



# Self Reliance in Rare Earths and Energy

## Creating a New Technology & Energy Economy

### The link between Rare Earths, Thorium and Energy



## A New Economic & Energy Policy *for the* United States of America

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# Congressional Failure | Commercial Failure

None of the current bills in Congress resolve / address any of the key issues related to China, rare earths, environment or capital formation for new producers:

- Congress ignores China's sovereign monopoly power.
- Congress proposes additional studies, not resolutions.
- Congress proposes lowering EPA / BLM standards.
- Congress proposes '*guaranteed loans*' for non-mining process technology and doesn't address the Thorium issue at all. Most Jr. RE Cos have a Thorium problem.

# There is no shortage of Rare Earths

Research conducted by The Florida Industrial & Phosphate Research Institute and USF confirms that the Phosphate mining industry in Florida dumps about 22,600 tons of rare earths\* every year – due to Thorium content.

Assuming a 50% recovery, Florida alone could cover nearly 100% of current U.S. rare earth requirements.

\*Monazite / heavy REs



FIPR Institute

January 4, 2012

Mr. James Kennedy  
Th.REE-M3 LLC  
P.O. Box 410380  
St. Louis, MO 63141

Dear Mr. Kennedy:

Thank you for your inquiry about the potential for Rare Earth Element (REE) production as a byproduct of Phosphate mining. Research on this issue was recently conducted by the Florida Industrial and Phosphate Research Institute, University of South Florida Polytechnic.

On an aggregate basis the total potential for recoverable REE resources from phosphate mining in Florida is around 22,600 tons per year. These numbers are based on annual production of about 20 million tons per year of phosphate rock product analyzing 700 ppm REE, and 20 million tons each of sand tailings and waste clay at approximately one third of the REE concentration in the rock product. A 50% recovery rate would equate to nearly 100% of current U.S. demand.

Low mineral concentrations do not present an insurmountable economic impediment to recovery because there are no direct mining costs associated with the Rare Earths. Furthermore, as a result of the high specific gravity of the mineralization low cost gravitational separation is possible within, and/or, at the end of the normal beneficiation process.

The old phosphate waste clay associated with historical mining operations is another potential source for REE. According to a 1989 study by Mobile Research, waste clay contained as much as 336 ppm of REE. Florida has accumulated over a billion tons of such waste clay, making this one of the largest heavy rare earth deposits in the U.S.

Some of these Rare Earths in Florida phosphate are associated with Thorium and Thorium's current regulatory status and complete lack of markets creates a liability that may exceed the economic value of these resources. Something needs to change.

Making regulatory changes and developing markets and uses for Thorium is one of the keys to unlocking these valuable resources for Florida and the United States. I appreciate your efforts in this, and hope this information is of use to you.

Best regards,

A handwritten signature in black ink, appearing to read "P. Zhang".

Patrick Zhang, Ph.D.

Research Director - Beneficiation & Mining

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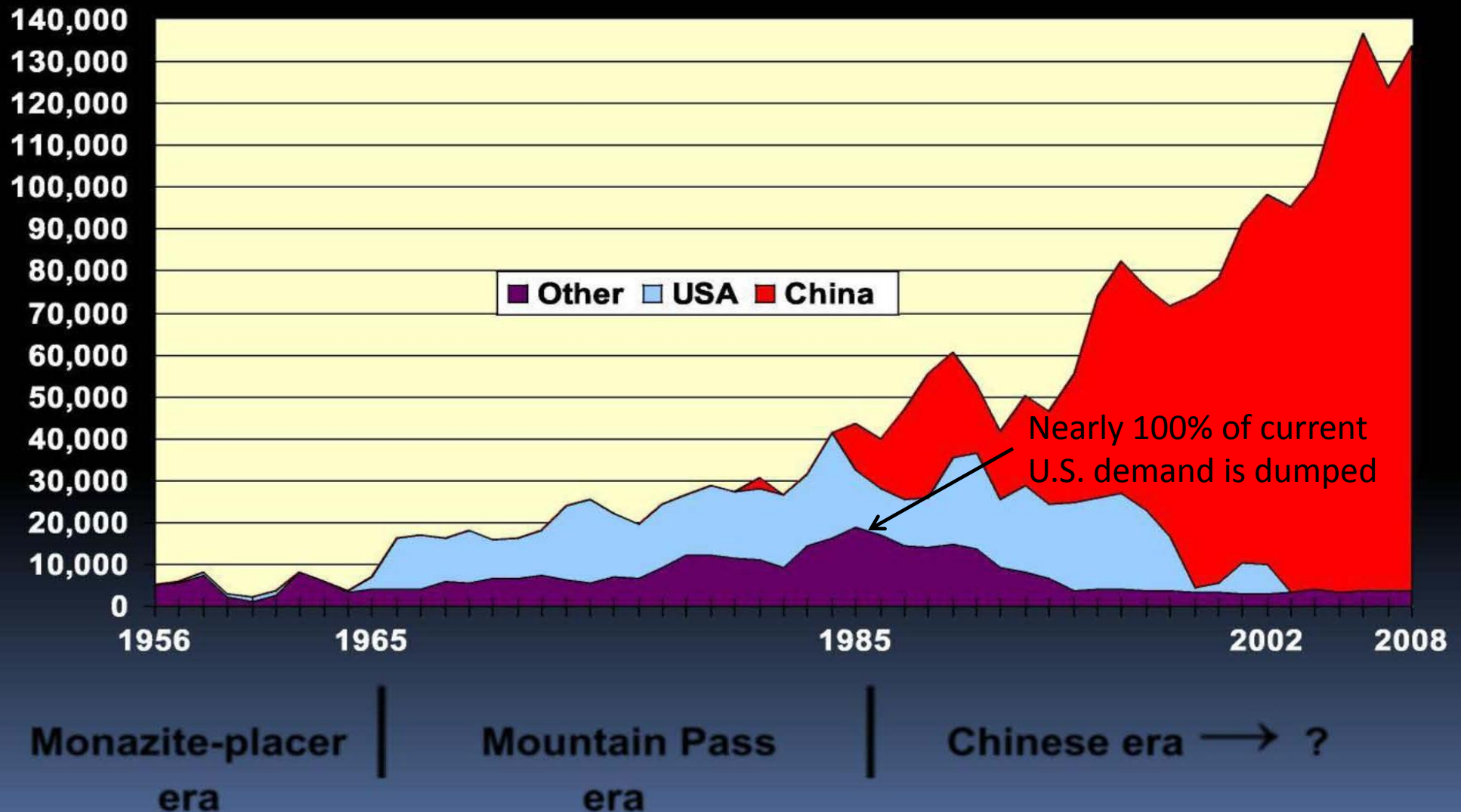


# Pre-Mt. Pass era – Nearly all REEs were a byproduct of Heavy Mineral Sands

by Gordon Haxel, Greta Orris, and James Hedrick, updated by Hedrick

Nearly all REE came from the heavy Mineral Sands mining industry as a Monazite byproduct.

In 1985 the Mineral Sands industry was producing over 10,000 tpy of REEs as a byproduct



# Monazite is a Common Waste Product

Thorium Bearing Monazites & other RE Phosphates are typically dumped as tailings by some of the following:

- Rare Earth / Bastnaesite Mines
- Iron Ore Mines
- Phosphate Mines
- Heavy Mineral Sand – Titanium / Zircon Placer Mines
  - Copper, Cobalt, Uranium, Aluminum mines, etc.

Resolve the Thorium issue and you have resolved the rare earth issue, including heavy rare earths.

# U.S. Thorium Policy Assures Chinese Primacy

Monazite is the 2<sup>nd</sup> most common RE mineralization and the #1 source of Heavy REs, so why aren't we using it ?  
U.S. Regulations force RE producers to avoid Thorium...

Low Thorium RE deposits are typically low in Heavy REs.

- Exceptions are rare and incompatible with demand.
- Bastnaesite deposits do not contain economic levels of Heavy Rare Earths.
- China's indifference to Thorium and its supply of Ionic Clays assure continued dominance in Heavy Rare Earths.

U.S. policy plays into the hands of China.

# All 'Western' RE Producers Avoid Thorium

*Regulatory risk prevents U.S. and other 'western' mining companies from developing Thorium rich deposits.*

Expected rare earth recovery from a **typical Bastnaesite** deposit, such as Molycorp (Mt. Pass).

La	Ce	Pr	Nd	Sm	Eu	Gd
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Y
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Low Thorium, but only half of the rare earth elements

Expected rare earth recovery from a **typical Monazite** deposit

La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
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Monazite is the largest geologic source for heavy REs but it typically contains elevated levels of Thorium so it is avoided by all 'western' mining companies.

