Exploring New Energy Frontiers with Petroleum Geoscience Talent and Technology*

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Abstract

The energy landscape is evolving from petroleum dominance to a widening array of renewable, low-carbon components. Along with wind, hydro, and geothermal, solar has reached an economic threshold that fosters market growth. Storage requirements for electric vehicles and renewable baseload are spurring increased demand for lithium, graphite, cobalt, vanadium, and nickel. Geologists who explore for and extract these metals will use skills honed in the oil and gas industry as well as familiar datasets, such as borehole records, surface geologic maps, rock mineralogy, and size statistics. Predictive models of ore accumulation rely on mass transport calculations at assumed heat, pressure, brine composition and mineral equilibria, and are comparable to those used to understand oil generation, migration, and trapping. Three dimensional geologic models to explore for and assess reserves of metals will benefit from enhanced geophysical techniques, including 3D seismic, as well as the application of play fairway analysis to better predict exploration corridors. Defining the heat resource, drilling, fracking, and circulating brines are also key components to the successful exploitation of geothermal energy. Structural geology and sedimentology studies remain crucial to proper siting, monitoring, and remediation of hydro-electric projects. Geoscientists can also maximize energy efficiency for development of renewable components via the use of low carbon energy resources, and we can apply our environmental experience to minimize the footprint of mines and manufacturing sites. Solar and wind design and construction are fertile ground for the application of geography and GIS skills. In parallel to development of new forms of renewable energy, a shift from heavy to light hydrocarbons for transportation and electricity generation requires traditional petroleum technology to define and extract stranded global gas resources. And, of course, we can always work to green the oilfield by introducing solar pumps and vapor recovery units. As geoscientists and engineers, we have opportunities to transfer our expertise in exploration, development, extraction, and remediation to processes associated with cleaner energy production. We can utilize our strengths in creativity, risk assessment, and environmental stewardship to become leaders in sustainable energy development.

