Lattice Energy LLC

Commercializing a next-generation source of safe CO_2-free nuclear energy

Asset-based lending in the oil & gas industry

Asset value of in-ground reserves used to support debt

Important source of financing for upstream exploration and production

Commercialization of LENR technology could increase value of reserves by 500x

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President and CEO

October 8, 2015

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http://www.slideshare.net/lewisglarsen/presentations

LENRs increase value of fossil Carbon reserves by 500x

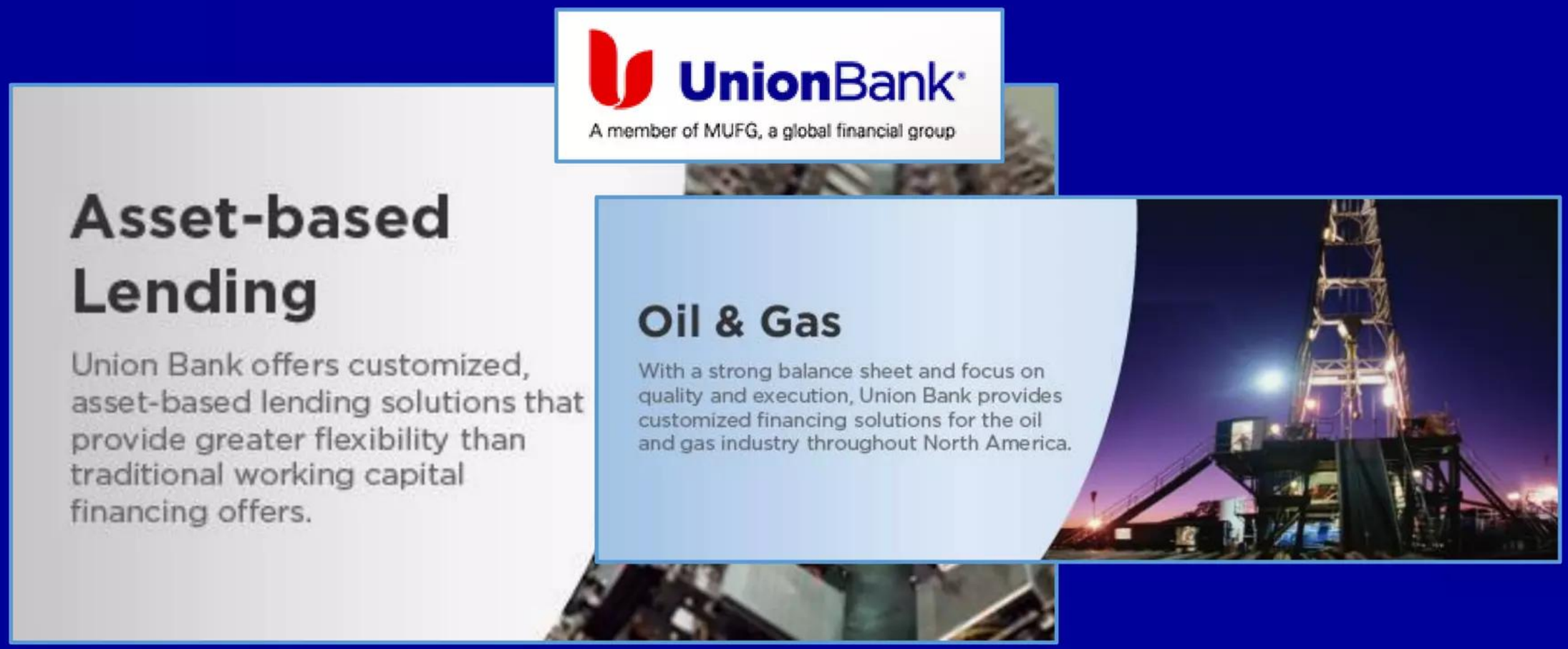
Dramatically expands debt financing opportunities for oil & gas industry

- ✓ Revolutionary LENR technology can potentially transform aromatic fractions found in oil, coal, natural gas, and biomass (lignin) into 'green' CO_2-free LENR fuels that possess >5,000x the energy density (Watt*hours/kg) of unleaded gasoline fuel
- ✓ In LENR fuels derived from extraction and processing of catalytic conversion of natural gas and aromatic fractions found in oil and coal, generation of thermal heat energy occurs via clean radiation-free, neutron-catalyzed *transmutation* of Carbon into Nitrogen and Oxygen rather than CO_2-producing chemical combustion with O_2
- ✓ Herein we show how development of LENR technology can potentially increase the economic value of Carbonaceous fossil energy reserves by at least 500x; much of this increase in realizable economic value comes from enormously larger energy densities and BTUs produced by nuclear LENR reactions versus purely chemical energy processes such as age-old combustion used by mankind for millennia
- ✓ In British Petroleum's 64th annual *Statistical Review of World Energy* (2015) they estimated that oil will run-out in 52.5 years, coal in 110 years, and natural gas in 54.1 years. Given at least 500x increase in the energetic economic value of LENR fuel, commercialization of LENRs on aromatic molecules could extend useful economic lifetime of fossil Carbon sources out to at least 25,000 years – maybe vastly longer
- ✓ Commercial LENRs eliminate the "Carbon Bubble" and "stranded assets" problems

Asset-based lending utilized in the global oil & gas industry

- ✓ **Asset-based lending (ABL)** is a mechanism that is commonly utilized to support debt financing by U.S. and foreign oil & gas companies engaged in exploration and production (E&P)
- ✓ **In reserve-based lending (RBL) facilities, borrowers put up in-ground hydrocarbon reserves as collateral for large loans**
- ✓ **Comments:** While ABL/RBL lending is somewhat akin to traditional working-capital-based ABL loan facilities, there are important differences. One key differentiating feature is that **RBL agreements can provide lenders with unilateral discretion to revise commodity price assumptions** and other relevant market or technology parameters used to estimate net present economic value of a borrower's in-ground assets

Example: Union Bank engages in asset-based lending



Asset-Based Lending

With more than 40 years of experience in asset-based lending, we provide a full range of solutions and services. Union Bank is a member of Mitsubishi UFJ Financial Group (MUFG). We are a strong and stable commercial bank with global capabilities.

Asset-based financing is designed for:

