# Modern Life is Built on Mining

A Focus on Technology Metals and Energy:

the pathway to a clean energy future through the Periodic Table & geology

Presented by James Kennedy
President of ThREEConsulting.com | Rare Earths & Thorium

**Preface:** The single most important commodity in the world is energy

It helps us grow our food, build and operate all forms of transportation, produce life saving drugs, safely store our food, keep us warm in the winter and cool in the summer.

Without cheap, abundant and clean energy humanity and the viability of our ecosystem would rapidly decline

There are only two primary sources of base-load* energy:

Energy from Hydrocarbons | Oil / Coal / Nat Gas
Energy from Atoms | Nuclear

Renewables** cannot produce / supply reliable base load due to many technical and physical limitations

However, all of these forms of energy rely on mined or extracted natural resources***

All of the energy we use today was discovered through the work of geologists.

*Base-load is steady, low-cost and uninterruptable grid energy
**Renewables, in this discussion, are limited to solar and wind
***Renewables rely on technology metals like rare earths

# Later We Will Talk About Careers in Geology:

## geo-physicists

the macro study of earth as a system: like plate tectonics and earth's origin

## geo-chemists

the micro study of earth as a system: seeking chemical signatures and origins

## geo-engineers

the intermediate study of various earth systems: like volcanos and rock dynamics

## exploration geo

the field application of everything above: finding oil fields & gold deposits

## economic geo

the applied work of confirming an oil field or gold mine can be developed profitably

## The Mining industry is mostly geologists

Mine financing, exploration, mineral processing & environmental remediation

All forms of naturally stored energy that are utilized in our world today come from just 4 places on the Periodic Table: from your back-porch-light to deep space satellites.

Geology deals with where and how these materials formed in our earth. Mining is about economic extraction.

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# *Hydrocarbons*

Today over 80 percent of the world's energy comes from hydrocarbons: Hydrogen + Carbon. This natural reservoir of energy was derived from the sun over millions of years.

Coal, Oil, Natural Gas and all other forms of hydrocarbons (gasoline, diesel fuel, propane, etc.) are comprised of various molecular combinations of Hydrogen and Carbon