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Website Cited

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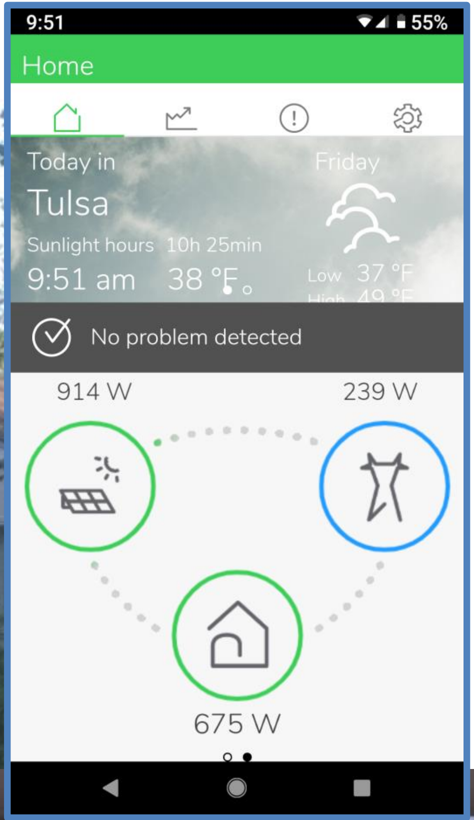
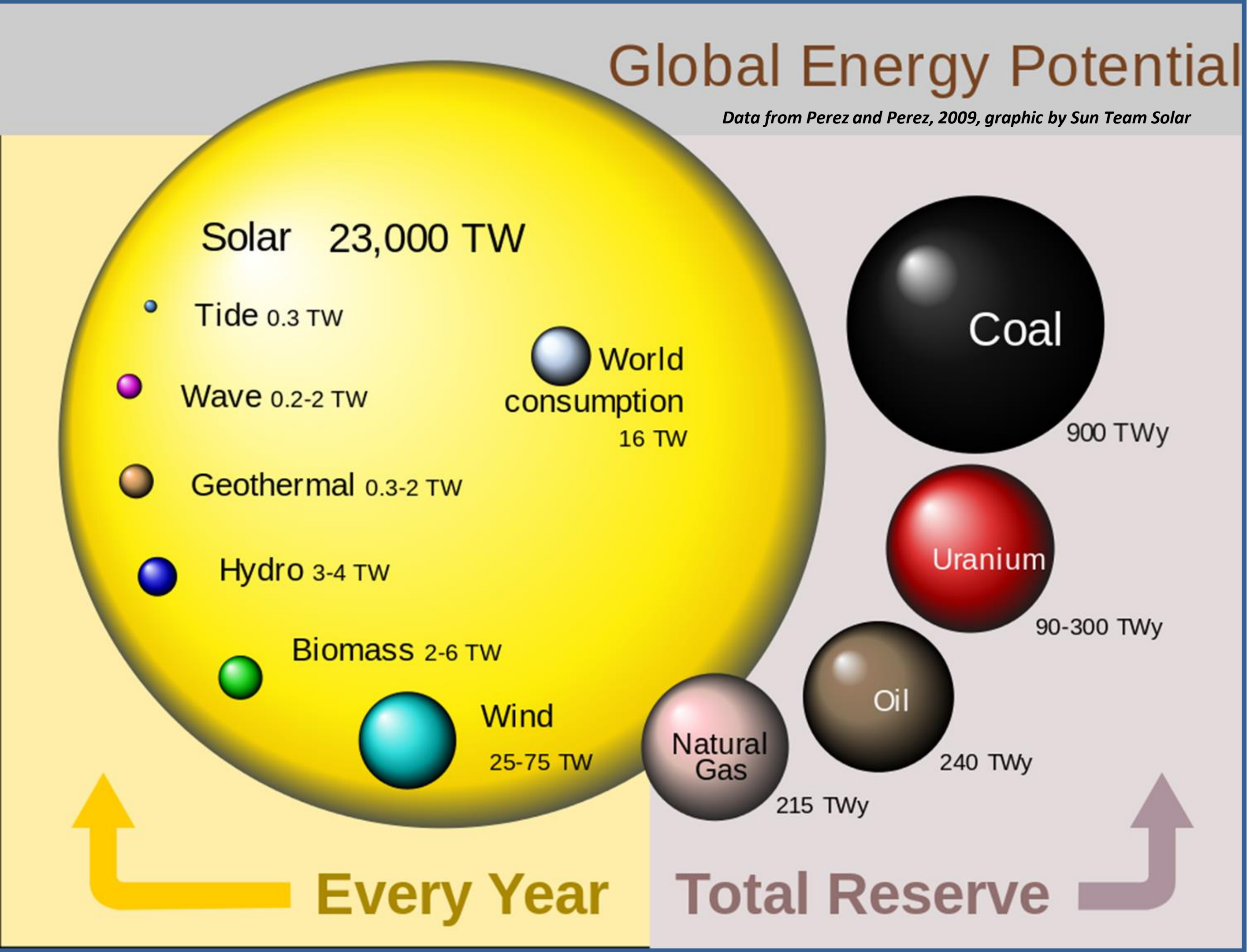
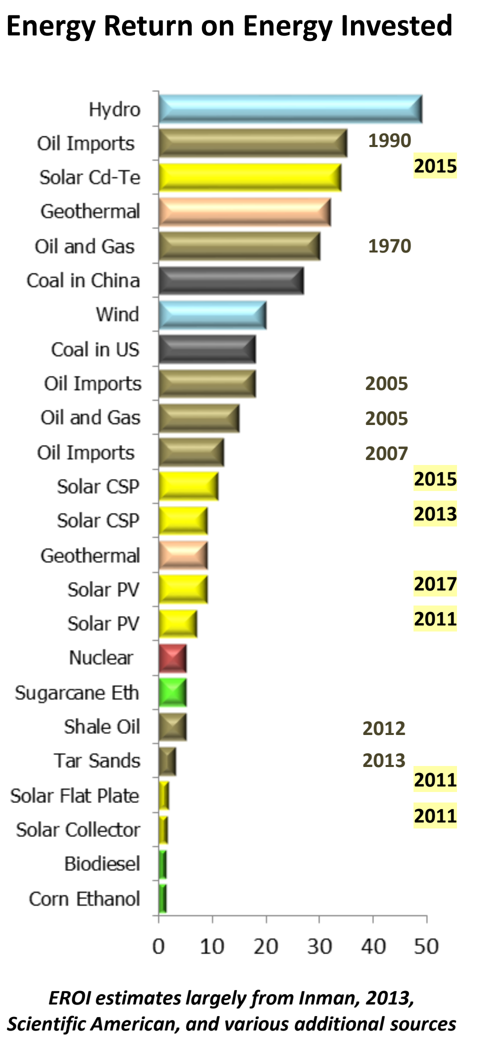