# Regulations & Liabilities | Fear & Loathing

Fear of the word '**RADIATION**' pollutes public policy, creating irrational results.

- Thorium is a low level Alpha emitter with a 12.5 B half-life. The following emit more harmful forms of radiation: x-rays, natural gas cook tops, sun light (especially high altitude exposure), K in Bananas.
- There are hundreds of industrial and household goods that are 'thousands of times' more dangerous, such as anhydrous ammonia or household bleach (potential death on contact or via consumption).

Thorium is not water soluble & cannot be metabolized



# Public Perception Obstructs Rationalization

The **FEAR** will not go away, so the simple resolution is consolidation and management of Thorium

- Move all Th-bearing rare earth production and waste byproducts to a centralized RE cooperative.
- Pass all Thorium/Actinide liability to a separate entity.
- Refinery funding would come from OEM consumers of RE products.
  - Off-take of oxides, metals and alloys would reflect direct investment by each OEM.
- Profits would be split between suppliers and OEM end-users.

# Access to Capital and Jobs to the U.S.

This structure would be impervious to China's Sovereign monopoly power and:

- Enhance access to capital for RE mines via off-take agreements, profit participation in finished goods and eliminating Thorium/Actinide liabilities.
- Restore confidence in the supply chain, thus reducing the need for OEM producers to find RE substitutes.
- Bring jobs and direct investment back to the U.S.

# Such a Proposal is Before Congress

The proposed language resolves the rare earth supply issue (including heavy rare earths), helps provide access to capital for Jr. RE mining companies, eliminates the need to lower environmental standards and creates a deep, broad and vertically integrated rare earth industry that can challenge China – including attracting high tech and OEM manufacturing facilities back to the U.S.

\_\_\_\_\_ The Rare Earth Problem is Solved \_\_\_\_\_

More importantly, the proposed language also creates a regulatory pathway for Thorium Energy, under a Federally Chartered Corporation – open to private U.S. and International investment.

# Rare Earth / Thorium Policy = Energy Policy

The U.S. developed the next generation of safe, non proliferating nuclear reactors 50 years ago.

The technology was abandon because it was non - compatible with our cold-war goals of military / civilian dual-use Light Water Reactors (LWRs) and the production of weapons grade fissile materials.

- The technology is a Thorium based Homogenous Liquid Fuel Nuclear Reactor typically called a Thorium Molten Salt Reactor (Th-MSR) or LFTR (Liquid Fueled Thorium Reactor / Liquid Fluoride Thorium Reactor).

# Why Th-MSR Will Redefine Nuclear Energy:

- Safe by design, Th-MSR automatically shuts down without human intervention – based on physics
- Cannot Melt down (operational range of 700 to 800c)
- Cannot Blow up – Not under pressure
- Can burn 99% of Thorium Fuel into safe byproducts
- Can reduce existing nuclear waste by + 90%
- ZERO green house gas emissions
- Does not require water for coolant.
- Modular Construction / Distributed Power
- MW Capital Cost = Modern Coal Based Systems

# DoE and LWRs | its Buggy-whip Bureaucracy

Instability by design, LWR needs constant intervention to prevent catastrophic failure.

- Operates at Extreme Pressure
- Operates at low Temperature (350C)
- Utilizes Solid Fuel technology
  - Resulting in less than 5% of Nuclear Fuel Utilization.
  - Resulting in 100% of the fuel requiring ‘internment.’
- Produces large quantities of Plutonium
  - Creating proliferation issues

LWR is not an economically viable system without massive subsidies – true cost are hidden from public.



# Light Water Reactors are Cold War Dinosaurs

## LWRs are incompatible with Civilian Power

- LWRs are a true 'Frankenstein' creature, based on military goals of Plutonium production for weapons – under the political cover of civilian power.
- Alvin Weinberg, the inventor and patent holder of the LWR, told Congress that LWRs were inherently unsafe and inappropriate for Civilian use.
  - Weinberg was fired for 'putting safety first'.

The truth is that the DoE is in the Weapons business, with over 60% of its budget dedicated to Nuclear Bombs

# Regulatory Risk vs. Reality

No U.S. company is willing to develop Th-MSR within the existing regulatory environment.

- The NRC and DoE have a well established history of preferring LWR Uranium based solid fuel systems.
- Public statements by the NRC put initial permitting of the Th-MSR fuel system out “30 years or more.”
- Yet, all new Gen-4 LWR designs fail to resolve most key safety, waste and proliferation issues.

China is not subject to DoE/NRC authority and is rapidly developing this U.S. technology. China has publicly stated that it will control global IP for the Th-MSR and has funded its program. *Yet, we do nothing...?*



# The DoE - A Kodak Moment

The DoE is living in a cold-war past. With 65% of their budget tied to the production and maintenance of Nuclear Weapons they have an irreconcilable conflict of interest.

- While the DoE and NRC push mindlessly for a new fleet of coldwar- centric reactors, China seeks to commercialize a much safer and economically sound alternative, the Th-MSR.
- China already controls rare earths. Continuing this mindless U.S. policy will assure China's control of energy.

Considering Kodak's failure to adapt to changes in technology and the market place, I guess you could say that the DoE and NRC are just having a Kodak Moment.

# The Age of Oil is Over

Currently the U.S. is involved in military conflicts intended to support our antiquated petroleum-centric foreign policy.

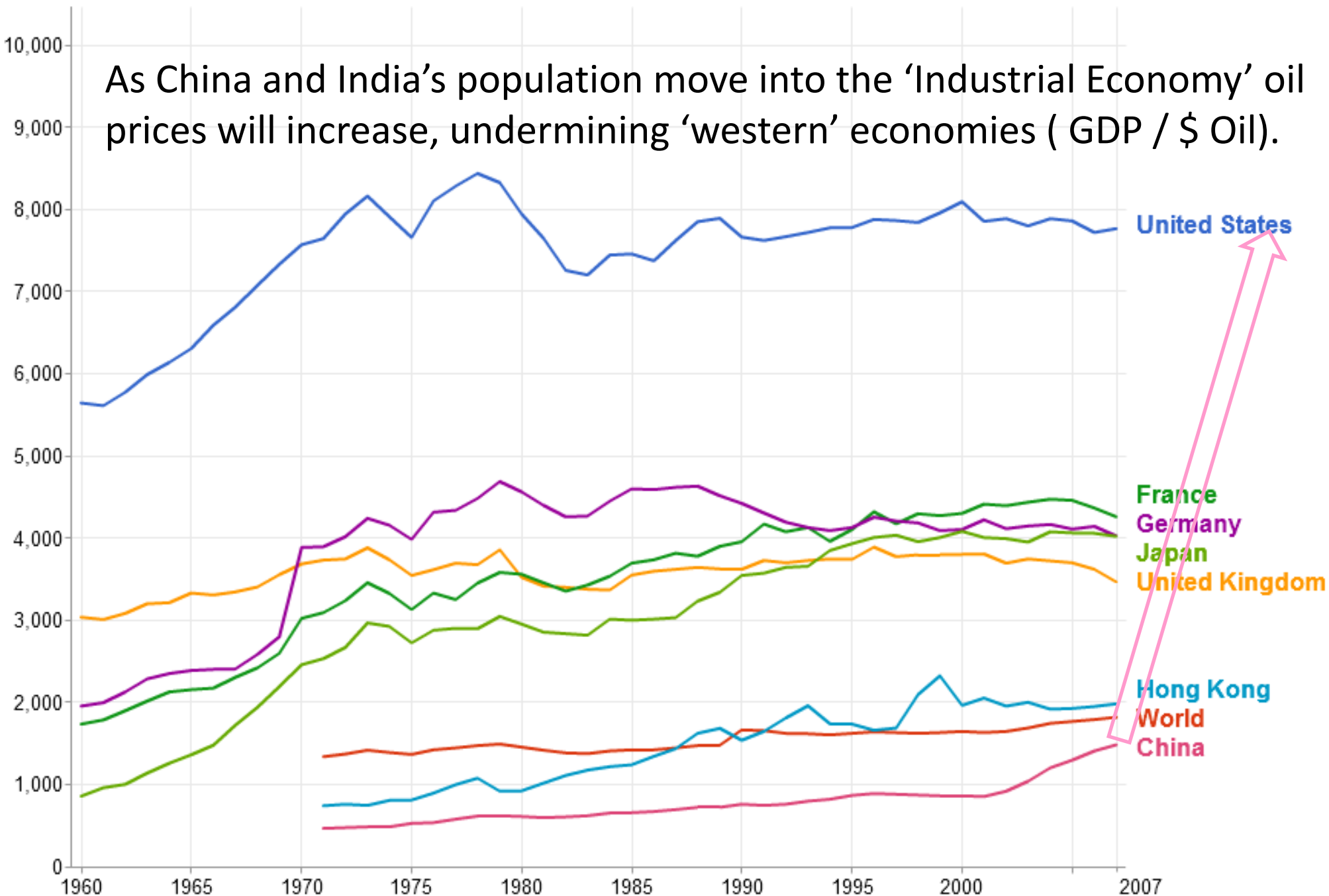
- Our Military and State Department are overwhelmed with contradictory goals and objectives – compromising our integrity, Treasury and National Security.
- The U.S. only holds less than 2% of the worlds liquid oil reserves domestically, with Sovereigns controlling more than 90% of global reserves collectively.

