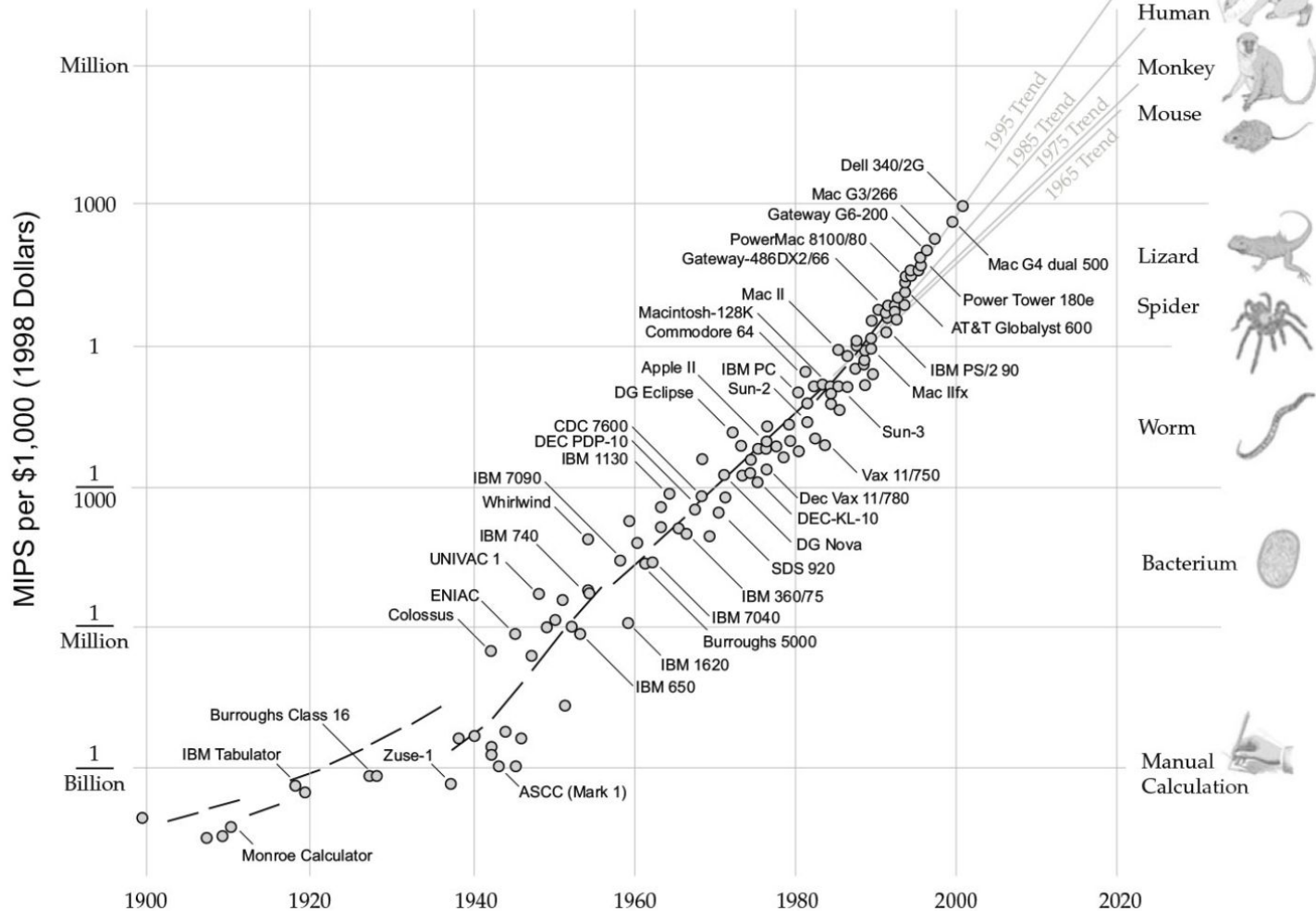
NEW
EVIDENCE
FOR
ABUNDANCE

PETER H. DIAMANDIS • STEVEN KOTLER

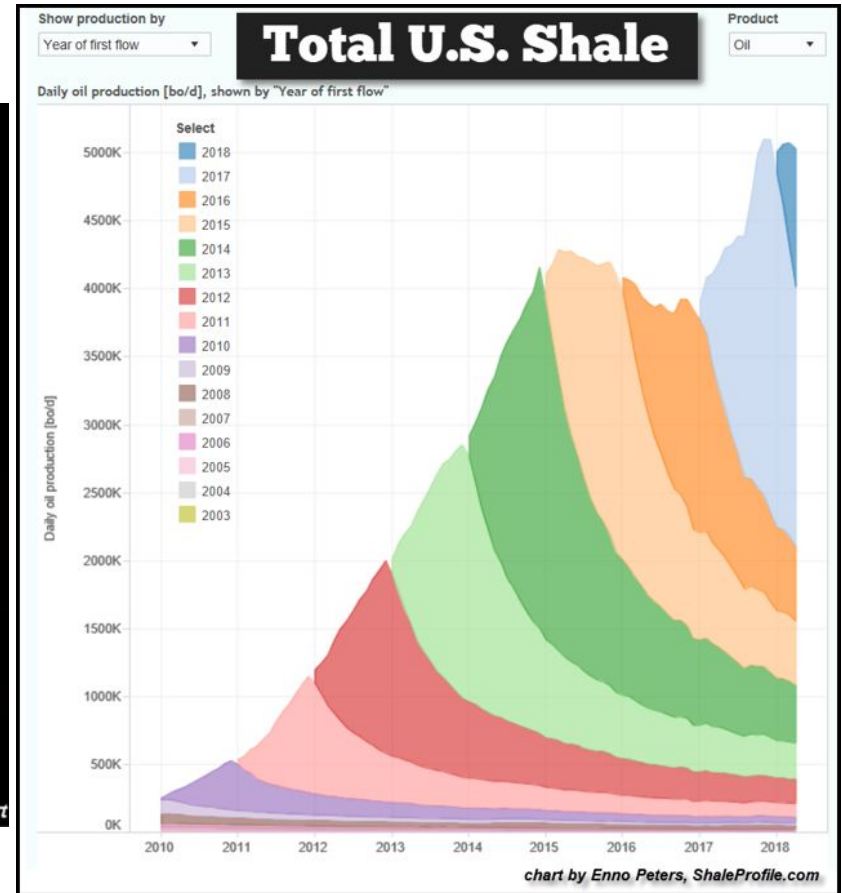
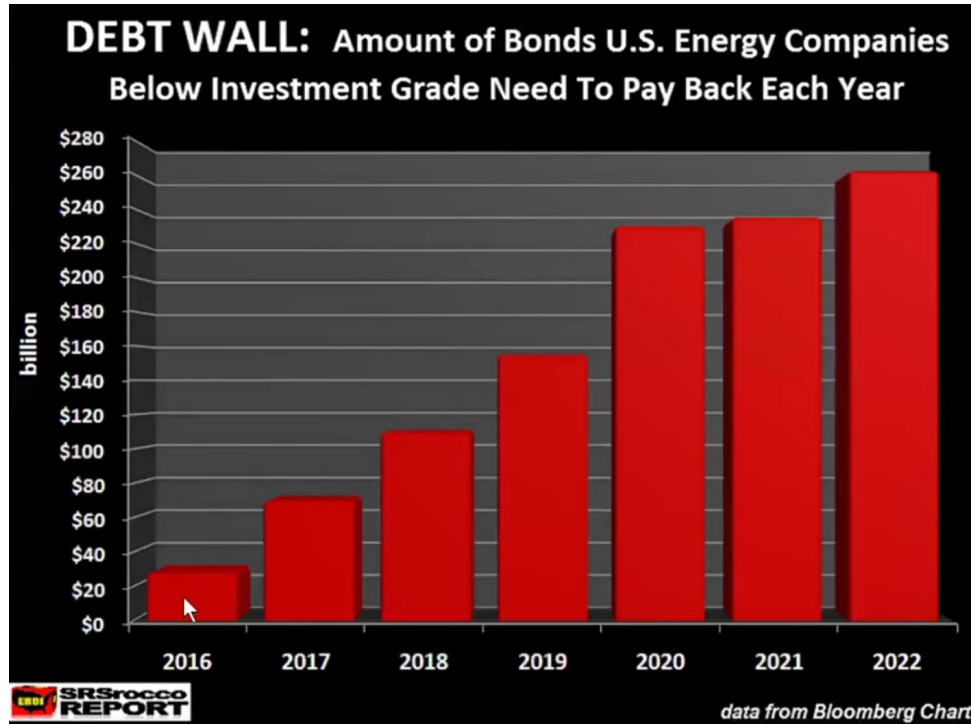


Evolution of Computer Power/Cost

Brainpower Equivalent per \$1,000 of Computer



Frack Shale Ponzi Scheme?