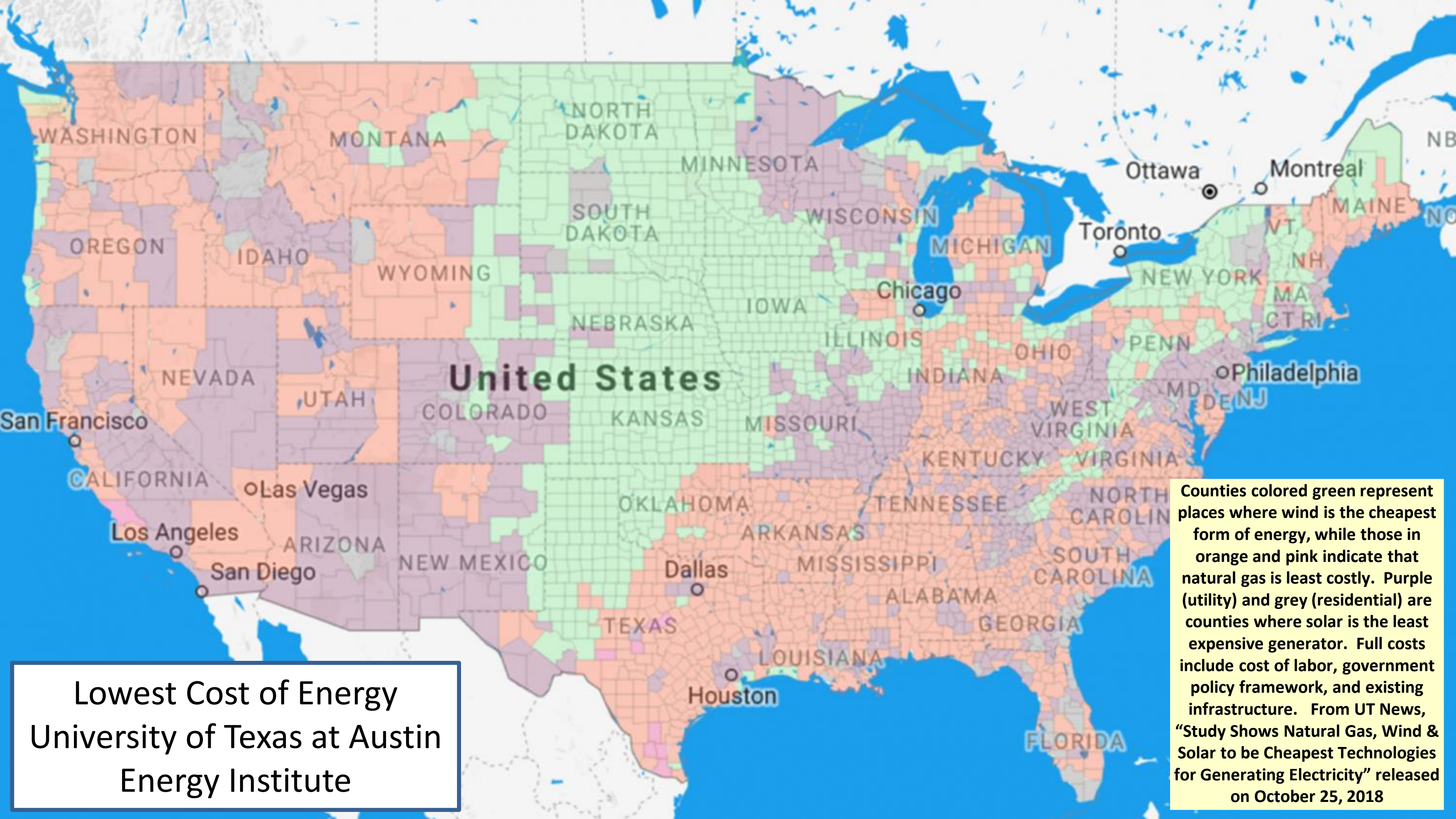
ROCK WHISPERER

Pacific Section AAPG

Founded in 1924


Global Energy Potential
Data from Perez and Perez, 2009, graphic by Sun Team Solar
Solar 23,000 TW
Tide 0.3 TW
Wave 0.2-2 TW
World consumption 16 TW
Geothermal 0.3-2 TW
Hydro 3-4 TW
Biomass 2-6 TW
Wind 25-75 TW
Coal 900 TWy
Uranium 90-300 TWy
Oil 240 TWy
Natural Gas 215 TWy
Every Year
Total Reserve


Energy Return on Energy Invested
Hydro
Oil Imports 1990
Solar Cd-Te 2015
Geothermal
Oil and Gas 1970
Coal in China
Wind
Coal in US
Oil Imports 2005
Oil and Gas 2005
Oil Imports 2007
Solar CSP 2015
Solar CSP 2013
Geothermal
Solar PV 2017
Solar PV 2011
Nuclear
Sugarcane Eth
Shale Oil 2012
Tar Sands 2013
Solar Flat Plate 2011
Solar Collector 2011
Biodiesel
Corn Ethanol
0 10 20 30 40 50
EROI estimates largely from Inman, 2013, Scientific American, and various additional sources



Lowest Cost of Energy
University of Texas at Austin Energy Institute

Counties colored green represent places where wind is the cheapest form of energy, while those in orange and pink indicate that natural gas is least costly. Purple (utility) and grey (residential) are counties where solar is the least expensive generator. Full costs include cost of labor, government policy framework, and existing infrastructure. From UT News, "Study Shows Natural Gas, Wind & Solar to be Cheapest Technologies for Generating Electricity" released on October 25, 2018