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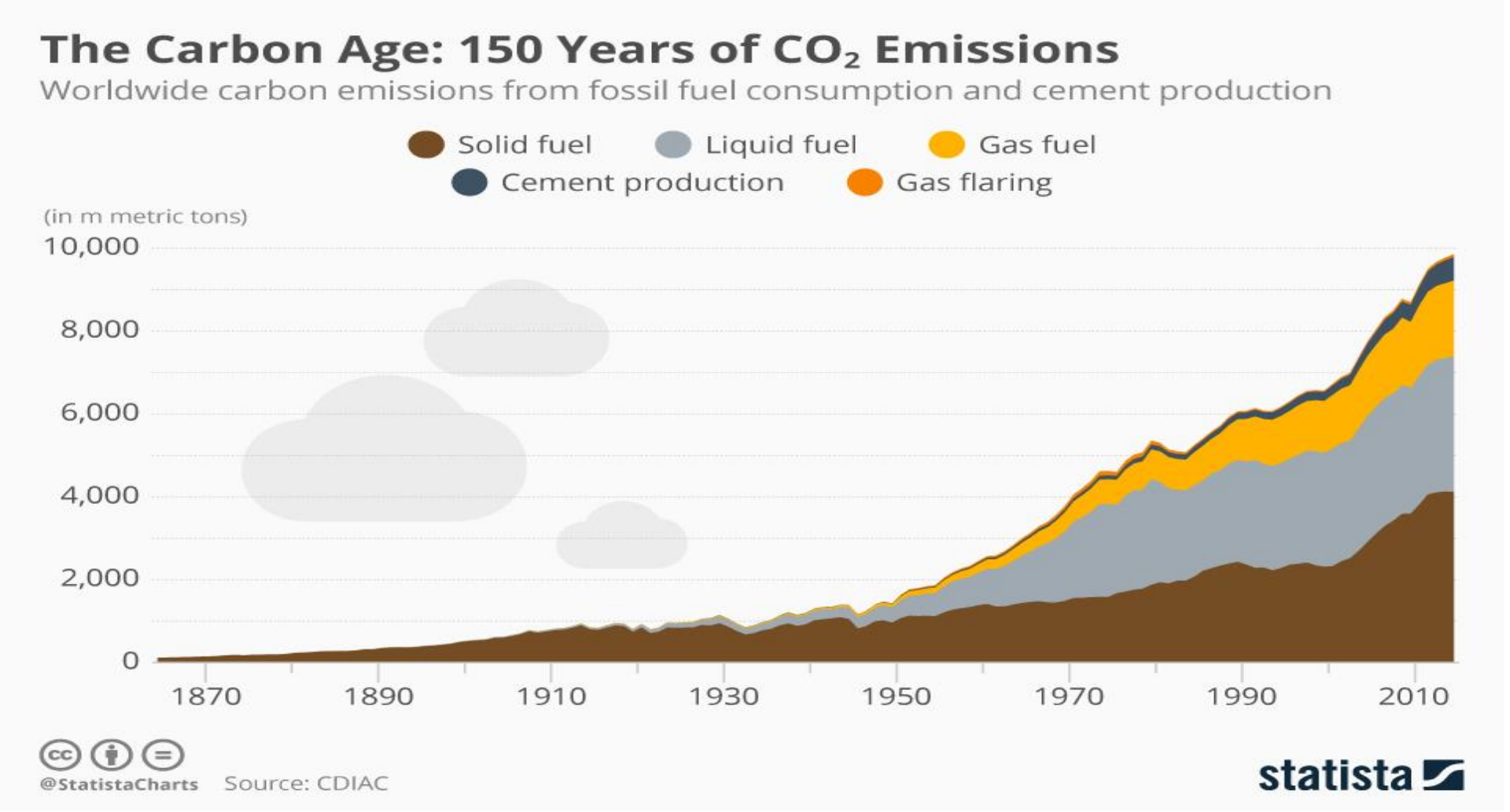
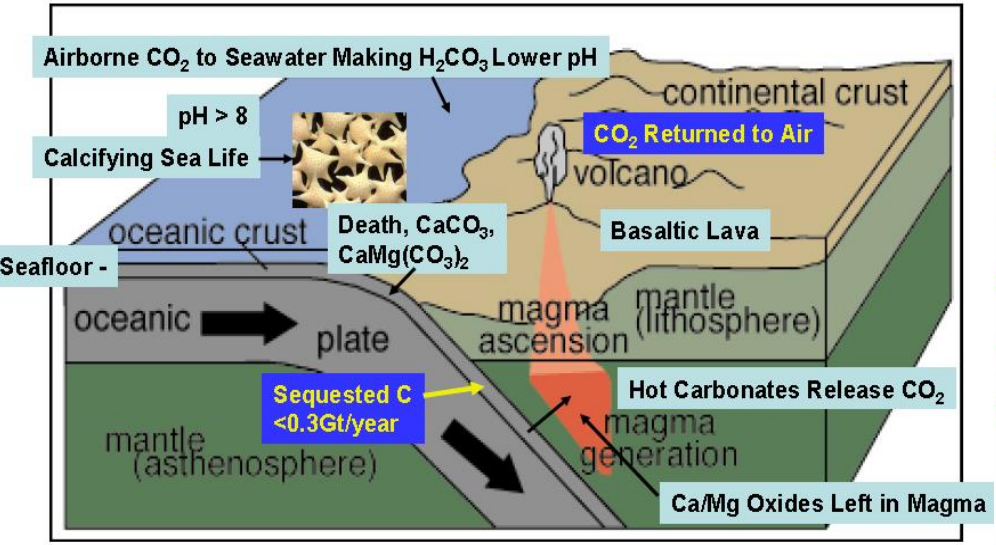
One of the chemical byproduct of using hydrocarbons is CO2. The long term consequence in the growth of hydrocarbon utilization is that CO2 production has outpaced the earth's natural ability to sequester the CO2. Higher levels of CO2 in the atmosphere can effect global temperatures and alter climate patterns.