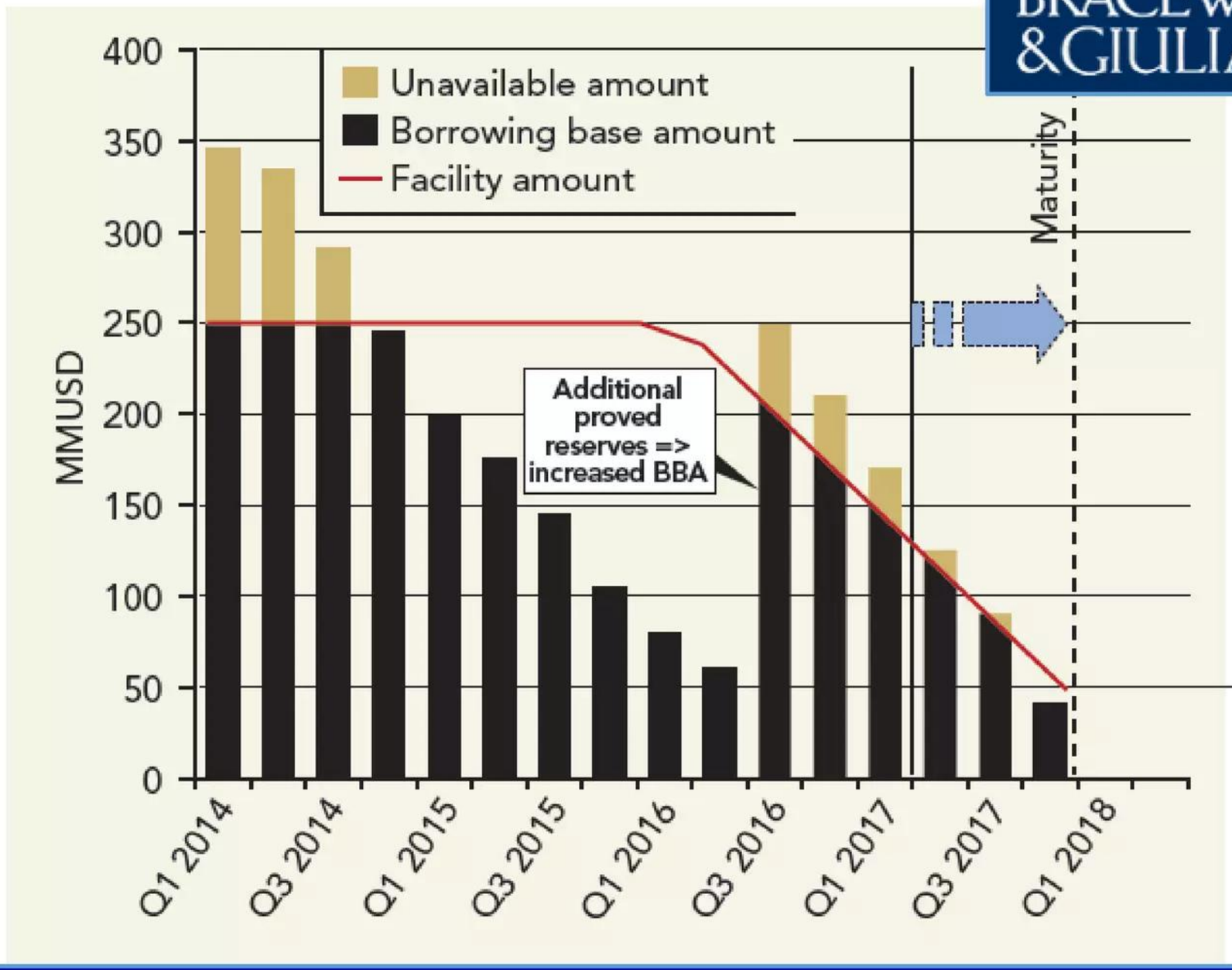
- Rapid growth
- Expansion into new products or markets
- High leverage
- Capital-intensive industries
- Acquisitions, recapitalizations, and turnarounds
- Cyclical and seasonal businesses

https://www.unionbank.com/commercial-bank/credit/asset-based-lending/index.jsp

Example of how a reserve-based lending facility works

Fig. 2: INTER-PLAY BETWEEN FACILITY AGREEMENT AND BORROWING BASE AMOUNT, COMPLEX CASE

BRACEWELL & GIULIANI



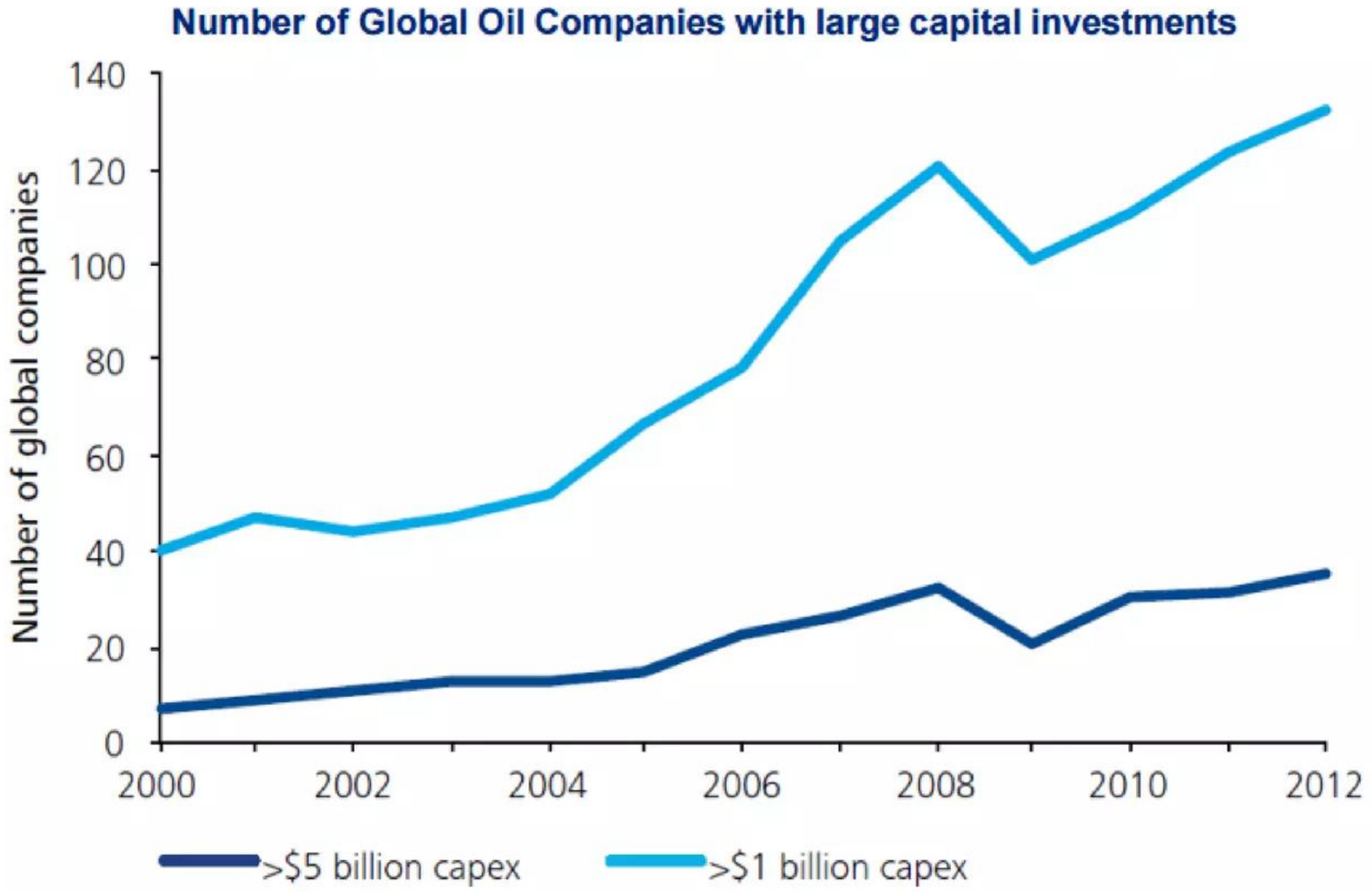
http://www.bracewellgiuliani.com/assets/OGFJ%20April%202014.pdf

Oil companies' capital expenditures continue to increase

Key trends

Projects become larger…

Deloitte.