Global Energy Transformation and the Career Opportunity Set

Solar
- Exploration – resource map exists
- Development – surface mapping
- Risk management – energy for manufacturing

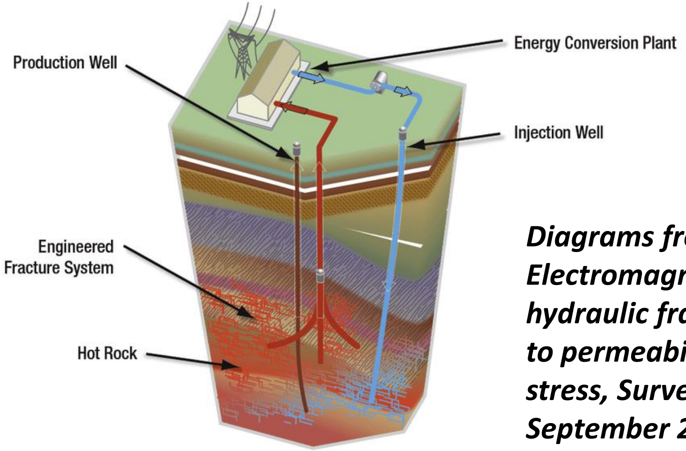
Hydro
- Exploration – hydrogeology
- Development – geoengineering; surface mapping
- Risk management – disruption of watershed

Geothermal
- Exploration – play and prospect definition
- Development – fracking for EGS; fracture mapping
- Risk management – drilling and cooling

Wind
- Exploration – meteorology and surface mapping
- Development – surface mapping
- Risk management – environmental impact

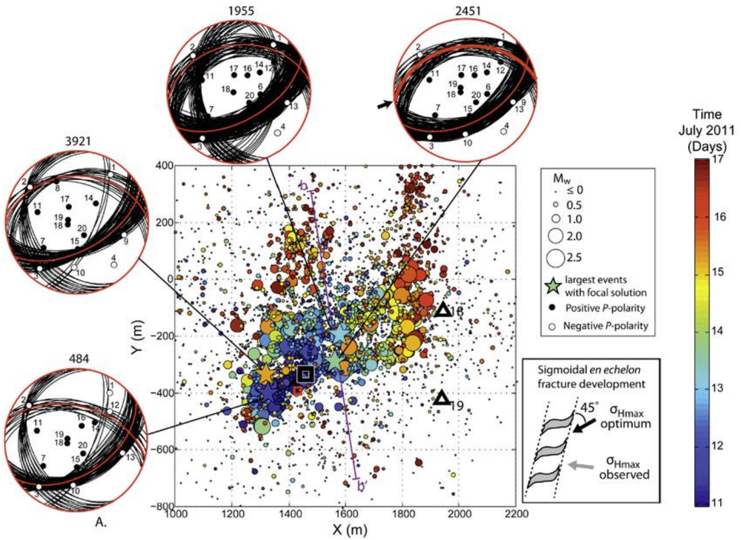
Critical Minerals
- Exploration – exploration, development geology
- Development – resource estimates, valuation
- Risk management – environmental impact

Natural Gas to Liquids
- Exploration – seismic attribute interpretation
- Development – resource estimates, valuation
- Risk management – environmental impact