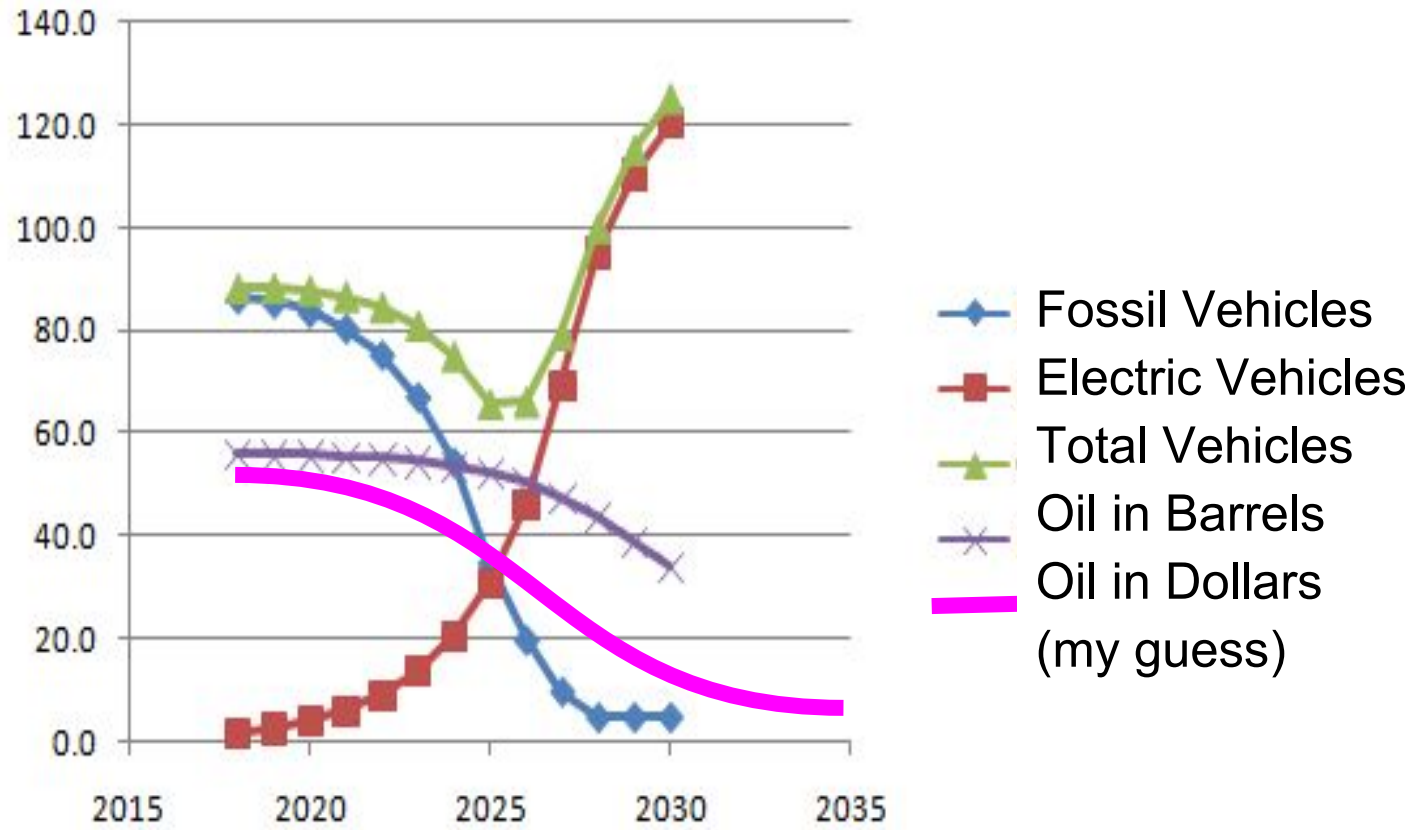
Not yet Ma!
I'm doing so well.
Still have more oil to go.
Then we'll save the Earth.

Stop burning those
Dinosaurs! Give it rest!
We're out of time!



Collapse
of oil
revenues
imminent.
Regardless
of Govt
policy.

Graph from Seeking Alpha
Ross Tessian, plus guesswork





1 IN 3 NEW CARS
IN PALO ALTO
IS ELECTRIC

PALO ALTO IS THE **#1 CITY IN THE COUNTRY**
BY PERCENTAGE OF NEW ELECTRIC VEHICLES*

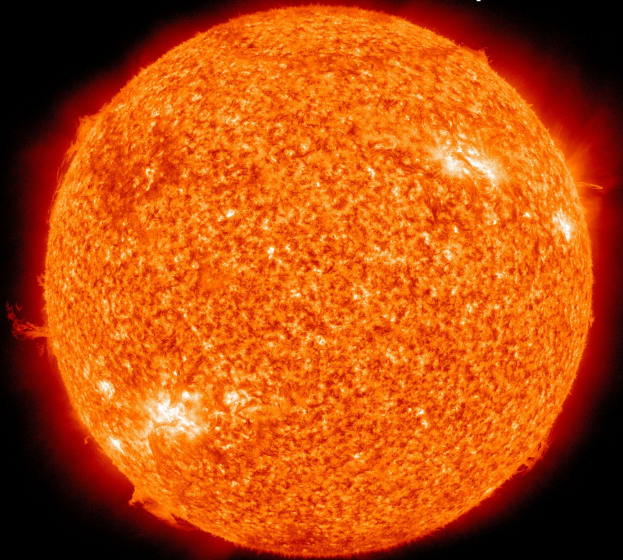
IT'S TIME TO GET CHARGED UP

A silver Chevrolet Bolt EV sedan is shown from the rear side, parked on a road. The car has a sleek, aerodynamic design with a prominent rear spoiler and LED taillights.

Nature Laughs at Fossil Fuels.

Energy(\$) is 90,000,000,000,000,000 times fuel g.

$$\text{\$} = 9\text{E}16 * \text{fuel}$$



Powerup: 100 kinds of atomic energy accessible

Younger Folks don't remember why "Nuclear" provokes Hate. In the 1980s a Full Court Press Against "Nuclear industry" because:

- Govt was building a Surprise First Strike Only Weapon
- Arms race cost seemed to be crippling social goals.