Sources: FactSet and Deloitte analysis

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https://www.energyinst.org/_uploads/documents/wpc.pdf

Wirz & Tan story in The Wall Street Journal, March 18, 2015

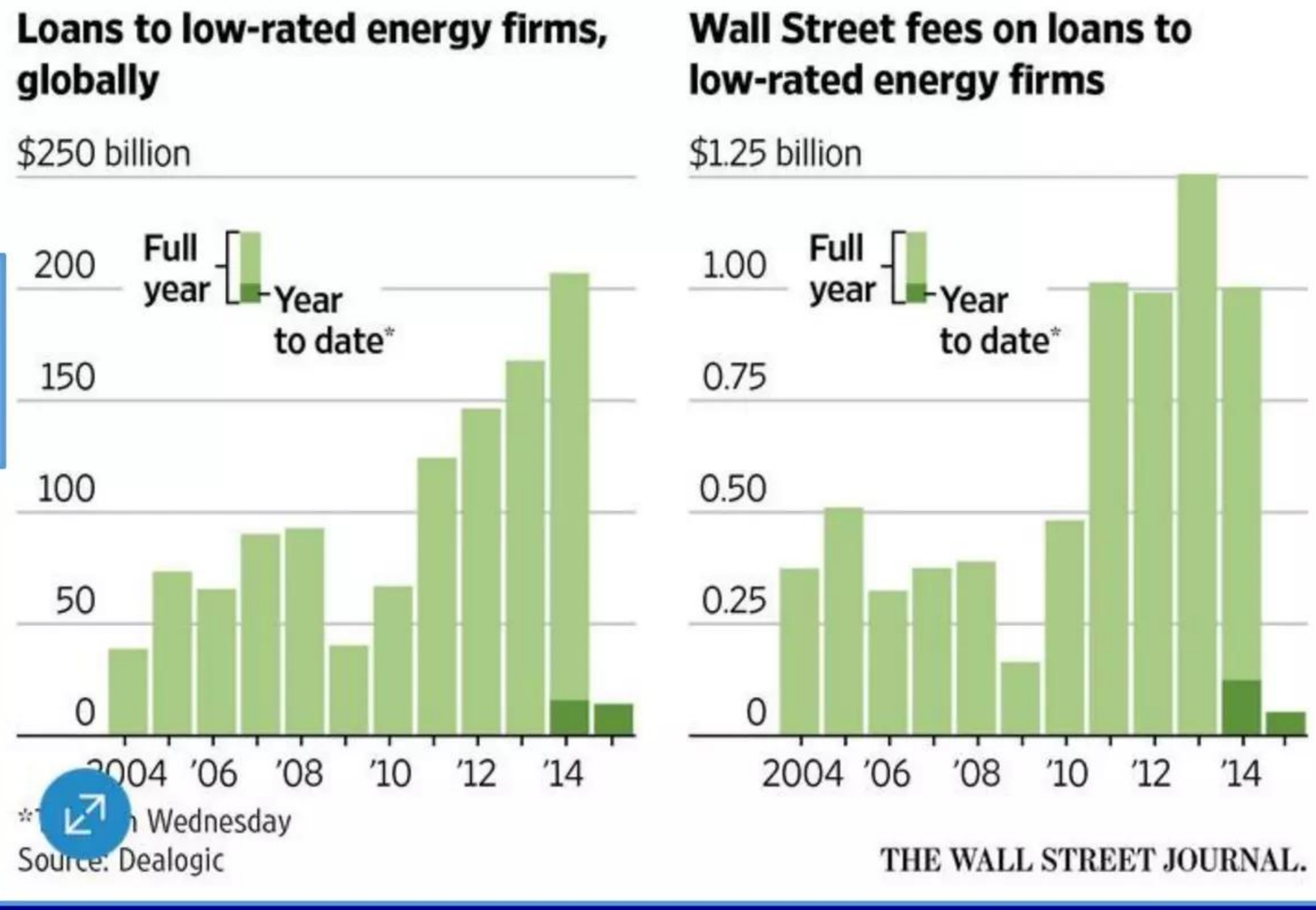
Banks Struggle to Unload Oil Loans

Citigroup, Goldman, UBS and others face losses as investors balk at riskiness of energy sector

By MATT WIRZ and GILLIAN TAN
March 18, 2015 9:29 p.m. ET

Running Dry

Banks are struggling to find buyers for some loans made to energy companies, following a lending boom that resulted in hefty fees.



Goldman Sachs

citi

UBS

http://www.wsj.com/articles/banks-struggle-to-unload-oil-loans-1426728583

Additional reading re asset-based oil & gas lending

"Reserve based finance - a tale of two markets"
J. Fox et al., *Oil & Gas Financial Journal* four-part article, 25 pp. (2014)
http://www.bracewellgiuliani.com/assets/OGFJ%20April%202014.pdf

"Funding challenges in the oil and gas sector - innovative financing solutions for oil and gas companies"
A. Brogan, EY - 8 pp. (2014)
http://www.ey.com/Publication/vwLUAssets/EY-Funding-challenges-in-the-oil-and-gas-sector/$FILE/EY-Funding-challenges-in-the-oil-and-gas-sector.pdf

"Challenges and opportunities in global oil & gas finance"
J. Sprayregen, Kirkland & Ellis LLP - 43 PowerPoint slides (2015)
http://www.grantspub.com/files/presentations/Grant_s%20April%207%20Presentation%20-%20Oil%20and%20Gas%20Restructuring.pdf

"A future for reserve-based lending in emerging markets? Limitations of the traditional model"
M. Marek & R. Wilson, *TJOGEL- Journal* 31 pp. (2014)
http://tjogel.org/journalarchive/Issue10/RBLEmergingMarkets.pdf

"Challenges and opportunities in global oil & gas finance"
World Petroleum Council Expert Workshop - 153 PowerPoint slides (2014)
https://www.energyinst.org/_uploads/documents/wpc.pdf

Commercializing ultralow energy neutron reactions (LENRs)

for stationary, mobile, and portable power generation applications

Breakthrough in nuclear technology: no dangerous radiation or wastes

Widom-Larsen theory enables LENR power generation devices

- LENR fuels get transmuted by absorbing neutrons which releases enormous heat
- Sustainable CO_2-free transmutation of Carbon could replace combustion processes

Widom-Larsen

Evolution of nuclear technology

Theory of LENRs

Revolutionary new type of safe nuclear energy technology

Unique advantages of ultralow energy neutron reactions (LENRs)

Widom-Larsen theory rigorously explains all of these unique attributes

No deadly gamma radiation

No dangerous energetic neutron radiation

Insignificant production of hazardous radwastes

Vast increase in energy density vs. other technologies

Revolutionary, disruptive, and environmentally safe

Laura 13

Image credit: co-author Domenico Pacifici
From: "Nanoscale plasmonic interferometers for multispectral, high-throughput biochemical sensing"
J. Feng *et al.*, *Nano Letters* pp. 602 - 609 (2012)

Electroweak reaction in Widom-Larsen theory is simple

Protons or deuterons react directly with electrons to make neutrons

Need input energy source such as electricity to drive LENR neutron production

electrons + protons (Hydrogen) → neutrons + neutrinos (benign photons, fly into space)

Require source(s) of input energy

Input energy creates electric fields > 2.5 x10^{11} V/m

Collective many-body quantum effects: many electrons each transfer little bits of energy to a much smaller number of electrons also bathed in the very same extremely high local electric field

Many-body collective electroweak neutron production

Heavy-mass e^{-}* electrons react directly with protons

Quantum electrodynamics (QED): smaller number of electrons that absorb energy directly from local electric field will increase their effective masses ($m = E/c^2$) above key thresholds β_0 where they can react directly with a proton (or deuteron) → neutron and neutrino

$$\text{Energy}_{\text{E-field}} + e^-_{sp} \rightarrow e^{-*}_{sp} + p^+ \rightarrow n^0 + \nu_e$$

ν_e neutrinos: ghostly unreactive photons that fly-off into space; n^0 neutrons capture on nearby atoms

Radiation-free LENR transmutation

Neutrons + fuel elements → heavier elements + decay products

Neutrons induce nuclear transmutations that release enormous amounts of clean, CO_2-free heat

Widom-Larsen enables commercialization of LENRs

Applied nanotechnology and LENRs are mutually joined at the hip

Development risks can be reasonable thanks to Widom-Larsen and nanotech

Guided by physics of the Widom-Larsen theory, an opportunity to commercialize LENRs as truly green CO_2-free nuclear energy source has been enabled by a unique juxtaposition of very recent parallel advances in certain very vibrant areas of nanotechnology (esp. plasmonics), quantum entanglement, new innovations in nanoparticle fabrication techniques, as well as an array of new discoveries in advanced materials science.