The global per capita GDP for our petroleum based economy has reached its terminus. A change in U.S. policy and direction is long overdue.

# Energy use per capita

Primary energy use (before transformation to other end-use fuels) in kilograms of oil equivalent, per capita. [More info »](#)

As China and India's population move into the 'Industrial Economy' oil prices will increase, undermining 'western' economies ( GDP / \$ Oil).





High Cost Oil - \$250 bbl

Total Global  
Recoverable  
Crude Oil  
Reserves

Low Cost Oil - \$50 bbl

**Global Markets Crash at \$100 per bbl**  
**Yet, per capita reserves will soon fall by +50%**

Current Industrial Participation is 1.5 billion people, or  $1200 \text{ b.bbl} / 1.5 \text{ b} = 800 \text{ b.bbl}$

**Global Reserves = 1200 billion bbl**

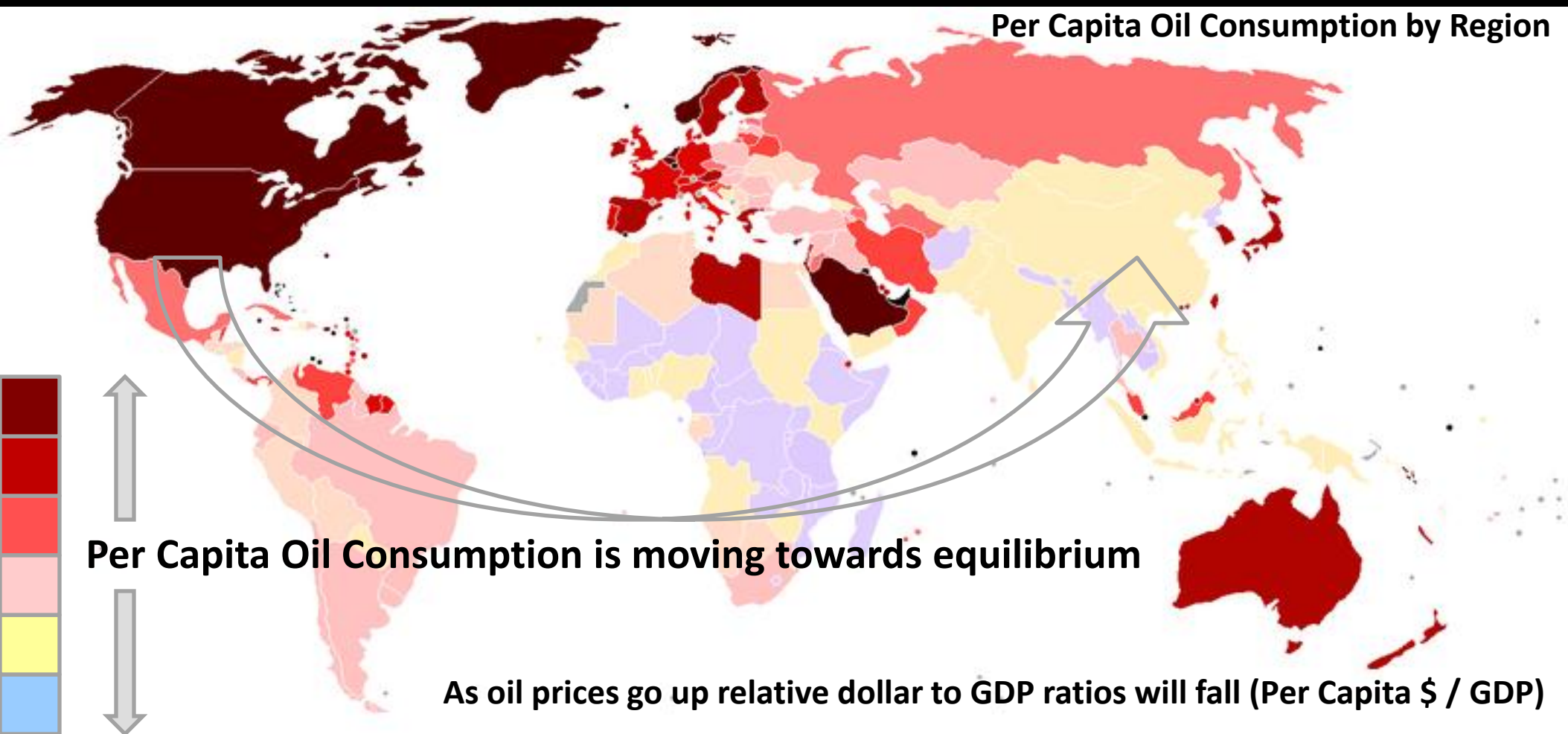
Future Industrial Participation may soon exceed 3.5 billion, or  $1200 \text{ b.bbl} / 3.5 \text{ b} = 340 \text{ b.bbl}$

**China and India's growing industrial participation will cause more and greater 'Price Shocks'.**

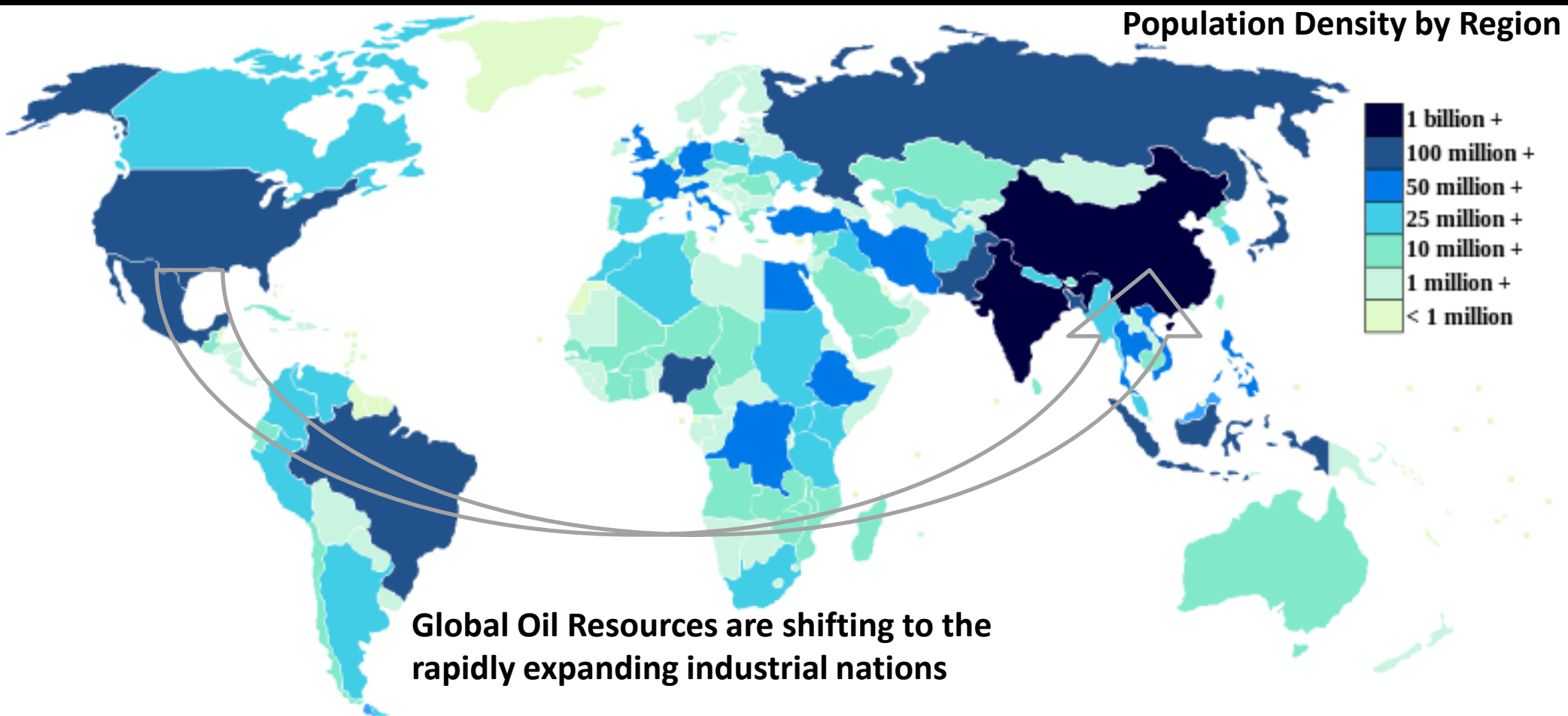


As oil demand and consumption shift to China and India the 'west' will experience new '*Price Shocks*' – 'western' GDP and living standards will fall.