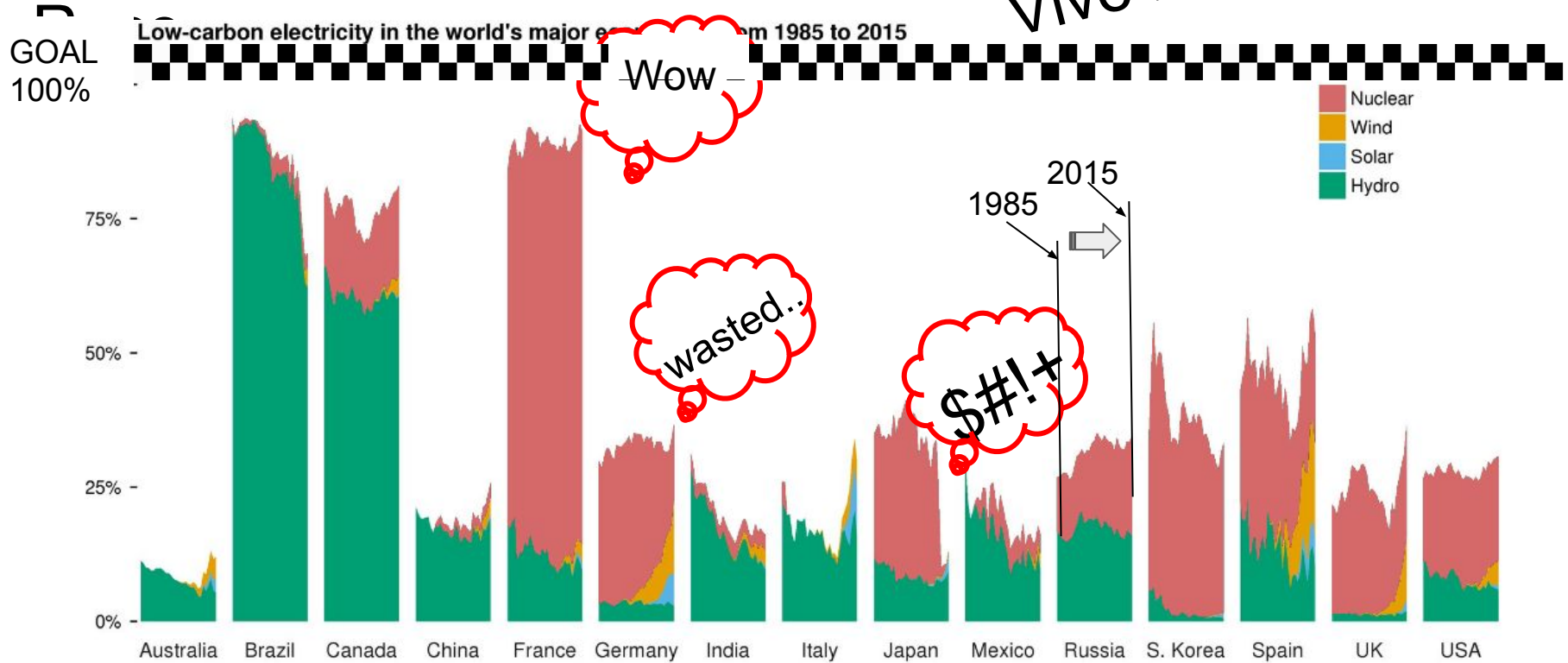
It's Time to stop this crippling battle.



Test launch of a Peacekeeper ICBM by the [1st Strategic Aerospace Division](#) (1 STRAD), [Vandenberg](#)

International Decarbonization

Vive la France!

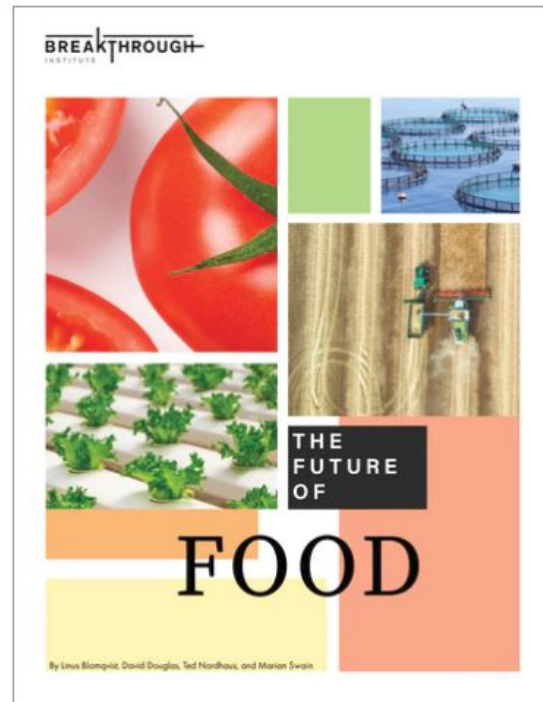
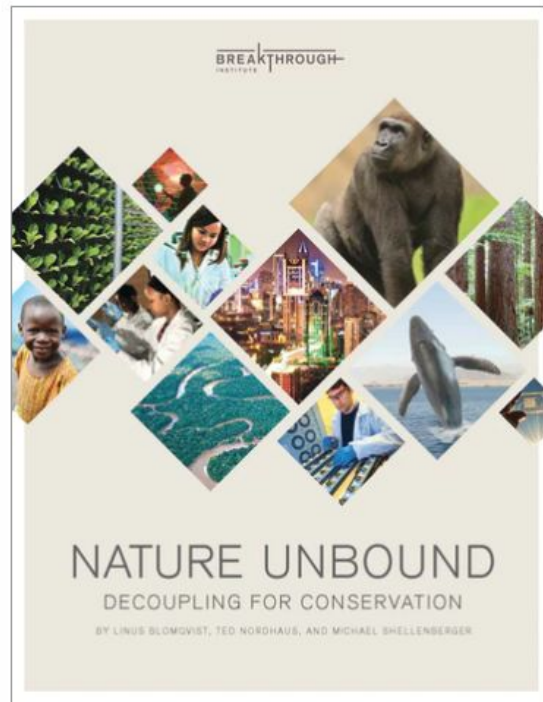
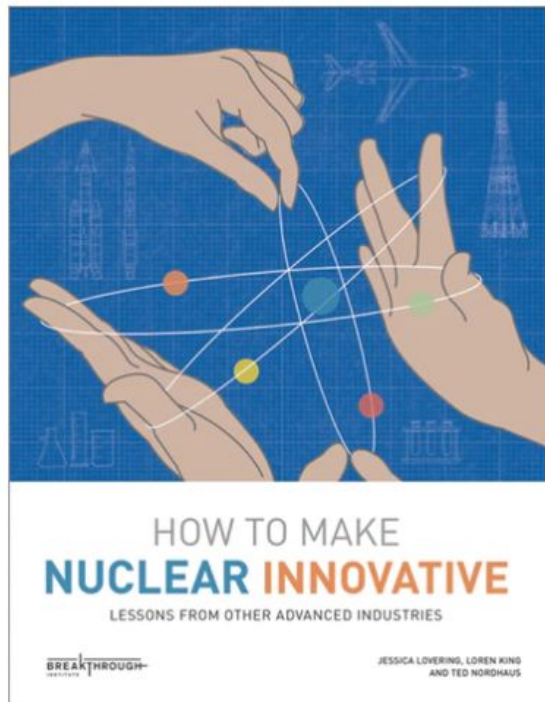


Data source: BP Statistical Review of World Energy 2016
Note: Russian data begins in 1990
Figure by: robert.wilson@strath.ac.uk

Inspiring Goals



Technological Solutions to Environmental Challenges



Even
Fusion
has
Startups

FUSION INDUSTRY ASSOCIATION



Startups Hosting Science?

- + Vast fast cash for equity.

PROS

- + Freedom from Bureaucracy, Academic Nepotism, Silos

- + Imperative to have economically relevant, positive plan.

- + Investors can help you many ways.

- + Coworkers share in the upside.

- + Can work in secret. No need to publish.

Can work the Press Release system

CONS

- Must work in secret. Patents, investors, competitors, trade secrets.

- Must fundraise. Investors can be frustrating. Dilution.

- Buzzword compliant? Exit Strategy? Market share? Market size? Time to Market? IPO?

- Pressure to claim we are close to commercialization.

Save the whales! Shutdown coal. Improve Nuclear.