LENRs are green: no energetic radiation or radwastes

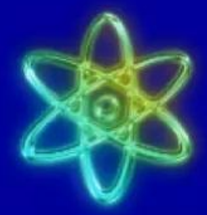
Lack of hard radiation obviates need for shielding and containment

Major opportunity to develop safe, battery-like portable LENR power sources

Fission and fusion processes both emit deadly MeV-energy neutron and gamma radiation

Fission reactors need 1 foot of steel and 3 feet of concrete to protect humans from hard radiation and wastes emitted by reactor; makes systems intrinsically large and heavy

LENRs enable devices something like this: small, portable battery-like power sources that are safe and disposable



Revolution in green nuclear technology

Much larger LENR devices based on dusty plasma embodiments can potentially scale-up to megawatts; akin to today's power plants

LENRs have energy densities 5,000x greater vs. gasoline

Estimate of multiple based on very conservative energetic assumptions

Energy densities of LENR transmutation processes surpass chemical combustion

LENRs Versus Chemical Energy Sources: Batteries, Fuel Cells, and Microgenerators	
Source of Energy	**Approximate Energy Density (Watt*hours/kg)**
Alkaline Battery	**164**
Lithium Battery	**329**
Zinc-Air Battery	**460**
Direct Methanol Fuel Cell (35% efficient)	**1,680**
Gas Burning Microgenerator (20% efficient)	**2,300**
100% Efficient Combustion of Pure Methanol	**5,930**
100% Efficient Combustion of Pure Gasoline	**11,500**
LENRs (based on an assumption of an average of 0.5 MeV per nuclear reaction in an LENR system)	**57,500,000** (maximum theoretical energy density – only a fraction would be achievable in practice)

Chemical Energy Sources

LENRs

LENR systems are energy-dense and readily scale-up

Energy density is a key advantage of LENRs vs. chemical combustion

Solar or wind - innately low energy densities; must be collected and concentrated

- ✓ Vast majority of vehicles are now powered by internal combustion engines burning gasoline or diesel fuels with O_2 because effective energy densities are much higher than all-electric vehicles powered by advanced chemical batteries
- ✓ At the present time, vehicles with internal combustion engines have substantially lower total lifetime $ costs than all-electric vehicles
- ✓ LENRs are at least 5,000 times more energy-dense than gasoline
- ✓ If LENRs can be scaled-up to power vehicles, have opportunity to displace internal combustion

Petroleum energy density: "A single gallon of gasoline contains approximately forty megajoules of chemical energy. Dividing energy by volume yields an energy density of ten billion joules per cubic meter. Gasoline is ten quadrillion times more energy-dense than solar radiation and one billion times more energy-dense than wind and water power."

Table 1 Energy density — Source: B.E. Layton, *International Journal of Green Energy* 5 pp. 438 - 455 (2008)

Source	Joules per cubic meter
Solar	0.0000015
Geothermal	0.05
Wind at 10 mph (5m/s)	7
Tidal water	0.5–50
Human	1,000
Oil	45,000,000,000
Gasoline	10,000,000,000
Automobile occupied (5800 lbs)	40,000,000
Automobile unoccupied (5000 lbs)	40,000,000
Natural gas	40,000,000
Fat (food)	30,000,000

Renewables

Fossil fuels

http://www.drexel.edu/~/media/Files/greatworks/pdf_sum10/WK8_Layton_EnergyDensities.ash

Examples of applications for potent LENR thermal sources

LENRs could reduce costs and enhance production in oil & gas industry

Market Application Examples	More details about applications	Economic Advantages
LENRs enable safe, radiation- and CO_2-free free nuclear energy production and power generation at substantially lower cost vs. competing nuclear (fission or fusion) and chemical technologies. Vastly greater energy densities and longevity at a lower price per kWh compared to chemical power sources for producing electricity	Integrate LENR heat sources w. different types of energy conversion technologies: e.g., create battery-like devices using thermoelectrics that can convert raw heat directly into DC electricity; or use heat to rotate a shaft for direct motive propulsion and/or in power generation systems (e.g., steam turbines); scale-up by increasing LENR-active surface areas and/or volumetrically in case of dusty plasmas	SAFE - no radiation shielding or waste issues. Could someday enter huge unit-volume portable power markets and be able to compete directly against advanced chemical batteries, small fuel cells, and fossil fuel microgenerators
Create large quantities of inexpensive raw process heat for bitumen extraction, heavy oil recovery, and/or oil shale processing. Could eliminate burning of natural gas used to make steam employed in SAGD process for underground bitumen extraction in oil sands regions of Canada (big decrease in CO_2 footprint and extraction costs)	Long-lived LENR thermal sources lowered down boreholes could be used to directly heat-up bitumen or heavy oil in underground rock formations to reduce production costs and enhance % recovery. Could use LENR heaters for *in-situ* underground upgrading --- maybe up to mid-distillates. Can also produce clean, inexpensive process heat for downstream petroleum operations such as refining	Major benefits to large oil and coal producers – can help increase long-term supplies of oil and reduce total production costs; shrink industry's global CO_2 emission footprint across all upstream and downstream operations

Fossil fuels could be converted into green LENR fuels

Breakthroughs in physics and nanotechnology make this possible

Bitumen, heavy oil, and coal may be much more valuable as CO_2-free LENR fuels

In 2009 Larsen discovered that aromatic molecules can potentially be extracted and processed to be converted into green LENR fuels in which there would be no hard radiation emissions, no production of any long-lived radioactive wastes or emission of gaseous CO_2 into the atmosphere; would instead release **> 5,000 times more thermal energy versus combustion of Carbon-based molecules with Oxygen**

These fossil hydrocarbons contain aromatic ring molecules on which LENRs can be triggered

Canadian natural bitumen

Heavy viscous oils found in many fields

Various grades of coal

Many moieties contain or are convertible into aromatics

LENR fuels can be created from many different types of Carbon sources

Base feedstock → Aromatic molecules → Nanoparticulate fuels

Contain aromatic molecules

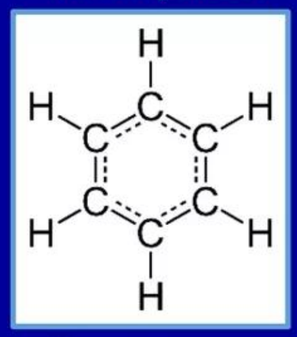
Examples:

- Heavy oils and natural bitumen — Extract
- Coal — Extract
- Lignin from renewable biomass — Digest
- CH_4 natural gas — Mo catalyst → LNG
- CO_2 → C nanofibers — Processing