We have hit the ceiling of oil based GDP

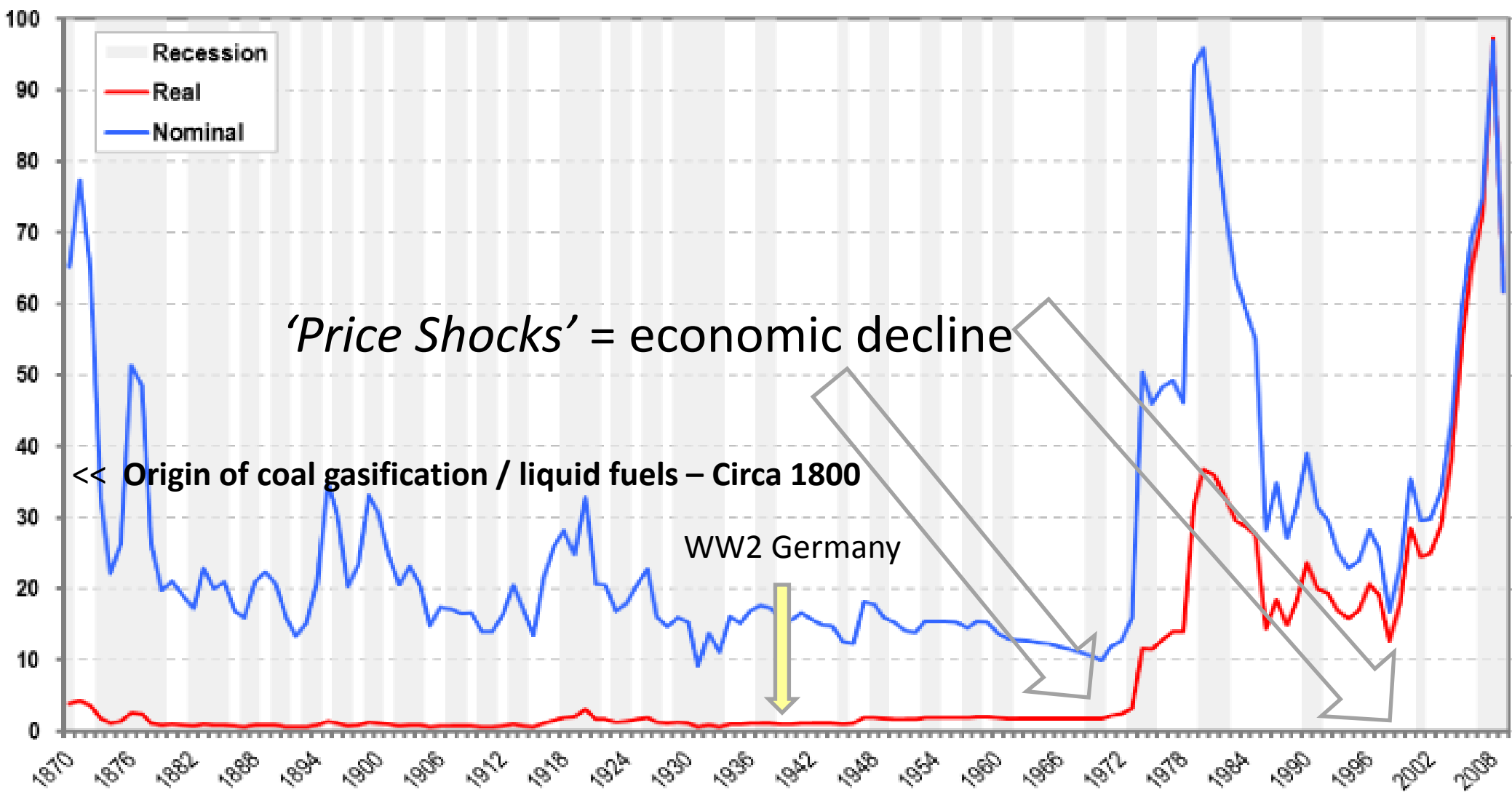


The Industrial Age Of Oil has peaked and is now in decline.  
Western per capita prosperity from oil will decline in direct proportion to growing Third World participation.



China and India are rapidly adding 2 billion new oil consumers

Future *Price Shocks* will intensify because supply is finite and production has peaked



# Petroleum Centric Policies are Outdated

Continuation of an economic & energy policy based on oil is unsustainable, as global consumers will soon double.

- The U.S. holds less than 2% of the worlds liquid oil resources within our borders.
  - Any National Policy must be based on domestic resources that are reliable – in case of emergency.
- The U.S. is forced to rely on ‘multinationals’, with no allegiance to U.S. interests, who define our energy policy.

Energy policy shapes and defines military Policy

# TH-MSR - The Future of Energy

- Eliminating 100% of combusted coal for electric energy and converting previously harmful emissions from coal into valuable commodities.
- Converging continuous coal consumption into 100% of our Nations liquid fuel requirements.
- 100% energy independence for all liquid fuels.
- Reducing global green house gas emissions by up to 40%.

Resulting in Massive Positive Transfer Payments to the U.S. and the opportunity for clean, safe, sustainable energy in a new age of American/Global prosperity.

# Th-MSR/LFTR = Energy Independence

## Total Thermal Energy Generation

1000 kg of thorium is  $1000/0.232 = 4310.3$  moles of Th232.  $4310.3 \text{ moles} \times 6.022 \times 10^{23} \text{ atoms/mole} \times 200.1 \text{ MeV} \times 1.6022 \times 10^{-13} \text{ J/MeV} = 8.322 \times 10^{16} \text{ Joules/tonne}$ . 1 GW-Year is  $1 \times 10^9 \times 365.25 \times 24 \times 3600 = 3.16 \times 10^{16} \text{ Joules}$ . Thus 2.637 GW(th)-years of thermal energy in the reactor.

One Ton of Thorium = 2.6 GW.y or 83,000,000 GJ of thermal energy.

- Operational Temperature of 700 to 800 c
- Capital Cost under \$2 million per 2500 Thermal / MW.y\*
- Fuel cost per ton = \$1000 or less\*\*
- NEAR-ZERO EMISSIONS - Carbon Sequestration Not Required\*\*\*
- U.S. Energy Independence

It would require over 3.5 million tons of coal to provide the same Thermal Energy (equal to 350 100-car train loads of coal).

\*U-233 or U-235 Fissile driver and Thorium fluorination costs are included in CAPEX.

\*\*Thorium is a no cost byproduct of Rare Earth Mining. Thorium does not require enrichment so actual production cost will be de minimus (\$0.0003 per kwh).