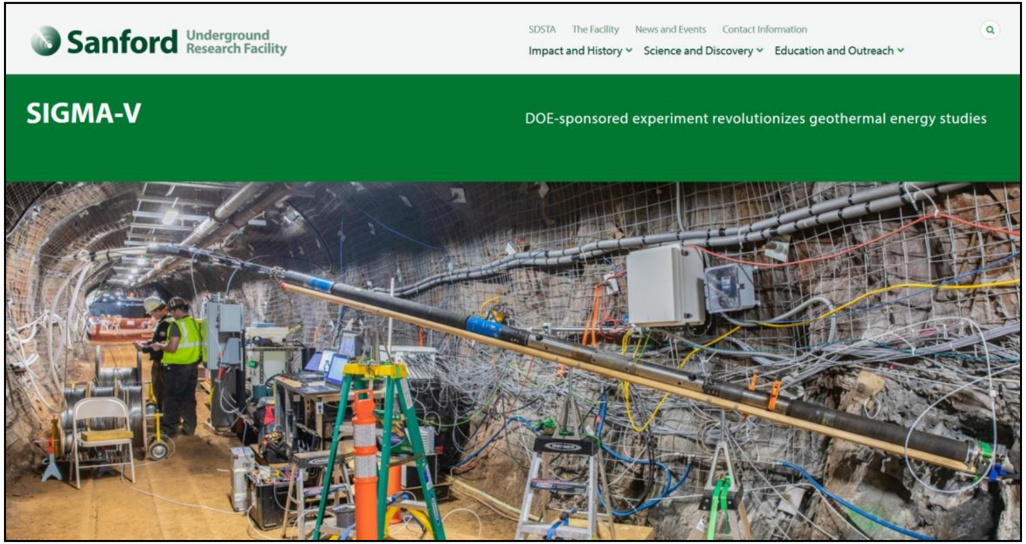


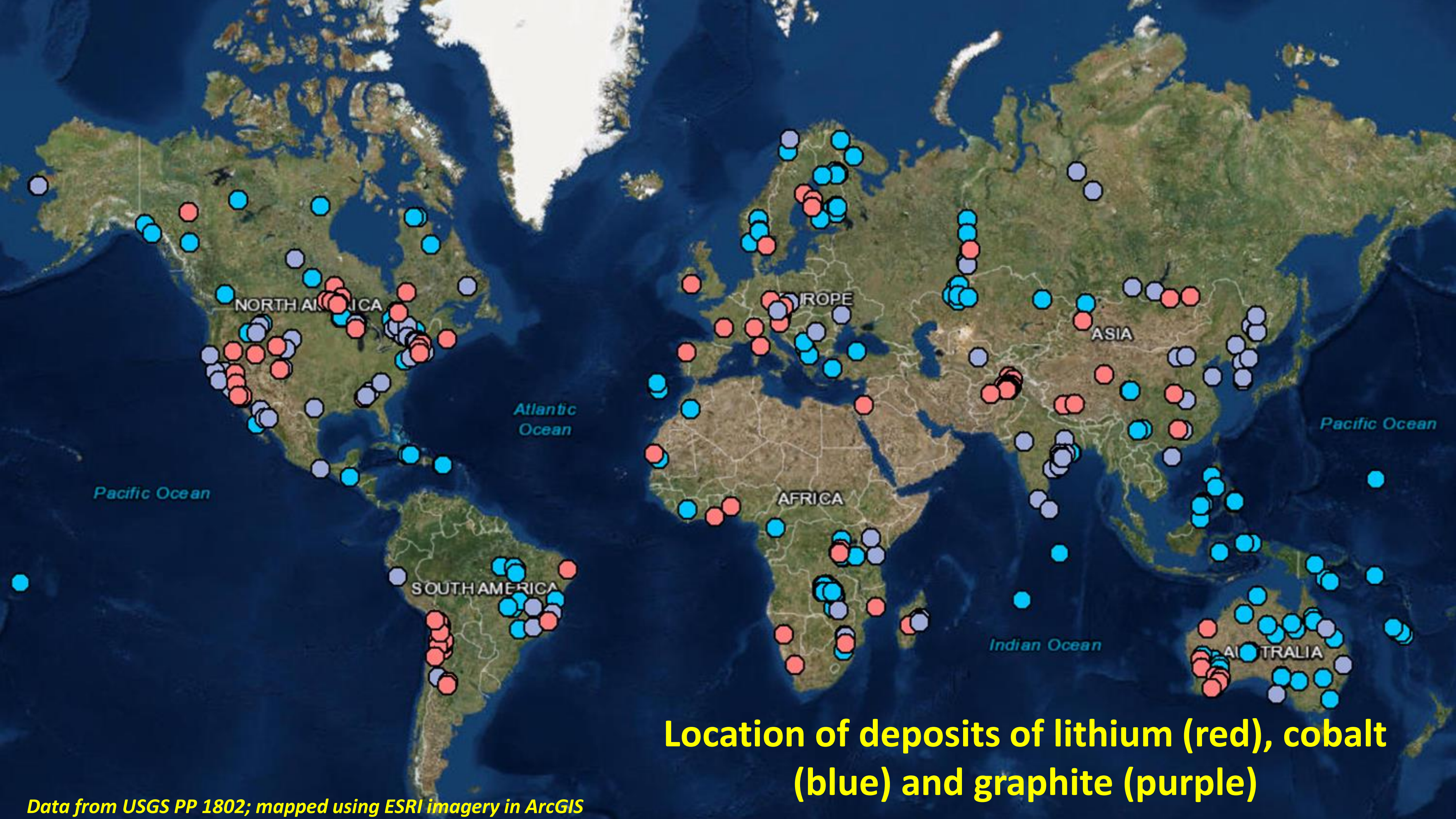
Enhanced Geothermal Systems

Diagrams from Thiel, 2017, Electromagnetic monitoring of hydraulic fracturing: relationship to permeability, seismicity, and stress, Surveys in Geophysics, September 2017.