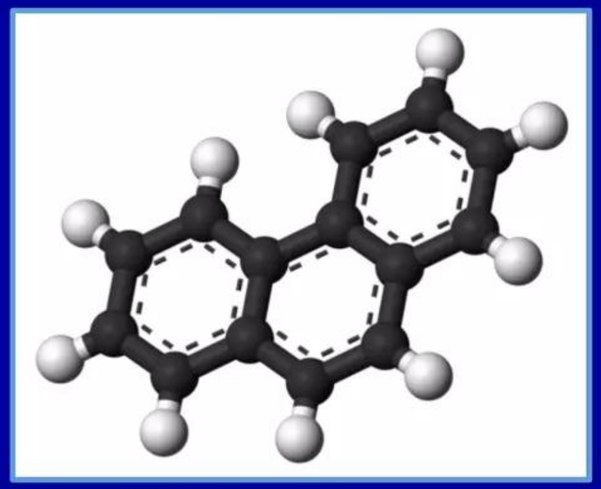
Chemical process

Variety of simple and complex aromatic molecules

Examples:



Benzene



Phenanthrene

Enormous gain in energy density makes processing conversions $$$ economic

Chemical processing

Process into

plus nanotech

Green CO_2-free LENR fuels

5,000x greater energy density

Bottom line: just about any Carbon-based moiety can be converted into aromatic ring-structure molecules using a chemical process

Aromatic Carbon can be transmuted rather than combusted

Oil, coal, lignin, and LNG could be processed into CO_2-free LENR fuels

Carbon atoms found on aromatic rings good fuel for radiation-free transmutation

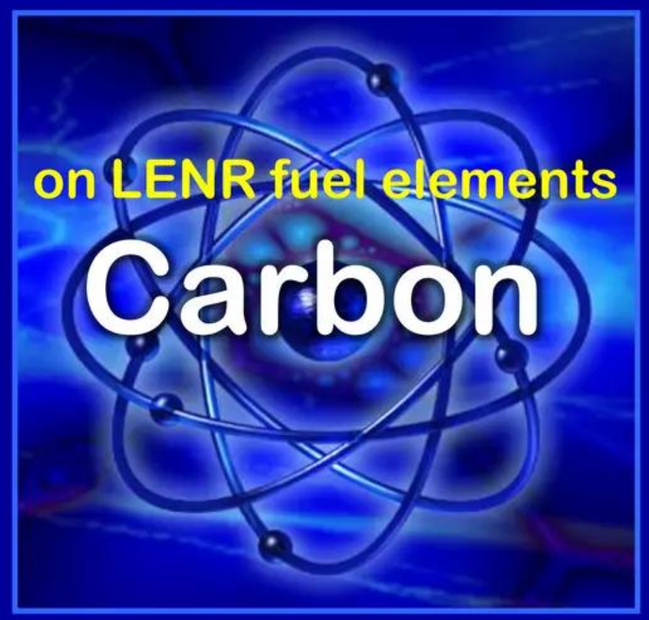
Radiation-free LENR transmutation

Neutrons + LENR fuel elements → heavier elements + decay products + heat

Catalytic neutron 'match'

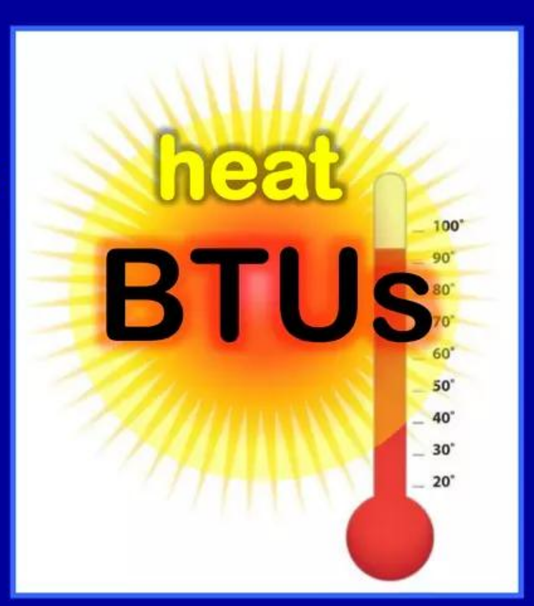
capture +

Neutrons are readily absorbed by LENR fuels such as Nickel, Titanium, Lithium, or aromatic Carbon atoms



produces →

Direct conversion of neutron capture and decay-related gammas to IR and beta/alpha particles create heat



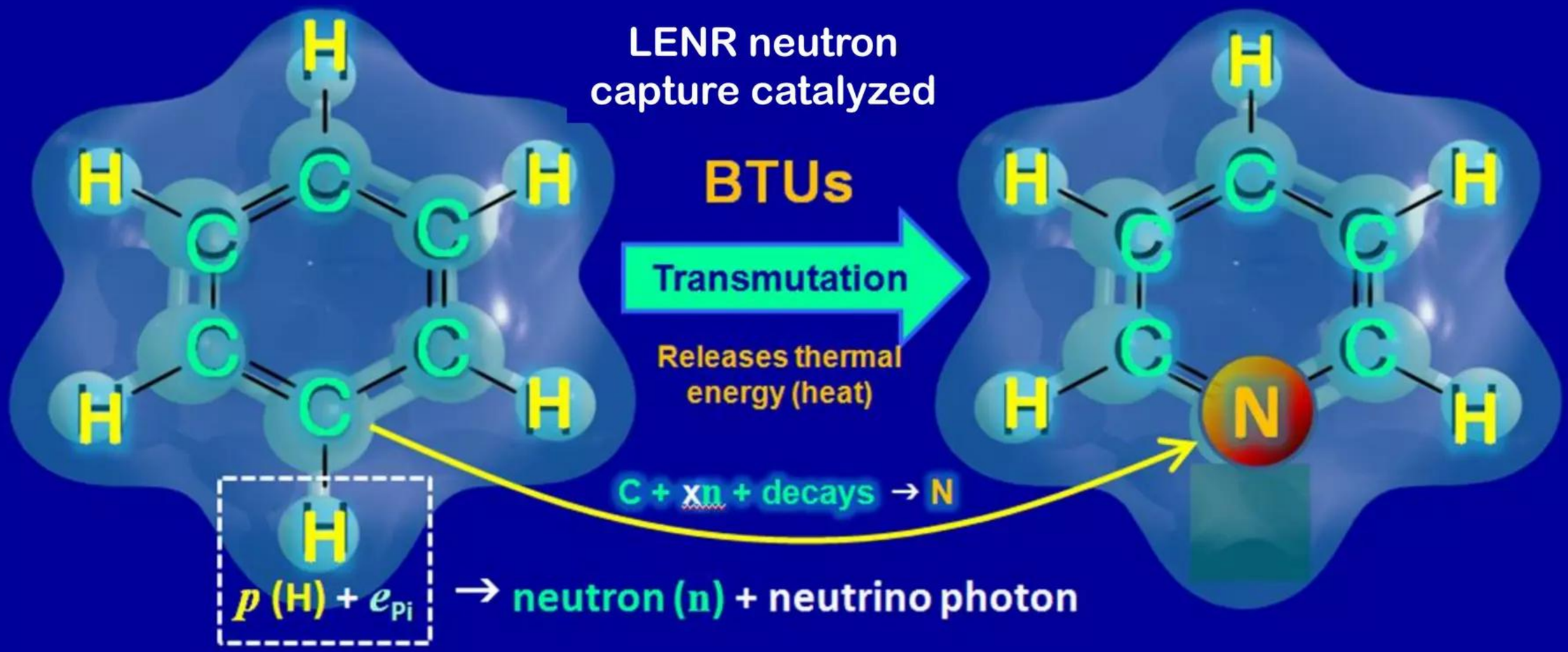
Process does not emit any deadly radiation or produce troublesome radwastes

Convert ring Hydrogen atoms (protons) into safe neutrons

Neutrons are captured by ring Carbon atoms that are then transmuted

In this example a Carbon atom is transmuted into a Nitrogen with LENR process

Aromatic Carbon molecules from biomass lignin become revolutionary bionuclear fuels