1960s style Light Water Reactors

Terrible design.

Mostly Kludges.

Great track record.

Uncompetitive today.

The AP1000 and EPR
troubles in China seem
like LWR industry's last
gasp.





Big majority (73%) of Americans In Favor of Inherently Safe Nuclear Power!

Q: American engineers invented molten salt reactors in the early 1960s to be cheap, produce little waste, and be fail-safe so human errors can't cause widespread damage.

Power failures and mechanical breakdowns can't damage anything outside the building.

Some nations and several small companies in the USA are now racing to bring it to market for the first time.

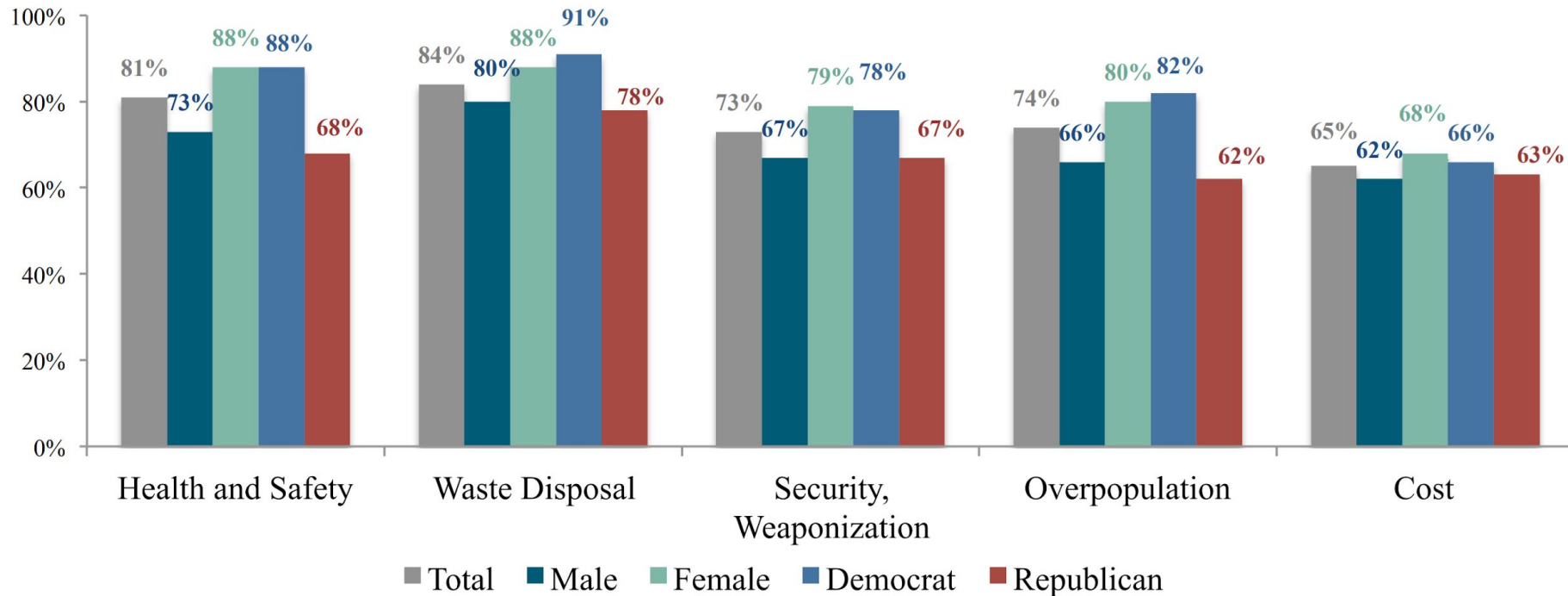
Assuming the claims are true, would you support moving on to better nuclear energy?

54% of Americans support increased funding for R&D in "Next generation nuclear energy"

8% of Americans agree that: "Energy Policy should be left to Wall Street, and the priority should be to protect today's jobs at old companies."

People have concerns about upgrading nuclear energy. Which of the following makes you concerned?

% Total "A Lot, Some"



Good news! We Have the Political Will to Get to Zero Carbon Energy!

Proof: Germany and California Spent Enough to go Zero Carbon from the Power Sector.

Didn't get what they paid for, due to anti-nuclear bias and premature plant shutdowns.

New coal, gas were added to balance the wind and solar which increased emissions.

Many New Friends of Nuclear power?

It's good to have a climatologist speak out FOR nuclear power and against sponsoring resolutely anti-nuclear mainstream "environmental" groups, and CA Governor Brown and Angela Merkel.

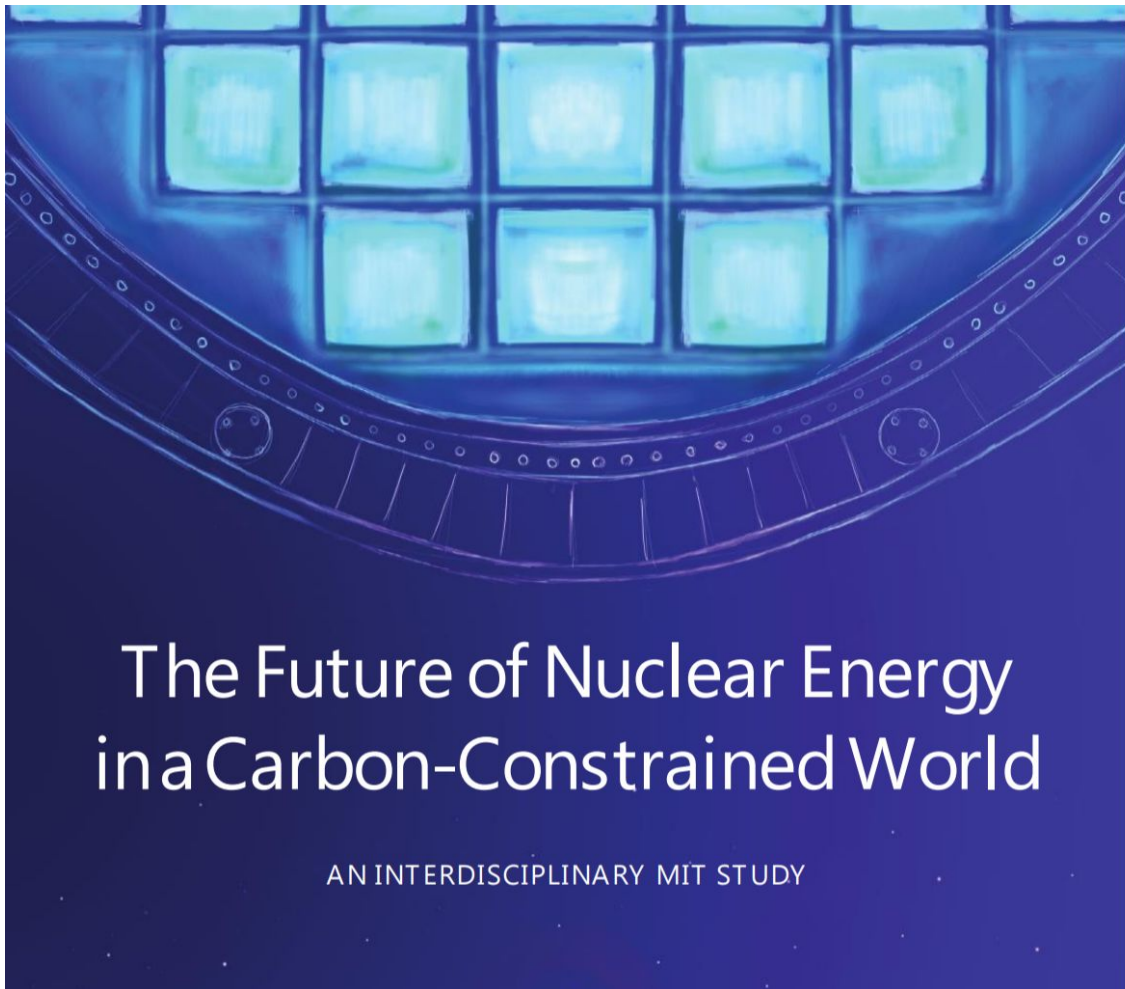
We need more honest speakers!