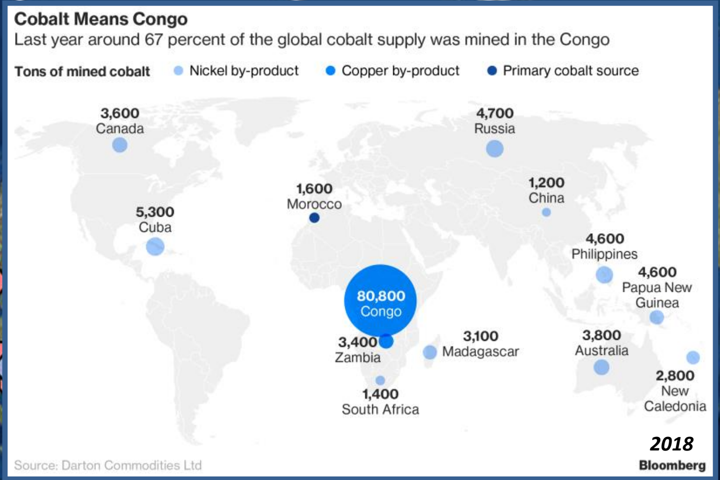
https://www.sanfordlab.org/experiment/sigma-v

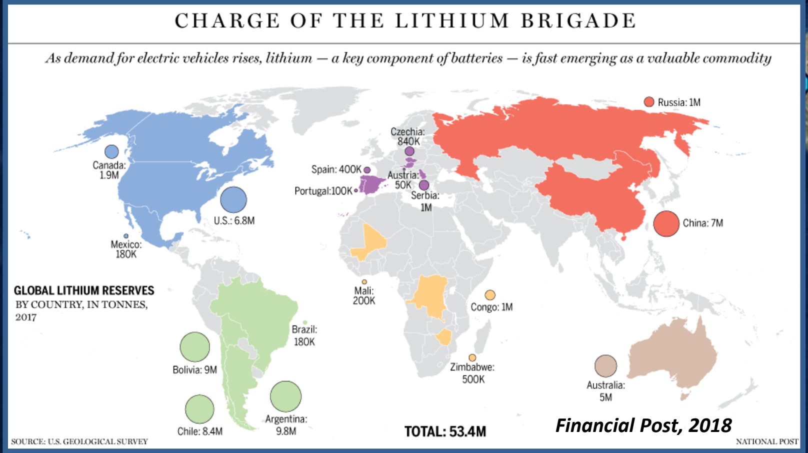


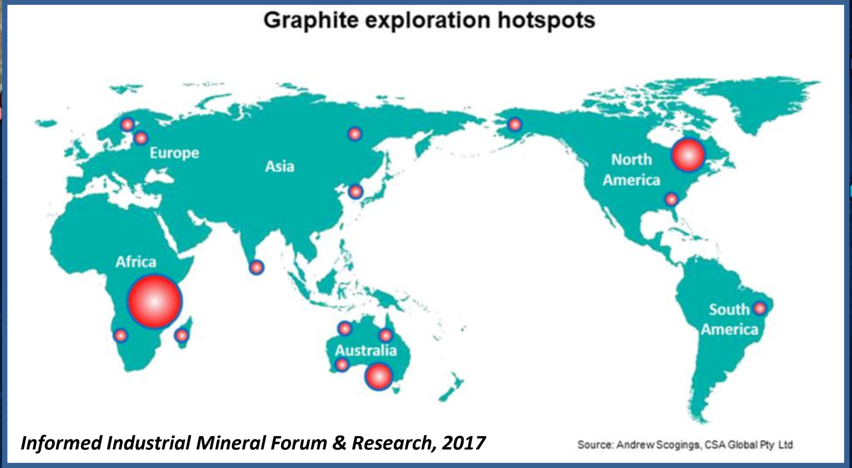


Location of deposits of lithium (red), cobalt (blue) and graphite (purple)