Process does not emit any deadly radiation or produce troublesome radwastes

Nanoparticulate LENR fuels could be used in many systems

Huge energy density advantages vs. fossil fuels & chemical batteries

Bionuclear LENR fuels energy densities could be 5,000x larger vs. gasoline

Consequence: an automobile powered by LENRs could travel around the entire world on a quantity of nanoparticulate fuel that fits into just a single FedEx box

LENR fuels would be inert and benign and could use existing package delivery systems for resupply; typical gasoline or diesel tanker truck carries ~5,000 - 12,000 US Gallons of liquid fuel; **LENR fuels producing same # of BTUs could be shipped in 1 - 2 FedEx boxes**

LENRs could enable vast increases in product performance

Energy densities of LENR fuels at least 5,000x > chemical processes

LENR-powered *systems* could easily achieve 10x - 100x chemical systems

Enhancements in product range and endurance if LENR technology were commercialized

	Product Name	Present capabilities with today's power sources Range (endurance)	Vastly enhanced capabilities with future LENR-based power sources	
			10x chemical	100x chemical
Various aircraft	GreenWing e430	180 miles (~3 hours @ 60 mph)	1,800 (30)	18,000 (300)
	Airbus E-Fan 2.0	99 miles (1 hour @ 99 mph)	990 (10)	9,900 (100)
	Predator MQ-1	1,800 miles (24 hours @ 75 mph)	18,000 (240)	180,000 (2,400)
	Super Heron	est. ~4,000 miles (45 hours @ 89 mph?)	40,000 (450+)	400,000 (4,500)
	Springtail	184 miles (2.2+ hours @ 94 mph)	1,840 (200+)	18,400 (2,000+)
	Crazyflie	Speed not measured (3 - 10 minutes)	? (30 - 100 min.)	? (maybe 5 - 17 hrs.)
	InstantEye	est. ~8 miles (18 - 20 min @ 25 mph)	est. 80 (3.2 hrs.)	800 (32 hrs.)
	Tesla Model S car	~300 miles (4 - 5 hours @ 70 mph)	3,000 (40 - 50)	30,000 (400 - 500)
	Shkval torpedo	6.8 - 9.3 miles (1.8 - 2.4 min @230 mph)	68 - 93 (18 - 24 min)	680 - 930 (3 - 4 hrs)
	Exoskeletons and autonomous robots	Require tether cables connected to some type of external power source	Duration of autonomous activity might be extended up to weeks or even months	

Note: roughly 730 hours in a month and 8,760 hours in a year; average U.S. car's IC engine runs for ~5,000 hrs over lifetime

LENRs solve issue of future "Carbon bubble" asset risk

Bank of England *et al*. weigh risks of "stranded" in-ground fossil fuels

Not only will such risks disappear but LENRs increase energetic value by >500x

theguardian
Winner of the Pulitzer prize

Bank of England investigating risk of 'carbon bubble'

Enquiry to assess chances of an economic crash if climate change rules render coal, oil and gas assets worthless

Quoted directly from news story by Damian Carrington, *The Guardian* online, December 1, 2014 at 08:47 EST

"The Bank of England is to conduct an enquiry into the risk of fossil fuel companies causing a major economic crash if future climate change rules render their coal, oil and gas assets worthless."

"The concept of a 'carbon bubble' has gained rapid recognition since 2013, and is being taken increasingly seriously by some major financial companies including Citibank, HSBC and Moody's, but the Bank's enquiry is the most significant endorsement yet from a regulator."

"The concern is that if the world's government's meet their agreed target of limiting global warming to 2º C by cutting carbon emissions, then about two-thirds of proven coal, oil and gas reserves cannot be burned. With fossil fuel companies being among the largest in the world, sharp losses in their value could prompt a new economic crisis."

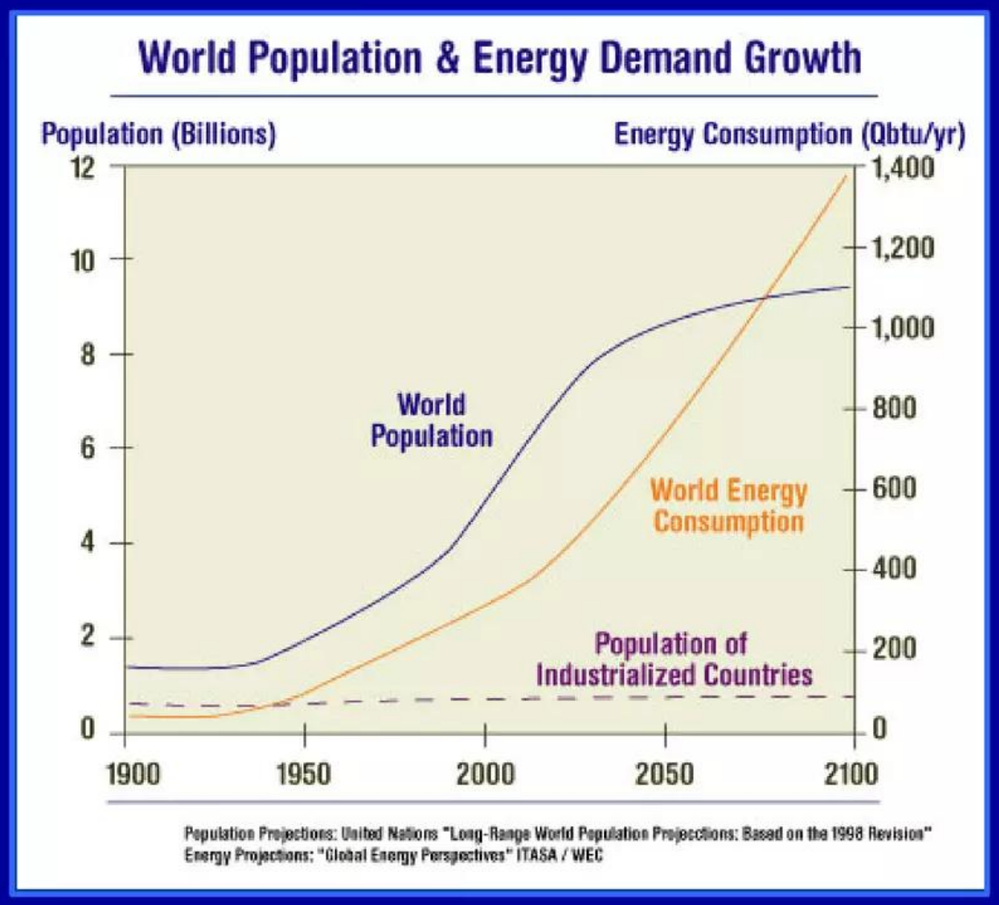
Source: http://www.theguardian.com/environment/2014/dec/01/bank-of-england-investigating-risk-of-carbon-bubble