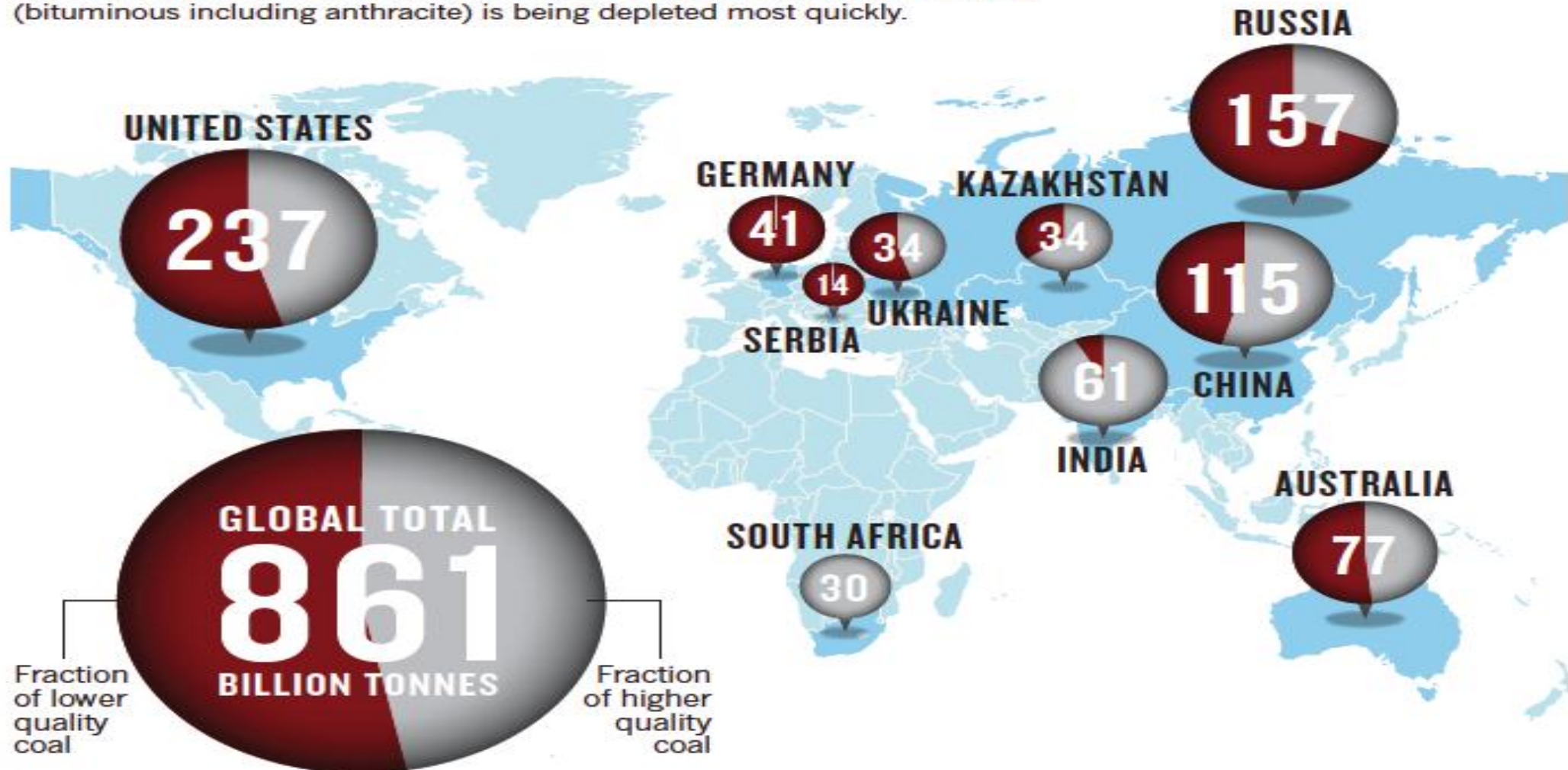
\*\*\*The coal gasification process would be segregated from the hydrogen/oxygen separation process and the hydrogen would then be combined directly with the syn-gas to reduce the production of CO or CO2.



The U.S. has the largest coal reserves in the world. Coal to Liquid Fuels assures total energy independence for the U.S.

## WORLD COAL RESERVES

Proven recoverable coal reserves reported to the World Energy Council by the top-ten coal-producing countries at the end of 2008. Coal of higher quality (bituminous including anthracite) is being depleted most quickly.



U.S. Coal can provide hundreds of years of clean liquid fuels

# Evolution | Economics | Energy

The history of human evolution and economics are linked to energy. With every advancement in energy came a wave of prosperity. What is the next wave ?

- Irrigation and Yoking of Animals for Agriculture – Mesopotamia
- Fire – Bronze to Iron to Steel
- Wind for Ships – Phoenicians
- Windmills – Dutch
- Water – England / U.S. (Industrial Revolution Begins)
- Coal / Steam – England / U.S. (Industrial Revolution)
- Oil – U.S. / First World (Industrial to Technological Rev)

Industrial Age based  
on coal, NG and oil

The age of oil is over and the 'Nuclear Energy Age' has not happened yet! A Thorium Energy Age based on a liquid nuclear fuel cycle is coming –

Who will control this Technology, China or the U.S.

# The U.S. as a global exporter of Energy

The U.S. needs to become a producer and exporter again. Energy is the largest market in the world. The global electric energy and liquid fuels market exceeded \$3.5 trillion in 2010.

- Whoever controls Th-MSR controls global energy.
- Under U.S. control Th-MSR could usher in a new era of Prosperity.
- Th-MSR would produce Carbon-Free energy and move our Nation towards total energy independence.

Rare Earth & Thorium = Energy Independence  
The U.S. needs a new Energy Policy

# End of Public Presentation

Public Policy Issues Follow

DoE | Agency Failure

# If Th-MSR is so great why does DoE reject it?

- DoE policy is frozen in time to the cold-war culture, policies & infrastructure of the past
  - DoE is primarily in the nuclear weapons business with 65% of its budget related to Nuclear Weapons.
  - Only 15% of the actual energy budget is related to energy solutions, but 44% of that funding is, again, for Nuclear.
- DoE and NRC Bureaucratic Self Preservation
  - Status quo | putting DoE's interest before National interest
  - Hiding 50 years of failure...
- Regulatory capture by all non-defense 'clients'
  - Tendency to promote non-viable base-load technologies

# U.S. Energy Policy Undermines our Economy

The Global Energy market is the only market in the world large enough to impact the current U.S. fiscal, monetary and trade imbalances, yet:

- DoE shows no interest in developing Th-MSR
- DoE is aware of China's intentions to develop Th-MSR
- DoE continues to promote the build-out of a new fleet of Uranium based Solid Fuel Light Water Reactors
  - These reactors would only compound the already massive legacy cost related to nuclear waste and decommissioning
  - These reactors are not economically viable, even with massive subsidies, and are already obsolete on paper (pre construction)

DoE is clearly disconnected from economic reality

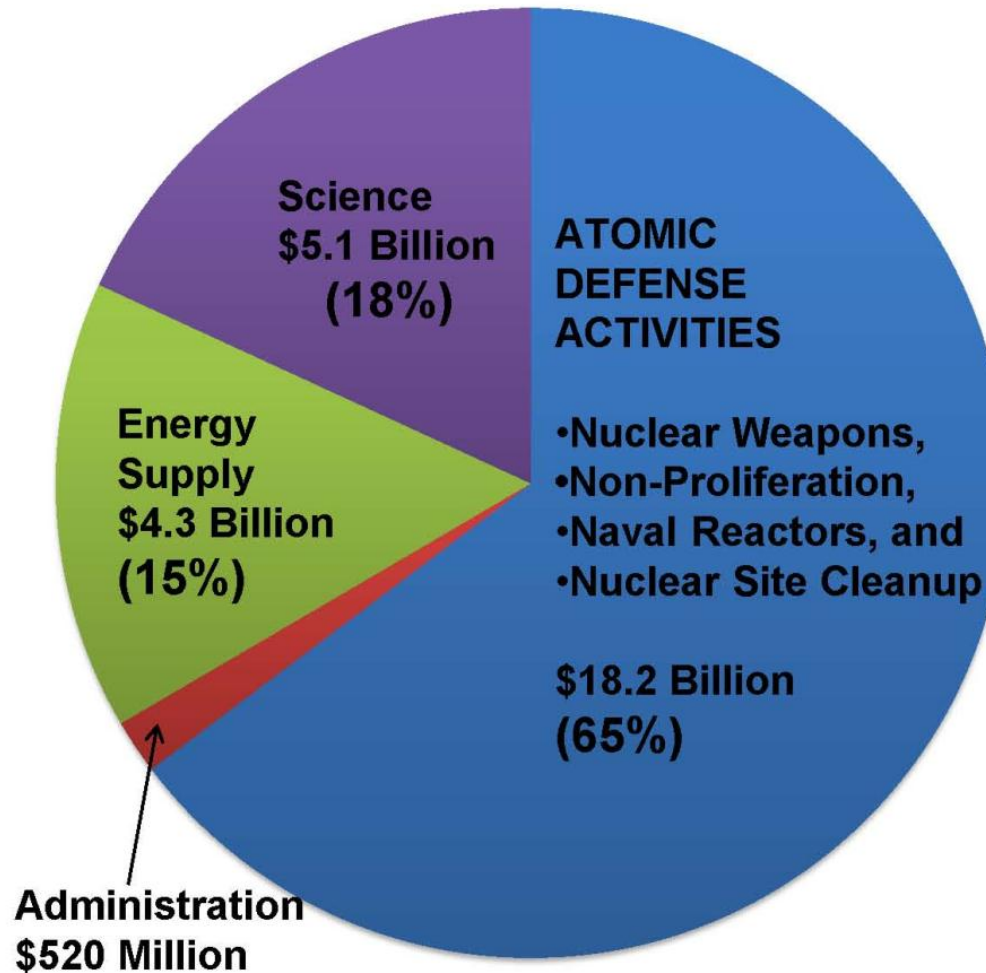


# U.S. Energy Policy = Bureaucratic Self-Preservation

- The DoE continues to protect, preserve and promote *Solid Fuel & LWR Systems* -- Why:
  - The DoE is primarily in the nuclear weapons business
    - Th-MSR is not compatible with a nuclear weapons program
  - The DoE is a “*captured agency*” that influences / controls research and regulators for the benefit of its ‘*constituents*’
    - Consequently, DoE, NRC and National Lab careers ebb and flow with the private sector.
  - The DoE’s non military *constituents*, the existing energy industry, are opposed to any new viable alternative base-load energy systems
    - Wind and solar do not threaten the status quo.
    - Typical DoE projects such as the Tocamac Fusion Reactor are eventually found to be technically / economically non-viable