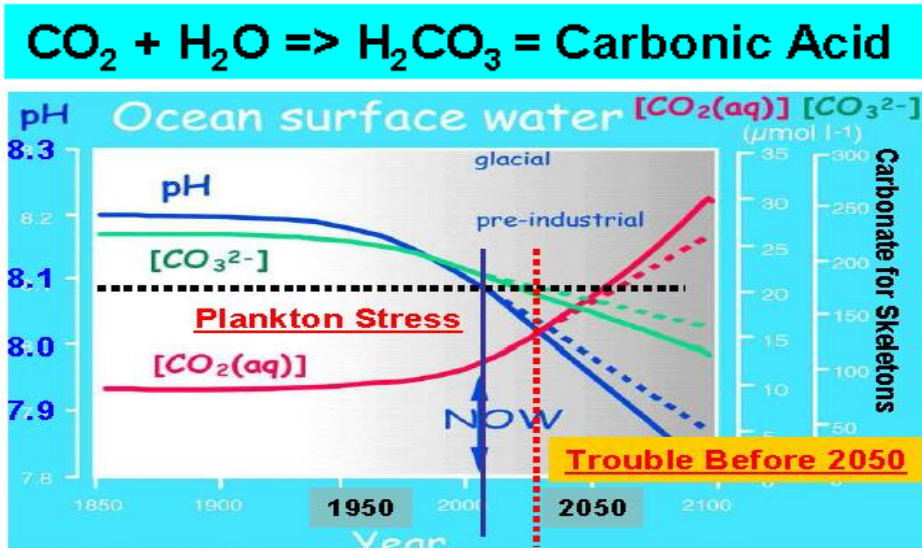


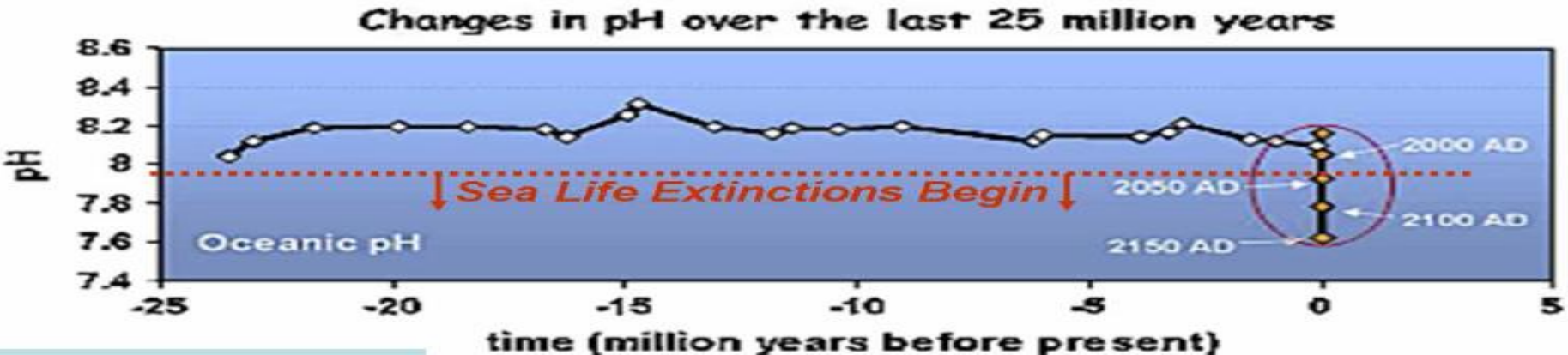
A more significant problem is that the CO2 in the atmosphere is eventually converted to Carbonic Acid and it accumulates in the ocean. This acidification process is changing the pH chemistry of our oceans.

Elevated pH will eventually make calcium biologically unavailable to plankton, krill and most other life forms that make up the base of the ocean's food chain.

*In life everything comes down to chemistry*



# *Nuclear Energy*

## *& the Process of Fission*

The only other proven source of energy resides at the bottom of the Periodic Table. Thorium and Uranium are natural elements that contain remnant energy from super-nova events eons ago

Plutonium is a man made element derived from the transmutation of Uranium

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Thorium and Uranium, natural elements in the earths crust, have over 6,000,000 times the amount of stored energy as any hydrocarbon compound (oil, coal or natural gas).

This represents the amount of energy required to break a chemical bond vs a nuclear bond

In other words, this is the difference between the bonding of molecules via shared electrons and the bonds that hold the nucleus of an atom.

When used to produce energy they do not emit any corresponding greenhouse gas.