Ex-Nasa scientist: 30 years on, world is failing 'miserably' to address climate change

James Hansen, who gave a climate warning in 1988 Senate testimony, says real hoax is by leaders claiming to take action



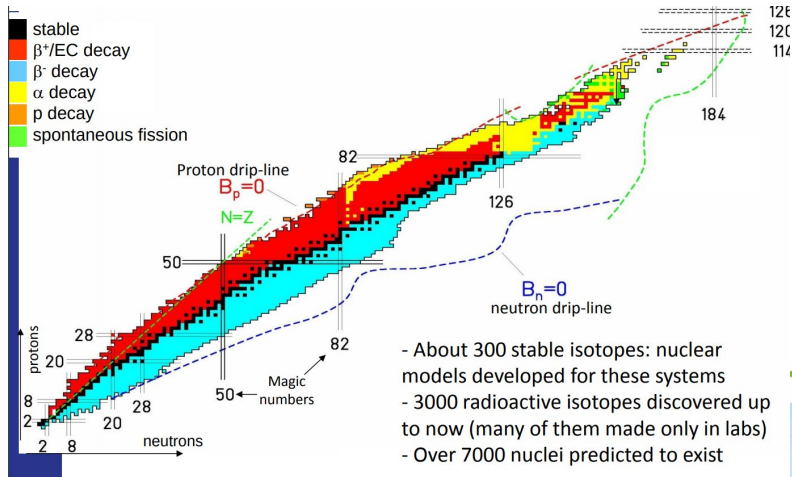
▲ James Hansen: 'All we've done is agree there's a problem.' Photograph: Ali Smith for the Guardian



Sept 2018



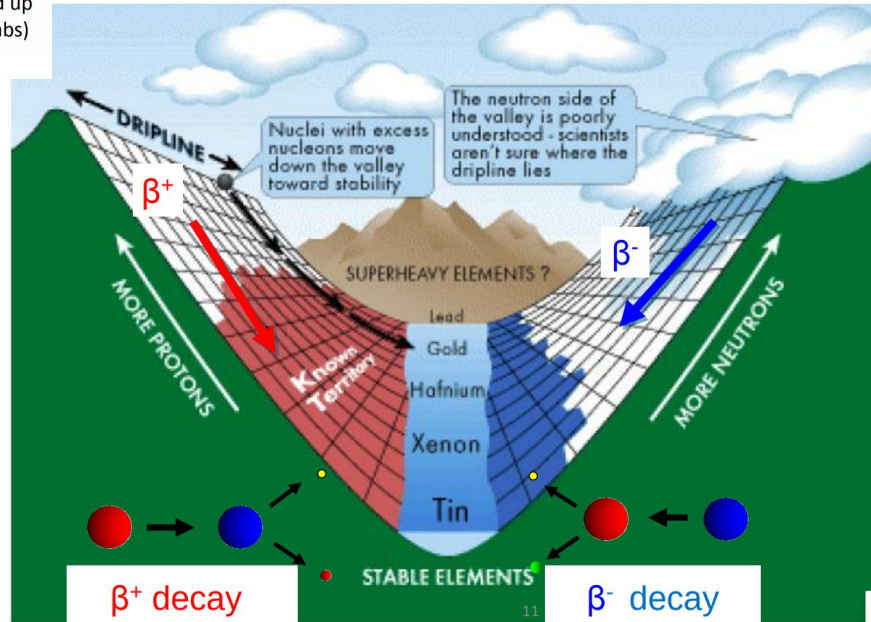
Download the report at
<http://energy.mit.edu/>



- About 300 stable isotopes: nuclear models developed for these systems
- 3000 radioactive isotopes discovered up to now (many of them made only in labs)
- Over 7000 nuclei predicted to exist

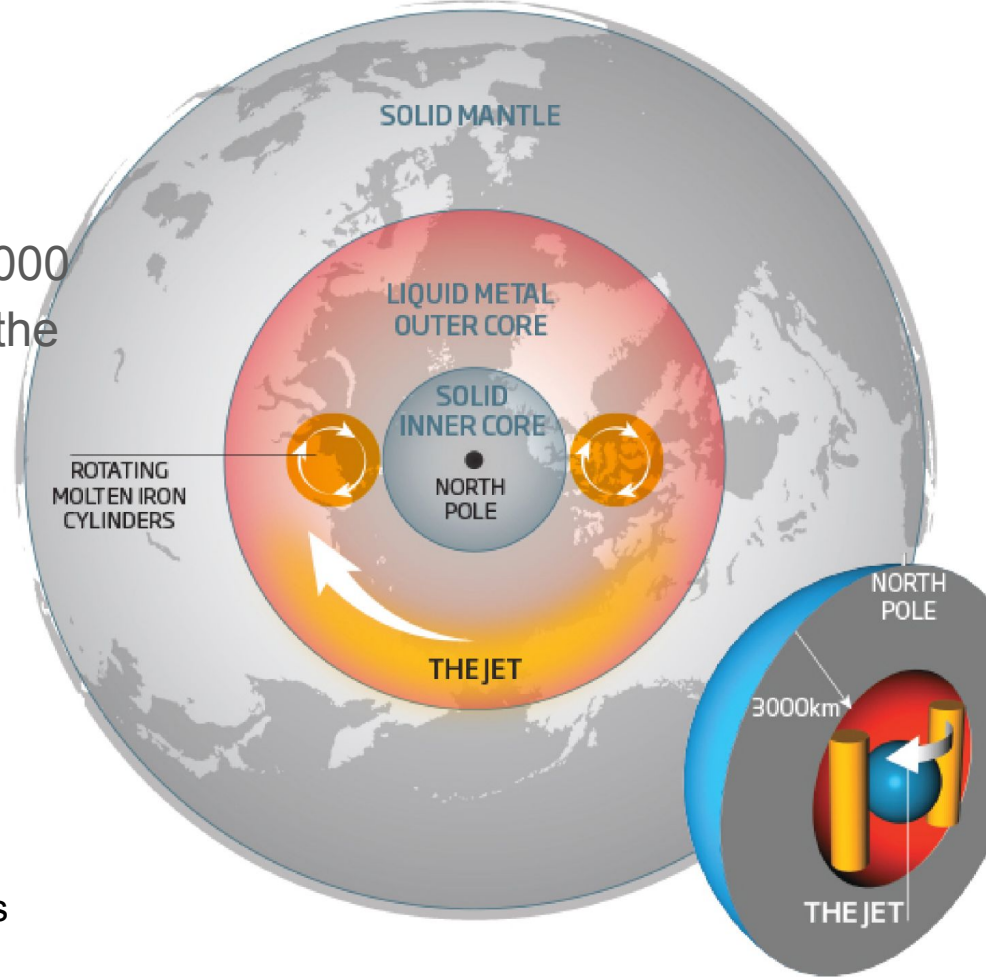
Atomic innovation space.

Valley of stability



Source:
 Magdalena Kowalska CERN 2014

European Space Agency's 2013 trio of satellites, called Swarm, can measure magnetic field variations underground 3,000 km. Images the molten core interface to the solid mantle.



from New Scientist, 2016 "Molten Iron River in Earth's core".

[Live Science](#) > [Space](#)

Bizarre Particles Keep Flying Out of Antarctica's Ice, and They Might Shatter Modern Physics

By [Rafi Letzter](#), Staff Writer | September 26, 2018 08:16pm ET

f 0

0

F

0

0

MORE ▾



LENR: Cautious view of a stigmatized field.