# DoE is just a front for Military Spending

## U.S. Department FY 2011 Budget Request



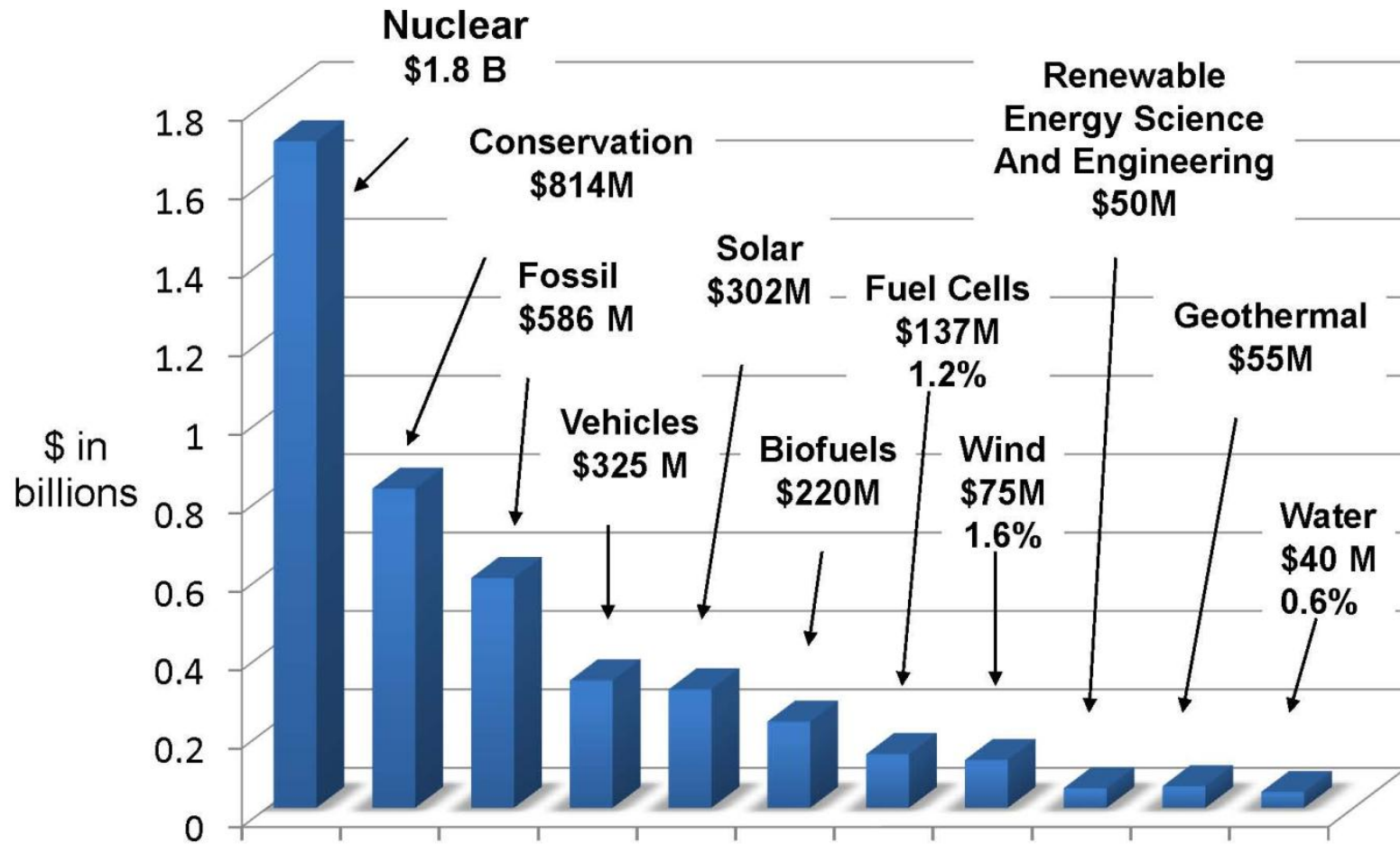
### Energy Activities Include:

- Energy Efficiency and Renewable Energy: \$2.2 Billion
- Fossil Energy: \$760 Million
- Nuclear Energy (fission & fusion): \$1.8 Billion
- Electric Transmission: \$186 Million
- Energy Information Administration: \$129 Million
- Power Marketing Administrations: \$95 Million

DOE plans to spend 10 times more on nuclear weapons than for energy conservation.

# 44% of Energy Spending is Nuclear

## Energy R&D Spending for FY 2011



**Nuclear energy gets 44% of energy R&D funds.**

# Letting China Take The Lead

China announced its intentions to develop the *Thorium Molten Salt Reactor* in January 2011. China's stated intentions are perfectly clear:

- China is seeking global IP control
- The project is fully funded (\$1 billion USD equivalent)
- Experts expect China to produce its first Th-MSR reactor within 5 years – China is uncontested

Private industry cannot challenge China due to the clear history of demonstrated regulatory obstruction on the part of the DoE and NRC.

# Chinese Lead with U.S. Technology

Chinese Academy of Science

January 31, 2011

Thorium / RE Conference at ORNL

China Announces Thorium Molten Salt Reactor (Google Translation)



This is Dr. Jiang Mianheng, who is leading the Chinese thorium MSR project in the Chinese Academy of Sciences. Dr. Jiang is a graduate of Drexel University with a PhD in electrical engineering. His father is Jiang Zemin, former president of the People's Republic of China from 1993 to 2003. He most recently toured Oak Ridge National Lab Fall of 2010 to see MSR.



**Google Translation -- Chinese Press Release - January 31, 2011:** "Yesterday, as the Chinese Academy of Sciences started the first one of the strategic leader in science and technology projects, "the future of advanced nuclear fission energy - nuclear energy, thorium based molten salt reactor system" project was officially launched. **The goal is to develop a new generation of nuclear energy systems, all the technical level reached in the trial and have all intellectual property rights.**"



# Chinese Espionage dates back to 2007

- **Forbes**
- **Congress Bans Scientific Collaboration with China,**
- **Cites High Espionage Risks**
- **By William Pentland**
- ***May 7, 2011***

October 2007: US media reports that China is suspected as the source of at least seven versions of socially engineered email targeting 1,100 employees at the Oak Ridge National Lab in Oak Ridge, Tennessee. Eleven staff possibly opened the malicious attachment, allowing the attackers to gain access to, and potentially steal, sensitive data, including a database at the nuclear weapons laboratory housing personnel records going back to 1990.



Oak Ridge National Laboratory, part of the Manhattan Project, developed the Th-MSR

# Willful Transfer of Technology to China?

The DoE's response is to continue to assist in direct Technology Transfer to China:

- Chinese downloads of Th-MSR data begin in 2005
- Chinese Computer Espionage at ORNL in 2007
- Chinese High-Level ORNL site visit 2010
- Chinese clearly state intentions to develop and control global IP for Th-MSR – January 31, 2011 Announcement
- Over 1,800 Chinese visitors to ORNL in 2011\*

\*The Congressional ban on Scientific Collaboration with China is restricted to NASA and the White House OSTP. DoE is free to transfer critical energy technology to China (see pg 32).

# ORNL Foreign Visitor Log

China top visitor every year since 2005

## 2008 Visitor List

1. China -- 812
2. India -- 432
3. U. K. -- 414
4. Germany -- 408
5. Russian Fed. -- 372
6. Japan -- 324

## 2011 Visitor Log | Post Fukushima

- |                   |        |
|-------------------|--------|
| 1. China -- 1,894 | + 133% |
| 2. India – 806    | + 86%  |
| 3. Germany – 591  | + 44%  |
| 4. Japan – 534    | + 64%  |
| 5. U. K. – 459    | + 10%  |
| 9. Russia – 312   | - 19%  |

Tracking the top 6 from 2008 to 2011 | China and India have Thorium programs, Germany looks to end Nuclear, Japan suffers Nuclear crisis, U.K. forms pro-Thorium Weinberg Foundation, Russia...?