Oil companies facing turbulent times in near future

Strategic issue: BP says oil supplies will likely run-out in 52.5 years

Besides resource depletion, climate change may force cuts in fossil fuel usage

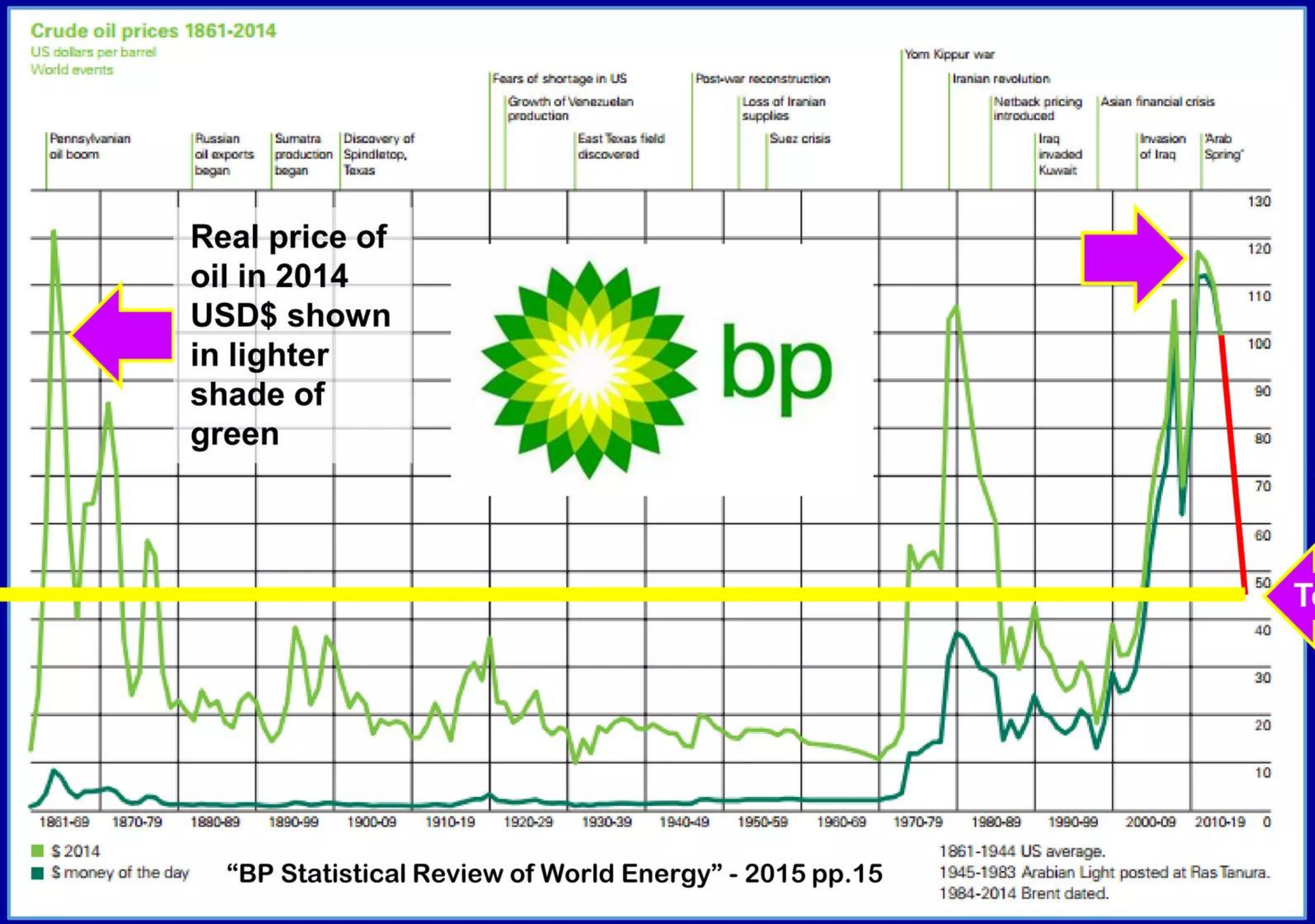
Global energy demand has been increasing exponentially and will try to continue to do so



- ✓ **Resource depletion:** BP says oil will run-out in 52.5 years and coal in 110; **what happens to world's fossil energy markets after that?**
- ✓ **Climate change:** emerging scientific consensus posits global warming is being caused by increasing CO_2 emissions from human activities; need huge cuts in CO_2
- ✓ Concern about global warming has lead to speculation about somehow mandating radical decreases in man's CO_2 emissions to help mitigate further rise in average global temperature; **restrict fossil fuel use?**
- ✓ **Further concerns about possible "Carbon bubble" that makes remaining in-ground fossil fuels unextractable and worthless**

Real price of oil has recently hit values seen back in 1860s

Real price is high even after recent decline; suggests resource depletion



https://www.bp.com/content/dam/bp/pdf/Energy-economics/statistical-review-2015/bp-statistical-review-of-world-energy-2015-full-report.pdf

Transmutation is economically attractive vs. combustion

LENRs increase net energy equivalent values of coal and oil by >500x

Oil is in barrels; Coal in short tons	Oil	Coal	Total adjusted economic value for oil + coal in US$
BP est. proven reserves as of the end of 2013	1,687,900,000,000	891,531,000,000	See BP's *Statistical Review of World Energy* (2014)
Percentage of proven reserves of a fossil fuel left in ground for whatever reasons (%)	0.33	0.80	See McGlade & Elkins in recent *Nature* article (2015)
Number of barrels of oil or short tons of coal deliberately left in the ground (reserves x %)	5.57007E+11	7.13225E+11	Hypothetical assumption for discussion purposes
For discussion purposes, simply assume price of oil and coal remains ~ same as it is today	US$ 50 bbl	US$ 55 ST	In fact, prices should rise as resources are depleted
Conservatively estimated economic value of reserves left-in-ground (US$ price x in-ground)	2.78504E+13	3.92274E+13	6.70777E+13
Assume that only 10% of in-ground oil and coal is recoverable as usable aromatic molecules	0.10	0.10	"Haircut" for non-aromatic fractions of oil and coal
Net economic value of green LENR fuels before adjusting for > energy density (value x .10)	2.78504E+12	3.92274E+12	Adjust for >>> larger LENR heat production in BTUs
Adjust energy equivalent economic value for higher LENR energy density (net value x 5,000)	1.39252E+16	1.96137E+16	3.35389E+16 US$

500x

Assumed proven reserves data is from the BP *Statistical Review of World Energy* (2014); assumptions re % of oil and coal left in ground (whether because of governmental fiats, voluntary restraint, taxation of extraction, or any combination thereof) taken from McGlade & Elkins (*Nature* 2015); assumption that net energy density (ED) of LENR fuels derived from aromatic rings found in oil and coal is ~5,000x > gasoline is probably quite conservative - very likely that an *additional* 10 - 12x increase may be achievable, i.e., >50,000x the ED of gasoline