Scientists must test their intellectual honesty from time to time by looking at research with conclusions outside the consensus. Otherwise how do you know you are a scientist, and not an adherent to an ideology? Or just fashionable.

Given my interest in energy, I was asked to meet with a "cold fusion" researcher. I said "No" until I had a chance to see why the field is so unpopular with many intelligent people. After a year of reading and talking to experts, I discerned a textbook example of an important and unexpected result that provoked every form of unscientific reaction, literally terrorizing honest researchers. Motivated reasoning, rampant academic nepotism, self interest, intra-disciplinary conflict, ideology, math dominance, and authoritarian rule.

Lattice Enabled Nuclear Reactions (LENR)

- 1922: Helium production from exploding wire observed: ACS Irion and Wendt.
- 1989: Pons & Fleischmann succeeded using electrolysis.
- Subsequent work has characterized the reaction.
- Third Kind of Nuclear Power- Neither Fission or Fusion.
(nor muon-catalyzed cold fusion.)
 - Hydrogen to Helium and heat like Fusion.
 - Tritium production observed.
 - But Tell-Tale Radiation mostly missing
 - So LENR mechanism is not Fusion.
- Observations continue despite lack of consensus theory.
- Increasing institutional support. LENRIA.org
(NASA, Navy, Airbus, Nissan, MHI, Toyota)
- ICCF21 conference recently held in Colorado.



Robert Godes of Brillouin Energy (right) holding a Brillouin Hot Tube and a Hot Tube running at SRI (left), 2015 (Courtesy Brillouin Energy and SRI)

ICCF-21

3 - 8 June, 2018 | Fort Collins, CO USA

Brillouin Design Considerations

Aim for commercial win, not science win.

Avoid material degradation.

Carry Heat Away. Use AC Current.

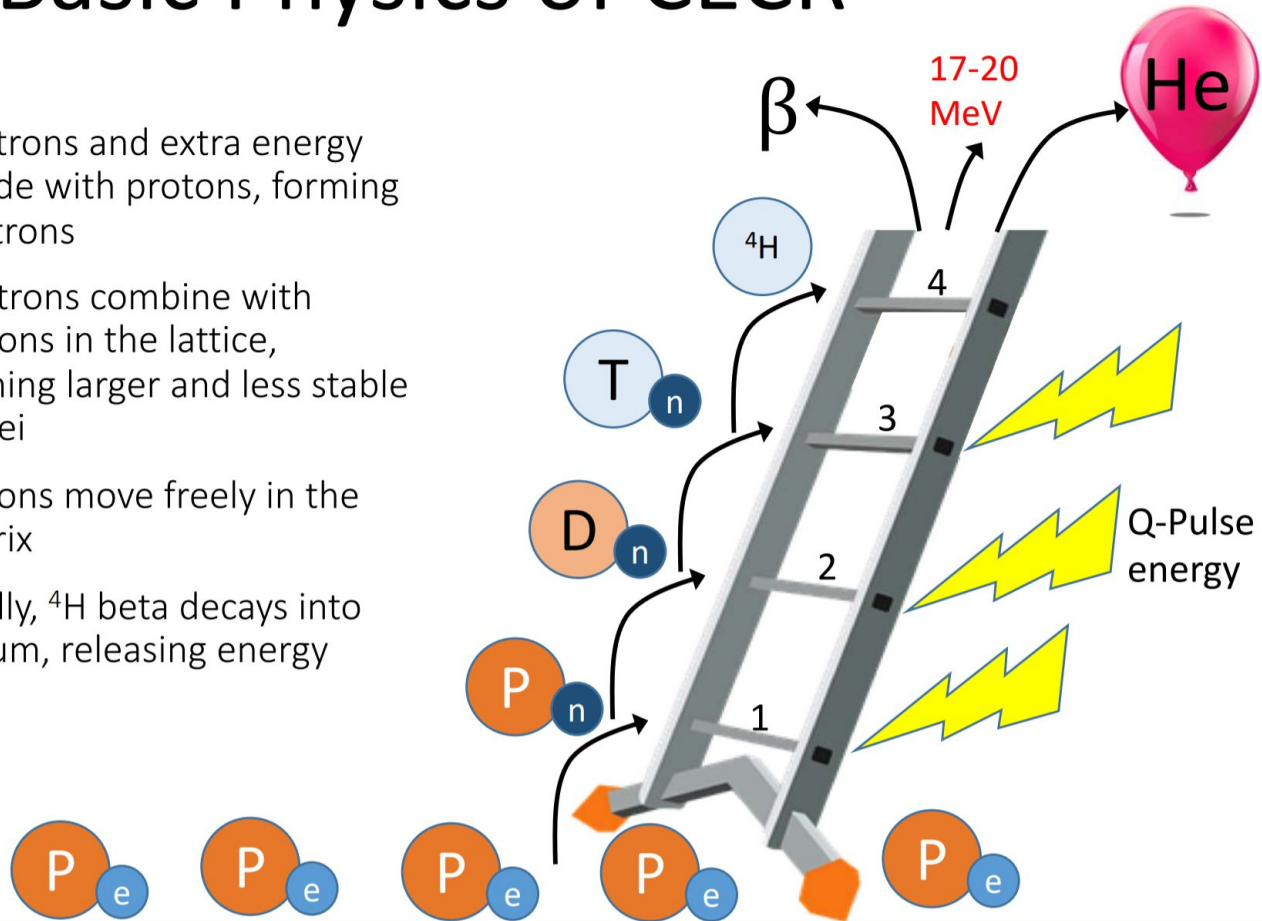
Control reaction rate using an electronic ignition system, not temperature.

Use best affordable measurements & reviewers. Record everything.

AI Computer model prediction of reactor instantly shows energy deviations no matter what control inputs.

The Basic Physics of CECR

1. Electrons and extra energy collide with protons, forming neutrons
2. Neutrons combine with protons in the lattice, forming larger and less stable nuclei
3. Protons move freely in the matrix
4. Finally, ${}^4\text{H}$ beta decays into helium, releasing energy



Confinement Induced Electron Capture

C. Martin^{1, a)} and R. Godes^{1, b)}

We describe a Gedanken experiment in which a bare proton can **capture an electron due solely to confinement**. We first briefly review **orbital electron capture** and related processes. We then describe the Fermi VA theory and how it can be applied to compute the cross section and rate using the full **relativistic Kinematics**. We set the problem up as a (proton, electron) pair confined in classical box of size L , and **compute the cross section** using the full Weak Interaction Hamiltonian. We provide numerical solutions for electron capture rate, and compare the power output relative to that of a neutron being captured in the post-reaction. **We find that the capture is most likely for $L=0.004-0.009$ Angstroms**, well beyond the radius of the proton and the Compton wavelength of the electron. We estimate the theoretical minimal power output for such a process, seeing **that is feasible at large box lengths**. Finally, we discuss proposals for future work and possible applications.

clean planet

The Birth of Next Generation

New Hydrogen Energy – LENR

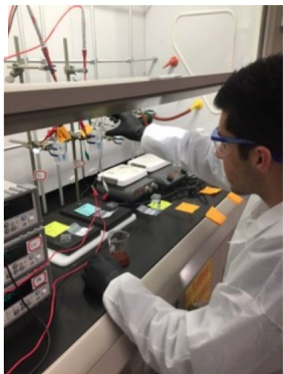
Dr. Yasuhiro Iwamura



LENR test kit

Announced.