Despite all evidence, ORNL is extremely dismissive of Chinese progress.

Yet, China has openly published its substantial progress in Scientific Journals?

Based on this publication, China had an operating salt loop, with stand-ins, as early as 2008.

Today they may be close to operating a fueled reactor.

## Interaction between Nuclear Graphite and Molten Fluoride Salts: A Synchrotron Radiation Study of the Substitution of Graphitic Hydrogen by Fluoride Ion

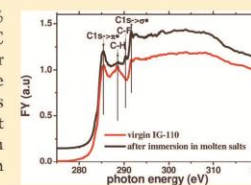
Xinmei Yang,<sup>†,‡</sup> Shanglei Feng,<sup>†,‡</sup> Xingtai Zhou,<sup>\*,†,‡</sup> Hongjie Xu,<sup>\*,†,‡</sup> and T. K. Sham<sup>\*,§</sup>

<sup>†</sup>Shanghai Synchrotron Radiation Facility, Shanghai, 201204 China

<sup>‡</sup>Key Laboratory of Nuclear Analysis Technique (Shanghai), Shanghai Institute of Applied Physics, Chinese Academy of Sciences, Shanghai, 201800 China

<sup>§</sup>Department of Chemistry, The University of Western Ontario, London, Ontario, N6A 5B7, Canada

**ABSTRACT:** The interaction between nuclear graphite and molten fluoride salts (46.5 mol % LiF/11.5 mol % NaF/42 mol % KF) is investigated by synchrotron X-ray diffraction and C K-edge X-ray absorption near-edge structure (XANES). It is found that there are a large number of H atoms in IG-110 nuclear graphite, which is attributed to the residual C–H bond after the graphitization process of petroleum coke and pitch binder. The elastic recoil detection analysis indicates that H atoms are uniformly distributed in IG-110 nuclear graphite, in excellent agreement with the XANES results. The XANES results indicate that the immersion in molten fluoride salts at 500 °C led to H atoms in nuclear graphite partly substituted by the fluorine from fluoride salts to form C–F bond. The implications of these findings are discussed.



### I. INTRODUCTION

Graphite, which can be used to slow down fast neutrons produced by nuclear reaction, has been used as a neutron moderator in many reactors, such as a molten salt reactor system (MSR). MSR is one of six reactor systems (gas-cooled fast reactor system, lead-cooled fast reactor system, molten salt reactor system, sodium-cooled fast reactor system, supercritical-water-cooled reactor system, and very-high-temperature reactor system) proposed by the Generation IV International Forum.<sup>1</sup> Different from most reactors in which solid fuel is used, a mixture of circulating liquid fluoride salts is used as fuel in the MSR system. The fuel in MSR is a mixture of molten carrier salts and fuel salts (uranium fluoride and thorium fluoride),<sup>1,2</sup> which flow through graphite moderator channels during the operation of a MSR reactor. The compatibility of nuclear graphite with fresh molten salts is one of technology gaps for MSR.<sup>1</sup> A large number of experiments in the literature indicate that graphite can react with fluorine and relatively oxidizing fluorine compounds, such as ClF<sub>3</sub>, BrF<sub>3</sub>, XeF<sub>2</sub>, and LiF, to form graphite fluoride (CF<sub>x</sub>)<sub>n</sub><sup>3–22</sup> where 0 < x ≤ 1.25. It should be noted that although the reaction of benzene with NaF to form monofluorobenzene is thermodynamically highly unlikely, our experiments used mixed fluoride ionic liquids. Thus, the conditions for the formation of C–F are more favorable when nuclear graphite is immersed in a hot ionic liquid of mixed fluorides.

Figures 1 and 4 in ref 4 present a structure model for graphite fluoride, showing that the C–F bond is not in the basal plane of the graphite sheet,<sup>9,23–28</sup> and fluorine preferentially bonds to the next neighbor carbon atoms in the basal plane on the other side. Therefore, the lattice of graphite is expanded by forming a C–F bond during fluorination.<sup>8,9,13,17,25,29,30</sup> The fluorination of graphite is dependent on the duration, temperature, and pressure of

fluorination and the size of crystallite.<sup>7,9,31</sup> The petroleum coke, which is graphitized from green coke at 2100–2700 °C, can also react with fluorine to form (CF)<sub>n</sub> (C<sub>2</sub>F)<sub>n</sub> or their mixture.<sup>7</sup> The nuclear graphite in our studies is IG-110 grade, which is graphitized from petroleum coke and pitch binder.<sup>32</sup> Therefore, there is a possibility for nuclear graphite to react with fluorine to form (CF<sub>x</sub>)<sub>n</sub>; however, most previous works have not focused on the interaction between graphite and the molten fluoride salts. Furthermore, for nuclear graphite, C–H bonds are partly residual after the graphitization of raw materials. The H atoms bonded to the C atoms at the edge of graphite can be replaced with F atoms.<sup>33–35</sup> Because the dissociation energy of C–F bond is higher than that of the C–H bond,<sup>36</sup> the C–F bond in graphite is more stable than the C–H bond. Therefore, a C–F bond can form by the reaction between nuclear graphite and molten fluoride salts, which will result in the expansion of the graphite lattice and affect the performance of nuclear graphite in MSR.

In this study, we investigated the interaction between nuclear graphite and molten salt (a mixture of 46.5 mol % LiF/11.5 mol % NaF/42 mol % KF). The molten salts used in our experiments exhibit melting points similar to a mixture of 67 mol % LiF/33 mol % BeF<sub>2</sub> and a mixture of 64.5 mol % LiF/30.5 mol % BeF<sub>2</sub>/5 mol % ZrF<sub>4</sub>,<sup>37</sup> which can be the candidate for molten salt coolants. In this study, the commercially available IG-110 nuclear graphite from Toyo Tanso Co. Ltd. was used. This material has been used as the neutron moderator for a high-temperature engineering test reactor in Japan and a high-temperature gas-cooled reactor in China.<sup>38</sup> We employed elastic recoil detection

Received: September 17, 2011

Revised: December 13, 2011

# DoE Disinformation | Washington Post 2.20.12

Acting as spokesman for ORNL, Dan Ingersoll explains DoE's disinterest in Th-MSR:

- 1) "it would be too expensive to replace or convert the nuclear power plants already running in this country."
- 2) "A thorium-based fuel cycle has some advantages, but it's not compelling for infrastructure and investments..."
- 3) "and that there is no ready stockpile of thorium in the United States. It would have to be mined. "
- 4) "The benefits don't outweigh the huge costs of switching technologies."
- 5) "I'm looking for something compelling enough to trash billions of dollars of infrastructure that we have already and I don't see that."

# Parsing DoE Double-Speak

1. “it would be too expensive to replace or convert the nuclear power plants already running in this country.”

The existing fleet is operating at or beyond the 50% mark of its engineered life. The existing fleet will need to be phased out and replaced within 20 years.

He is not talking about replacement or conversion. His concern is over public acceptance of the old technology operating along-side a new and safer technology.

This statement is misleading.

According to a recent IEAE Draft Report: "About 70 percent of the world's 254 research reactors have been in operation for more than 30 years "with many of them exceeding their original design life," "Eighty percent of the world's nuclear power plants are more than 20 years old, raising safety concerns..." It failed to mention that **100% of the reactors in the U.S. are + 30 years old and 10% are 40 years old...**

2. “A thorium-based fuel cycle has some advantages, but it’s not compelling for infrastructure and investments...”

This sentence implies that the DoE views investment decisions related to Nuclear Energy based on rational economics. Not true.

It is impossible to finance the construction of a single new LWR without MASSIVE GOVERNMENT SUBSIDIES, even though much of the true operating and waste disposal cost are dumped on the public.

This statement is dishonest.

3. “and that there is no ready stockpile of thorium in the United States. It would have to be mined. “

DoE recently stored 7 million pounds of Thorium Nitrate in the Nevada desert (completed 2006).

When you refine Monazite and other Thorium bearing rare earths, the Thorium ‘falls out’ as a free byproduct.

One 15,000 tpy rare earth refining facility, exclusively using existing Monazite mining waste, would produce sufficient Thorium to power the entire Northern Hemisphere – **no new mining required.**

This statement inaccurate and dishonest .

4) “The benefits don’t outweigh the huge costs of switching technologies.”

This statement ignores the massive hidden cost and liability transfers of the existing technology as it continues to operate.

This statement also assumes that there are no costs in rolling out a new fleet – an edict that is currently under way.