Transmutation is economically attractive vs. combustion

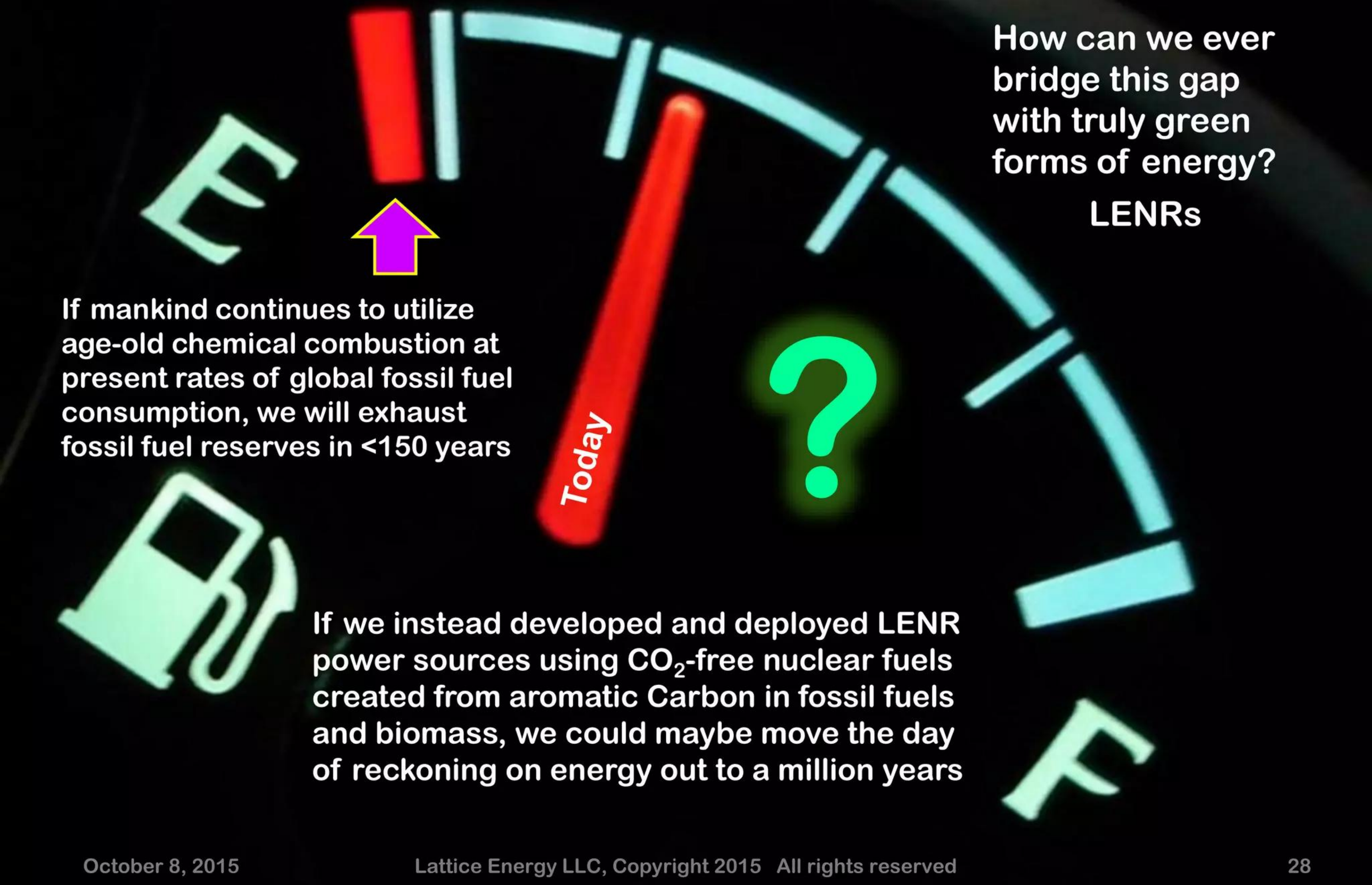
- ✓ At this point, it is not clear exactly how or even whether rates of extraction and/or use of fossil fuels for combustion could be substantially reduced. That said, for purposes of discussion let's assume that leaving 33% of remaining oil and 80% of coal fallow in the ground might be a real possibility via governmental fiats. What would it be worth in terms of economic $$$ value for the oil and coal industry to be able to extract those potentially 'stranded' fossil Carbon resources and generate vastly more CO_2-free energy via LENRs? (note: non-aromatic components of oil and coal would still be available for use as chemical feedstock) Answer to this question is provided in previous slide's Table: 3.35×10^{16} US$

- ✓ For purposes of discussion, let's arbitrarily assume that US$ 250 billion invested over 10 years would be needed to fully commercialize LENRs (Lattice believes it is ~2 - 3 orders of magnitude *less* than that number). What multiple of that investment would the realized economic value of 3.35×10^{16} US$ represent; dividing that number by 2.5×10^{11} US$ yields ratio of 1.34×10^{5} – huge economic multiplier resulting from a 10-year US$ 250 b investment

- ✓ In 2014 alone, the global oil & gas industry collectively spent US$ 670 billion searching for and developing new fossil fuel resources. In 2013, just Chevron, ExxonMobil, and Royal Dutch Shell together spent more than US$ 120 billion on such activities. Lastly, drilling a single deep water oil well can cost US$100 million. Investment capital that is needed to fully commercialize LENR technology is well-within financing capabilities of major oil players

- ✓ LENRs have not yet been successfully commercialized but the science behind it is certainly real --- what remains to be accomplished is mainly device engineering and scale-up of system power outputs. Besides Lattice and NASA in USA, Mitsubishi Heavy Industries and Toyota in Japan have experimental R&D programs, are filing patents, and are publishing some of their results in peer-reviewed scientific journals. Given the very attractive economic proposition that has been outlined herein, more large companies will very likely enter the LENR technology race and eventually, somebody or somebodies, somewhere, will succeed

LENR fuels derived from Carbon would be sustainable



How can we ever bridge this gap with truly green forms of energy?

LENRs

If mankind continues to utilize age-old chemical combustion at present rates of global fossil fuel consumption, we will exhaust fossil fuel reserves in <150 years

If we instead developed and deployed LENR power sources using CO_2-free nuclear fuels created from aromatic Carbon in fossil fuels and biomass, we could maybe move the day of reckoning on energy out to a million years

Key take-aways

- ✓ Ultralow energy neutron reactions (LENRs) are new type of clean, green CO_2-free nuclear energy source that has huge energy densities, vastly lower costs versus fission or fusion, and could enable truly sustainable economic growth
- ✓ Development and utilization of LENR thermal sources for process heat could help reduce upstream and downstream costs for oil & gas producers and significantly decrease CO_2 emission footprints for the entire oil & gas industry
- ✓ Should be possible to develop green LENR fuels derived from aromatic fractions present in oil, coal, and biomass as well as C-aromatics produced from natural gas; these would be suitable for use in many applications that include stationary/portable power generation and vehicular propulsion
- ✓ Oil & gas companies that successfully employ technology to produce LENR fuels for sale to customers will: (1) exploit a major strategic diversification opportunity to expand beyond their present product lines and (2) greatly enhance their capacity for RBL debt financing as a result of very substantial increases in net present economic value of their proven fossil fuel reserves
- ✓ Existing crude oil refineries could be modified to add capabilities for production of LENR fuels in parallel with traditional industry products
- ✓ Not competitive; LENRs are a strategic opportunity for oil & gas companies

Additional relevant information in Lattice documents

"Lignin comprises ~33% of total plant biomass; aromatics found therein could potentially be liberated and converted into green CO_2-free bionuclear LENR fuels with energy density 5,000x > than gasoline" [28 slides]
http://www.slideshare.net/lewisglarsen/lattice-energy-llc-renewable-lignin-biomass-aromatics-convert-into-green-radiationfree-lenr-fuels-sept-14-2015

"LENR transmutation of Carbon is superior energy strategy - slashes CO_2 emissions for vehicles as well as electric power generation" [32 slides]
http://www.slideshare.net/lewisglarsen/lattice-energy-llc-lenr-transmutation-of-carbon-better-energy-strategy-than-obama-clean-power-plan-aug-3-2015

"Compelling economics of transmutation vs. combustion of carbonaceous energy sources" [44 slides]
http://www.slideshare.net/lewisglarsen/lattice-energy-llc-compelling-economics-of-transmutation-vs-combustion-of-carbonaceous-energy-sources-jan-14-2015

"Transmutation vs. combustion - are LENRs a Chicxulub for fossil fuel dinosaurs?" [49 slides]
http://www.slideshare.net/lewisglarsen/lattice-energy-llc-transmutation-vs-combustion-are-lenrs-chicxulub-for-fossil-fuel-dinosaurs-oct-6-2014

"Index and User Guide to the Widom-Larsen theory and ultralow energy neutron reactions (LENRs)" [133 slides]
http://www.slideshare.net/lewisglarsen/lattice-energy-llc-hyperlinked-index-to-documents-re-widomlarsen-theory-and-lenrs-september-7-2015