A STEM Kit for University Curriculum Enrichment¹ Generating Energetic Nuclear Particle Tracks by Electrolytic Co-Deposition[®]



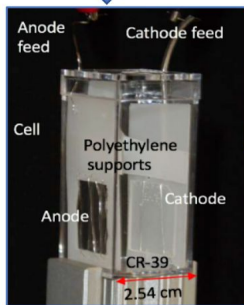
Student Adding
Electrolyte to Cell

*US Patent 8,419,919 for
energetic particle production
from electrolytic co-deposition.*



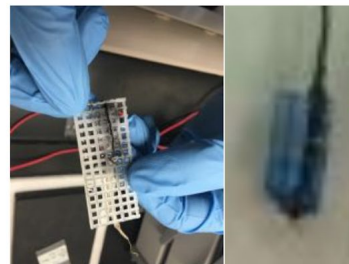
Active and Control
Cells

*Experiment Takes 3 – 5 weeks
To Assemble, Run, Disassemble,
Etch Detectors and Analyze Tracks*



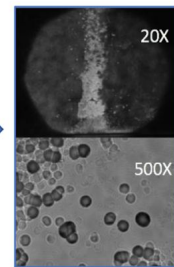
Cell layout

Disassembled Cathode and
Nuclear Track Detector

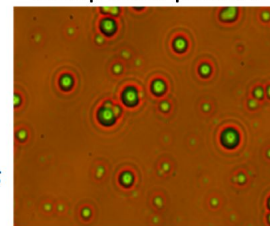


*Solid State Nuclear Track
Detectors (CR-39) With
Energetic Nuclear Particle Tracks*

Etched



Composite picture

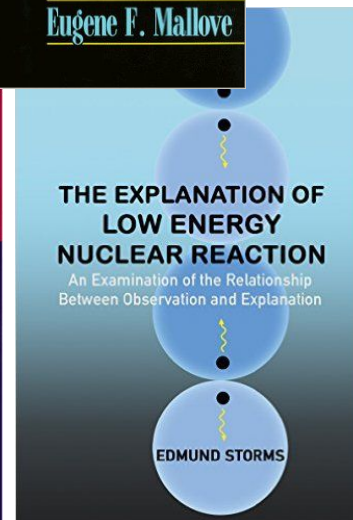
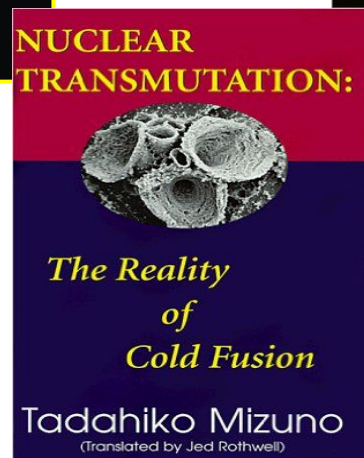
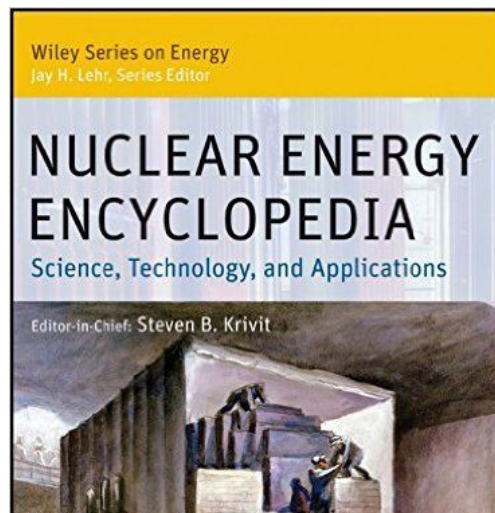
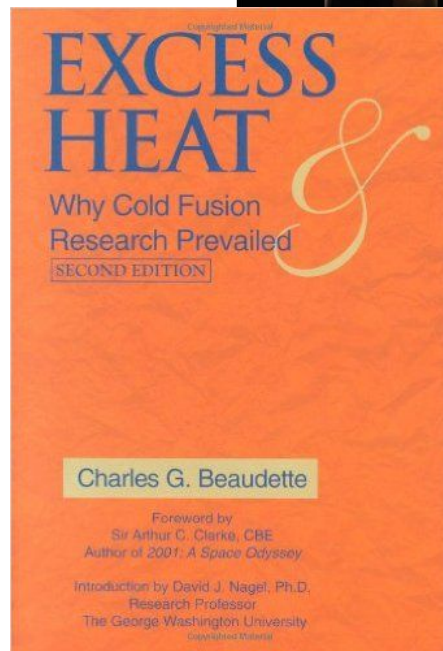
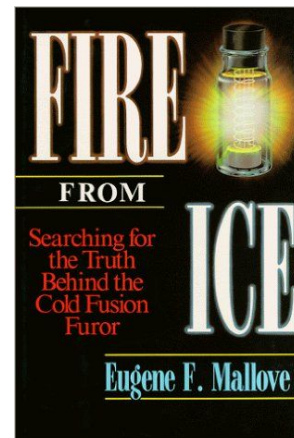


Kit includes materials for three active and control runs, teacher and student manuals, video and technical support.

Available by Fall 2019. Contact: info@trackers.org

¹ P. Mosier-Boss and L. Forsley, "Energetic Particle Emission in Pd/D Co-deposition: An Undergraduate Research Project to Replicate a New Scientific Phenomenon", *J. of Lab. Chem. Edu.*, 6(4): 69-77 (2018).

Books



Fusion (Hot plasma)

Realm of Plasma and Particle Physics

Best **predictive theory** in science. Experiment follows theory to 9 decimal places!

Easy math. Classical Mechanics- Billiard ball physics.

Great Evidence. Basis of astronomy. Watch Sol every day. H-bombs work.

Terrible Engineering. Unstable destructive forces. Unobtainable materials. Corrosive events. Very hard to engineer in to stable power plant. Little progress on that goal to date.

Subgoal of positive stable experimental energy balance still not achieved.

Dominated by ITER which is a 30 year path to promise of nothing.

Strong governmental and academic support.

Low Energy Nuclear Reactions (LENR)

Too interdisciplinary. Chemistry, EE, Condensed Matter Physics, Control theory.

Cheap common materials (AFAIK) -- No regulatory delays.

Simple Engineering. Promise of low cost.

Lots of candidate theories- no consensus.

No generally accepted purchasable demo reactor. *

Lots of repeatability issues.

Horrible Math. Difficulty of Quantum field theory in Condensed matter **dwarfs** treatment by today's analytic math or supercomputer simulation.

Literature shows observations of every number you would like to see for practical energy- but not at the same time and place repeatedly.

Weak governmental and academic support.

A case study for nuclear transmutation possibility in-silico by terahertz spectroscopy and imaging

For Anthropocene

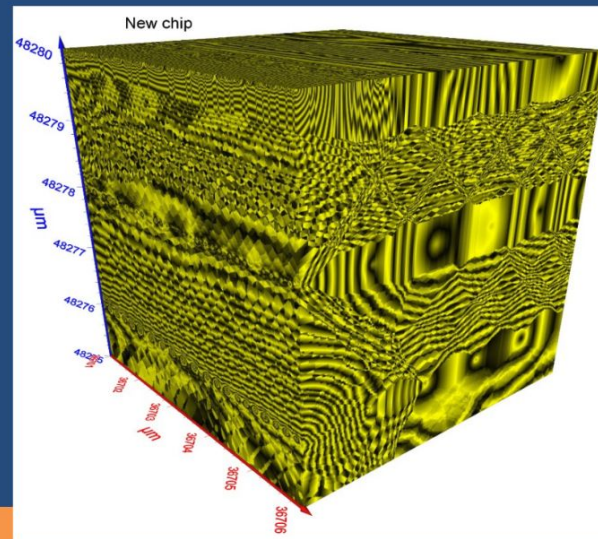


Figure 3. High resolution 3D image of 4 Samples ($1 \mu\text{m}^3$) from the Nickel rich area.