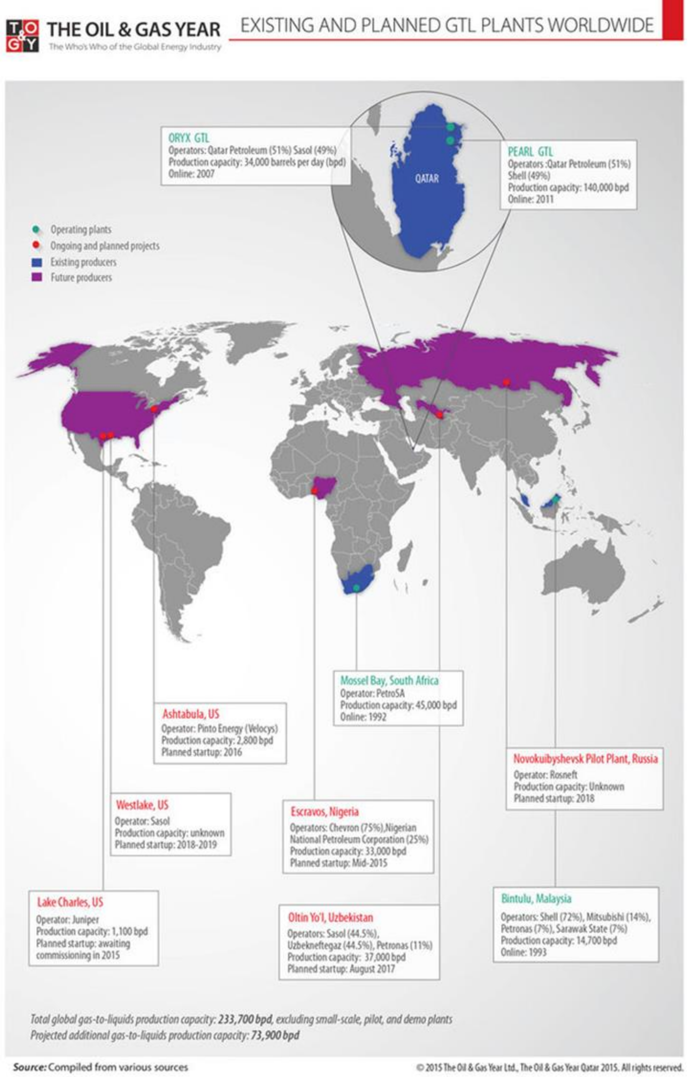
Data from USGS PP 1802; mapped using ESRI imagery in ArcGIS