Switching to Th-MSR now would put the all risks and cost on the private sector, while the general public enjoys the benefits in debt, trade, fiscal and economic recovery.

This is what you would call ‘*spin*’...

5) “I’m looking for something compelling enough to trash billions of dollars of infrastructure that we have already and I don’t see that.”

This is where it gets interesting... What is he talking about?

His concern about *trashing* “billions of dollars of infrastructure” can only be true if he feels that Th-MSR has the potential to displace the current fleet. To date, no other DoE supported project has merited this level of concern. Why?

Double-Speak interpretation: replace the word “infrastructure” with “DoE Bureaucratic Power”.

Lets try it –

Double-Speak | “the gap between one’s real and one’s declared aims”

*I’m looking for something compelling enough to trash billions of dollars of **DoE Bureaucrat Power** that we have already and I don’t see that.”*

From the beginning of civilization any entity or institution that was able to aggregate power on the basis of a belief system (including technology) would take any measure to prevent a change in that underlying belief system: even if it undermined the viability of the underlying civilization.



# Time for Change in U.S. Energy Policy

- Private industry understands the value of the global energy market.
- By creating a regulatory pathway, private industry can challenge China in the development of Th-MSR.
- If successful, the U.S. would have a new global export capable of offsetting our Nations massive trade, fiscal, and monetary imbalances.
- Th-MSR development does not require government handouts or subsidies.


Th-MSR only requires a safe regulatory pathway.

# Mindless DoE Policy

DoE Policy: Energy Technology  
Transfer to China | U.S. China  
Clean Energy Research Center

Why require taxpayers to help  
subsidize the “off-shoring” of  
energy technologies to China?

Why assist in the transfer of  
critical technology to China?

Actual DoE document   
Who approved this Flag?



## U.S.-China Clean Energy Cooperation

A PROGRESS REPORT BY THE U.S. DEPARTMENT OF ENERGY

January 2011



U.S. DEPARTMENT OF  
**ENERGY**



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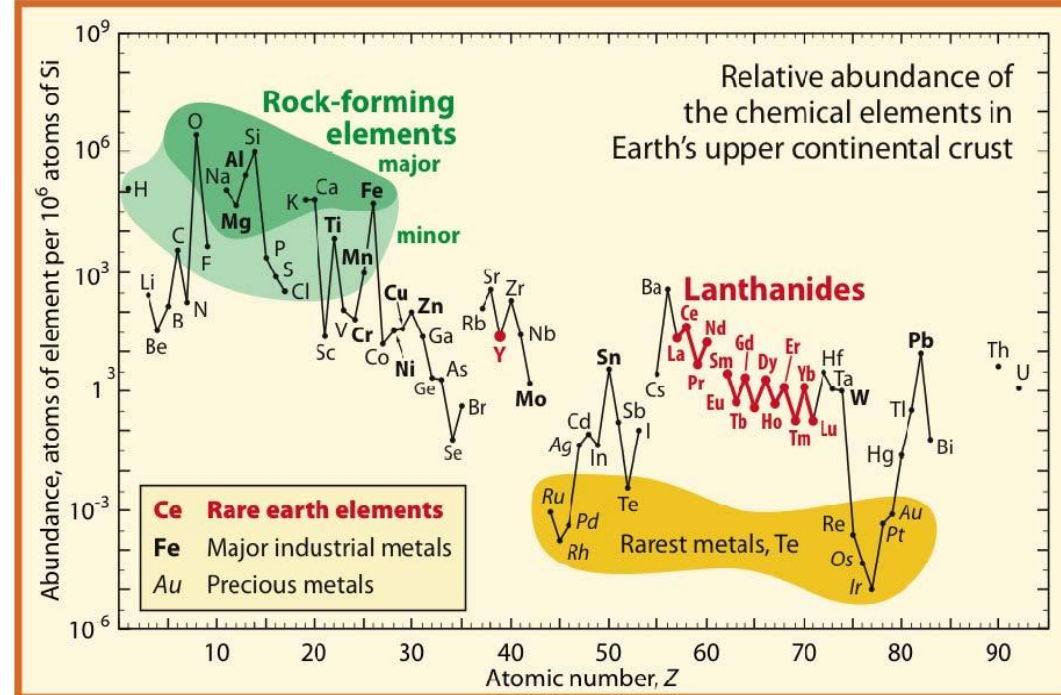
**Lanthanide Series**

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**Actinide series**

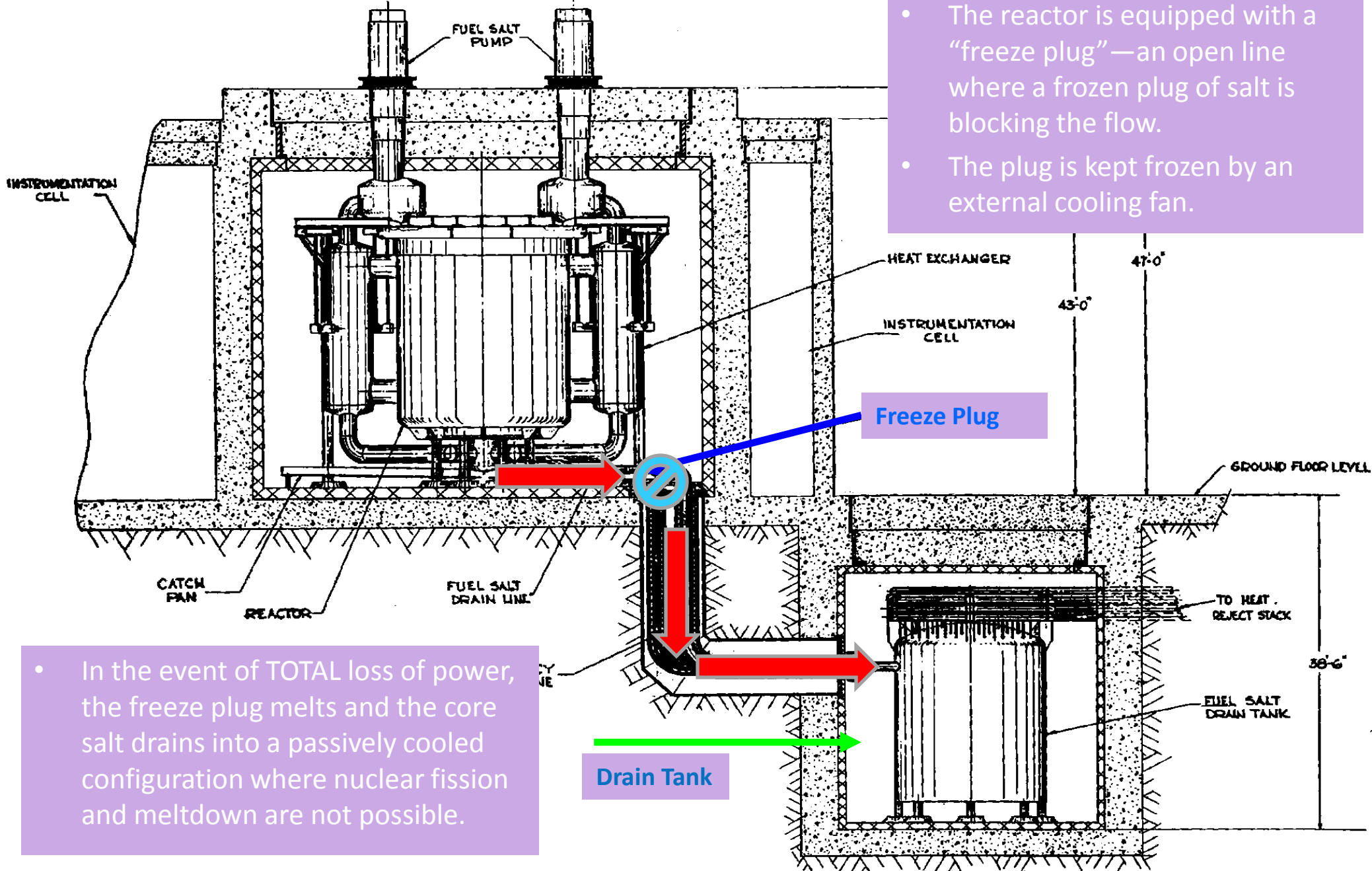
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**Rare Earth Elements**



# LFTR is passively safe in case of accident

- The reactor is equipped with a “freeze plug”—an open line where a frozen plug of salt is blocking the flow.
- The plug is kept frozen by an external cooling fan.



- In the event of TOTAL loss of power, the freeze plug melts and the core salt drains into a passively cooled configuration where nuclear fission and meltdown are not possible.