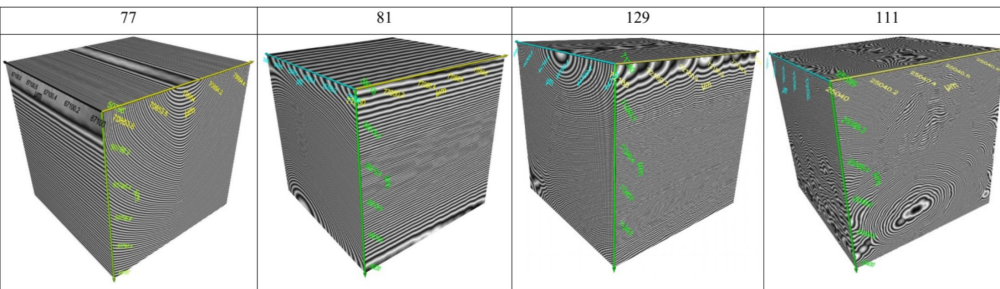


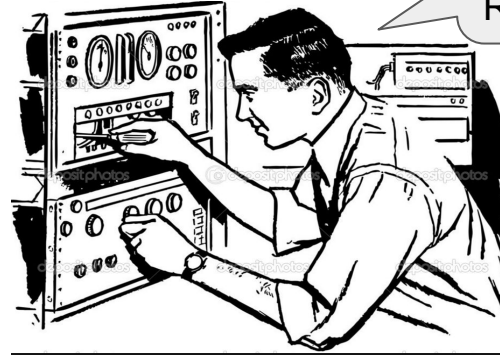
Figure 3. High resolution 3D image of 4 Samples ($1 \mu\text{m}^3$) from the Nickel rich area.

Thermodynamics was a curve-fit of the Engineers log book.

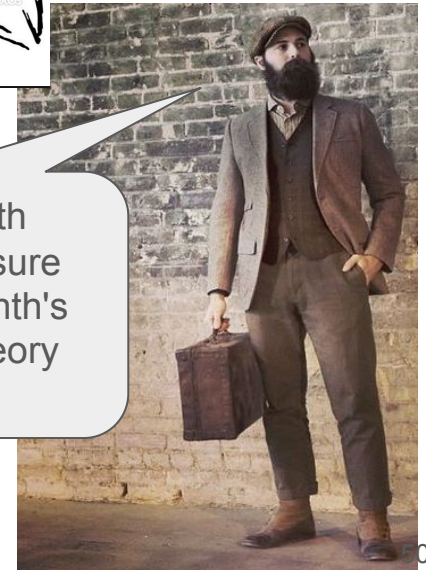
The successive developments of the steam engine-- separate condenser, expansive working, compound cylinder-- right down to the steam turbine at the end of the century were essentially successive essays in engineering, solved in practice before they were solved in theory." J.D. Bernal

Bad Reasons Why Physics Resists LENR

- Bias against Instrumentation
 - A UCLA Physicist told me: "I don't allow calorimetry in my lab. Too hard. Physicists have Instruments!" while pointing to his neutron detector which LENR will never light up.
- Theory Elegance and Theoreticians Dominance
 - String theory is a beautiful, popular, and untestable theory that never falls short of lab funding.
 - See Lee Smolin *"The Trouble with Physics, The Rise of String Theory, The Fall of a Science, and What Comes Next"*



My Instruments Say Cold Fusion is Real!



That's the trouble with instruments. Make sure to update to this month's version of String Theory and try again.

Micro-calorimeter

Unsuccessful Attempt to detect LENR in an atomic force microscope. (AFM)

Using a Manufactured Platinum tip. ...inspired by...

**Observation of a chemical reaction
using a micromechanical sensor**

J.K. Gimzewski ^{a,1}, Ch. Gerber ^a, E. Meyer ^{a,b} and R.R. Schlittler ^a

^a *IBM Research Division, Zurich Research Laboratory, CH-8803 Rüschlikon, Switzerland*

^b *University of Basel, Klingelbergstrasse 82, CH-4056 Basel, Switzerland*

Received 14 September 1993; in final form 23 November 1993

Safer Cheaper Fission. Molten Salt Reactor (MSR)

Public Interest Groups.

- Thorium Energy Alliance
- ThirdWay.
- Breakthrough Institute.

Safe

No New Technology (1976)

Rapidly Deployable

Fixable

Cheaper than Coal

Cheap Construction

Cheap Fuel.

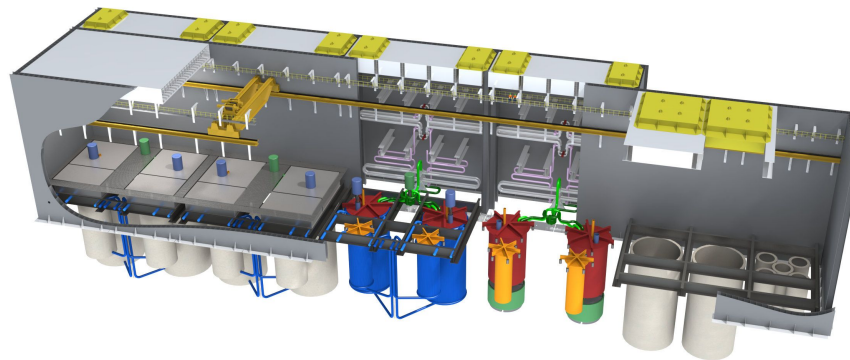
Cheap Decommissioning.

Companies:

- Terrestrial Energy
- ThorCon Power
- Terrapower



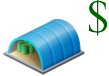




Countries:

- Canada
- Malaysia
- India
- China



Thorium is your guarantee you never run out of Uranium. But you never will. Start with all the "nuclear waste" and depleted U and unneeded warheads we need to get rid of anyway. Next absorb it from the ocean.

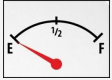
MSR Molten Salt Reactor *improvement factors*

	Proliferation	100x	Liquid fuel not vulnerable to theft. Unsuitable for weapons as is waste.
	Waste	1000x	300 year cool down. No security threat. Absorbing existing waste!
	CapX	10x	No containment dome, or high pressure plumbing or critical systems redundancy. 600C allows normal cheap GE turbines. Safety defuses NIMBY.
	Opex	10x	Low waste. Small staff. Rampable. Low stress!
	Fuel Cost	15-100x	Trivial. 15x less fuel, simply recycled from waste and in distant future, thorium, or seawater uranium.
	Terrorism or Leak	1000x	No steam escape. Walk away safe. Leaked material freezes and sits there until shoveled up.
	Speed of Scale	10x	Automated Factory / Shipyard Built. 7 Hours of Labor per Ton of Steel.

MSR Molten Salt Reactor



Earthquake 100x



Fuel resource depletion 1 billion years Renewable potential breeder of thorium.



600C Industrial heat 10x

600C is much better than 300C and it can go behind-the-fence in factories.



Decommissioning 1000x

Far less hot matter.
Designed for transfer to central facility.



Mining and environmental sacrifice 100x

Potential use of U from seawater or Thorium after burning down existing waste.



Regulatory Delay 10x

Build it in Canada to power USA



Water use 100x

600c hot-side Brayton Cycle, water free.

A Double First in China for Advanced Nuclear Reactors

Safer reactors designed in the U.S. and Europe make their power grid debuts in China

By Peter Fairley

The AP1000 and EPR troubles seem like LWR industry's last gasp.

These projects are 99% Kludge by weight.

The folly of adding parts to enhance safety.



Photo: SNPTC

Nine years after construction began at China's Sanmen nuclear power plant, the world's first AP1000 unit has connected to the grid.





What can I do?

Envision success.



Demand leadership.



Fight Innumeracy

Prioritize Big Problems.

Personal Vulnerability Should be a Priority

Make Money Steadily: Help Replace a Trillion Dollar industry.

**My 12% Chance of Death
by Air Pollution.**

Don't Wait for Change to come from WELL ENDOWED institutions beholden to the status-quo.

Never Trust Any Technology over 50. Or 5?

Consider working on or with a Fledgeling Company.