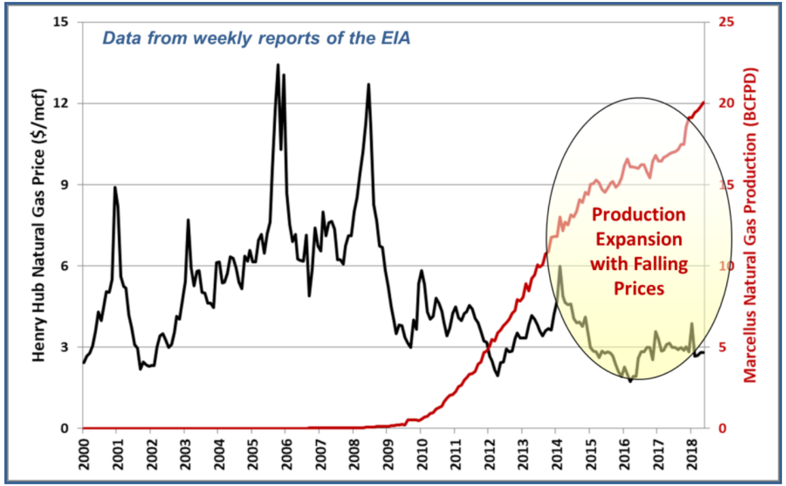




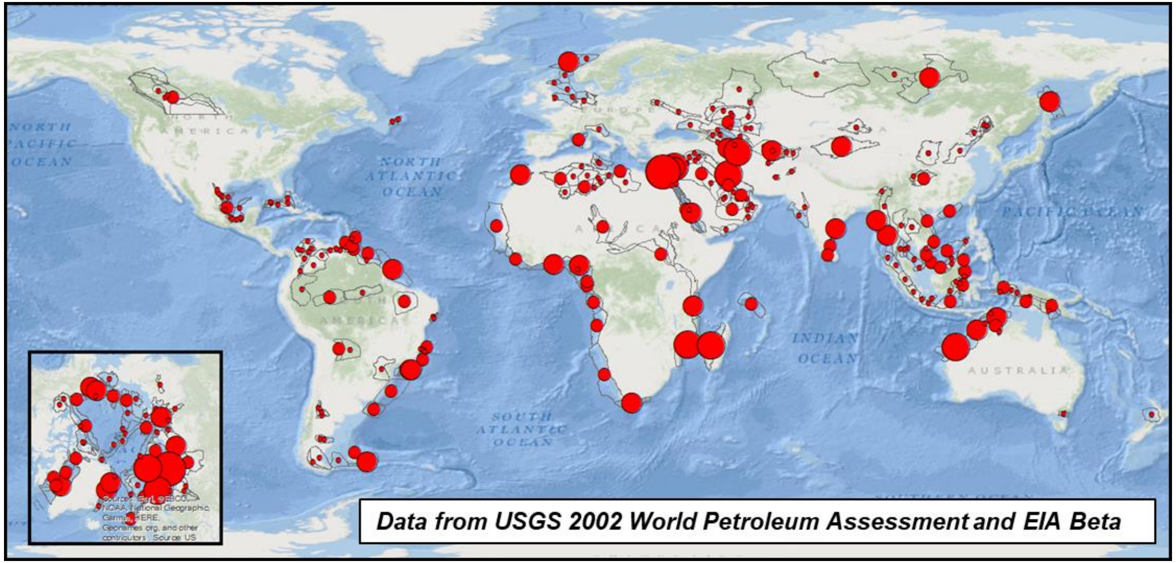


Data from USGS PP 1802; mapped using ESRI imagery in ArcGIS

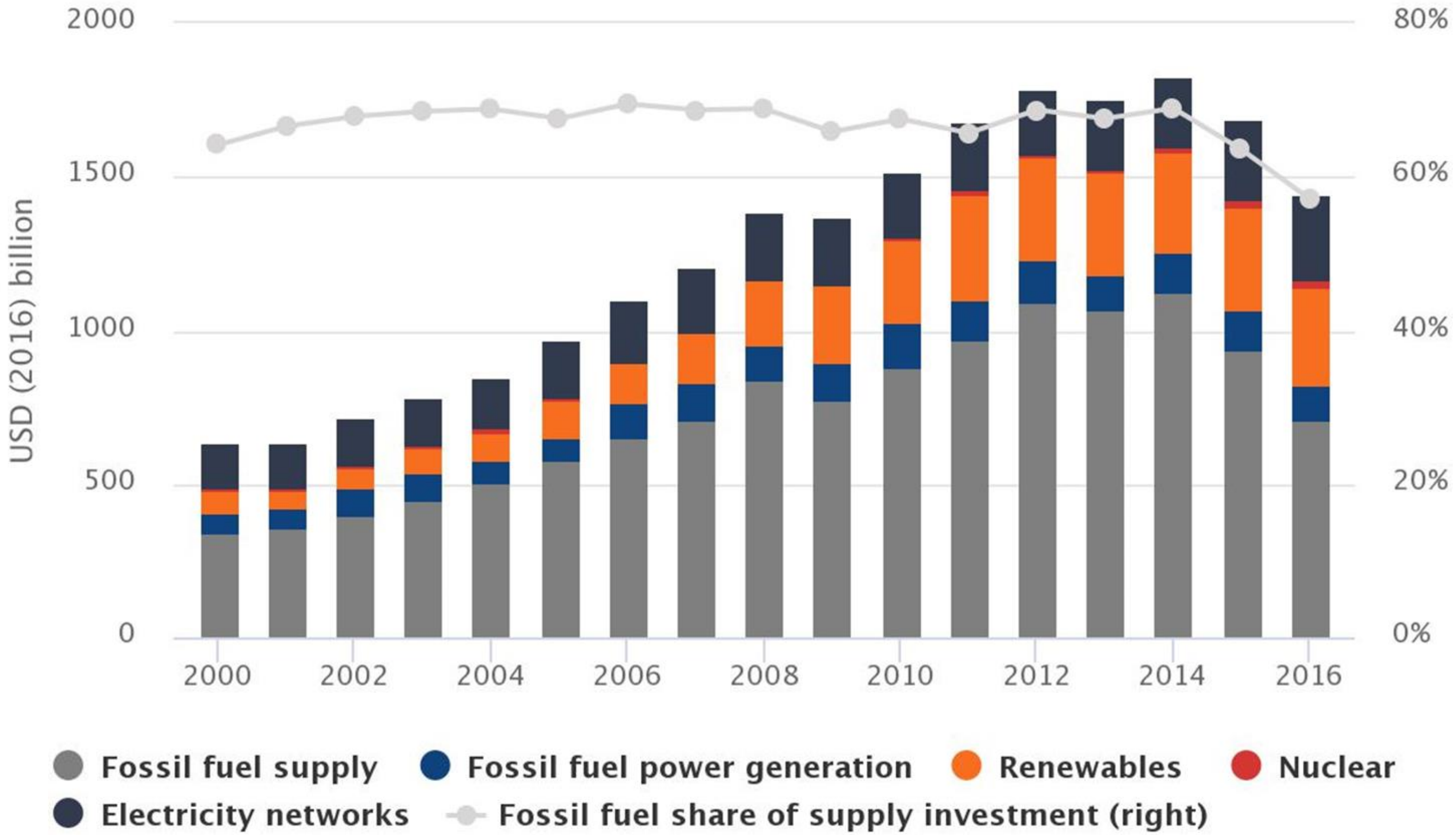




Commercialization of Gas-To-Liquids technology will enable monetization of stranded gas and production of low C transportation fuels



Global investment in energy supply, 2000–2016



From the IEA World Energy Investment 2017

Oil and gas business model

- High risk
- High rate of return
- High capital investment
- Long investment cycle
- Infrastructure dependent

Solar business model

- Low risk
- Utility style returns
- Low capital investment
- Rapid deployment cycle
- Grid parity or by-pass

iShack


…the world is overrun by cheap and
plentiful clean energy… how do we adapt?
- Dan Frey, THG Energy Solutions, 2017
- Image from Google Earth
rockwhispererllc.com
edith newton wilson on LinkedIn

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