# Making Bonds & Breaking Bonds

**Formation:** The bonds of hydrocarbon molecules naturally occur within the relatively low- energy of the earth's environment.

**Deformation:** When you break these bonds you get environmentally undesirable molecular recombination's that are released into the atmosphere (CO2 and other greenhouse gas emissions)

**Formation:** Every atom heavier than Iron can only be created within the extreme-energy environment of an exploding super-nova, the merger of neutron stars or some other galactic collision.

**Deformation:** The splitting of atoms of like thorium or uranium in a nuclear reactor can result in the production of undesirable fission products, also know as nuclear waste

The energy required to create thorium and uranium is among the greatest forces in our universe !

Consequently, thorium and uranium are natures' greatest natural '*batteries*'.

The division of these materials is also a natural process called nuclear decay, or measured as a half-life.

The process of nuclear fission, the splitting of an atom, in an atomic reactor is simply a time-lapse acceleration of this natural process.

So, what are the risks and cost of nuclear fusion, or nuclear energy ?

The commonly listed risks are:

- Unsafe reactors
- Management of nuclear waste
- Responses from the class ????

All commonly listed externality cost, environmental concerns or risks associated with nuclear technology are legacy issues built into the design of the current technology.

All of these commonly listed concerns have been mitigated in modern and proven designs

# I have worked with all of these experts:

## geo-physicists

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# *‘Renewables’*

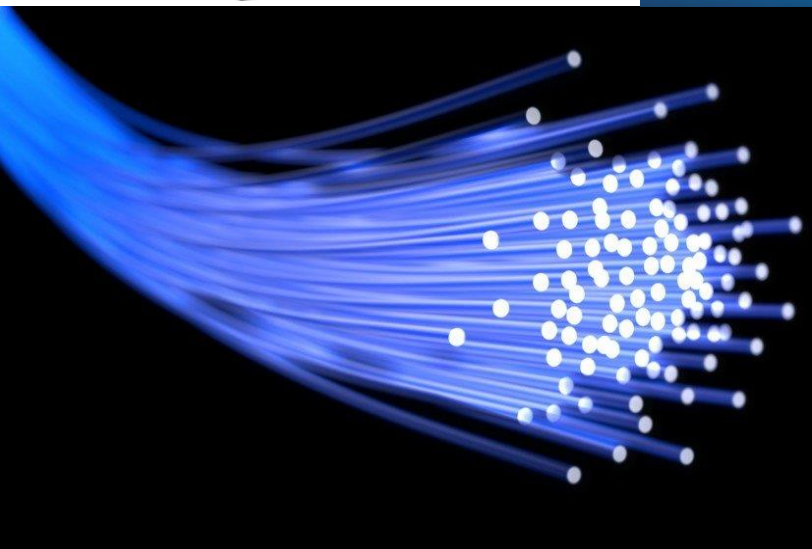
# *Technology Metals & Energy*

Regarding the global economy, the demand for technology metals and materials is growing rapidly.

Nearly every commercial application of these materials enhances product performance while saving energy.

These resources are found and largely developed by geologists, geochemists and geophysicists.

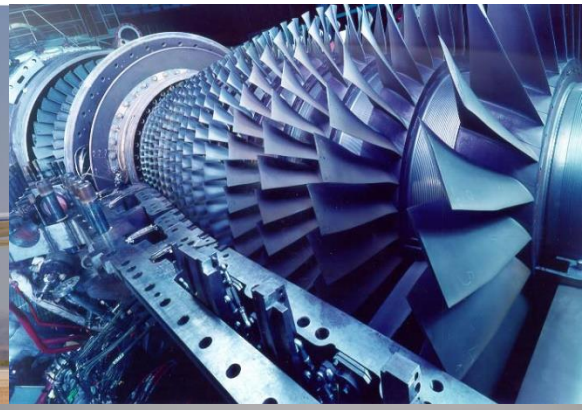
These materials are found in almost everything we depend on in our daily life.

These materials are critical to nuclear energy, medical imaging, air frames, advanced metallurgy and modern weapon systems.

A recent report by our government confirmed that the U.S. is 100 percent import dependent on other nations for most of these materials.




Highlighted below are some of the key technology metals and materials needed for nearly all renewable technologies. These same materials are used in most consumer electronics, high efficiency technologies and ‘smart’ devices

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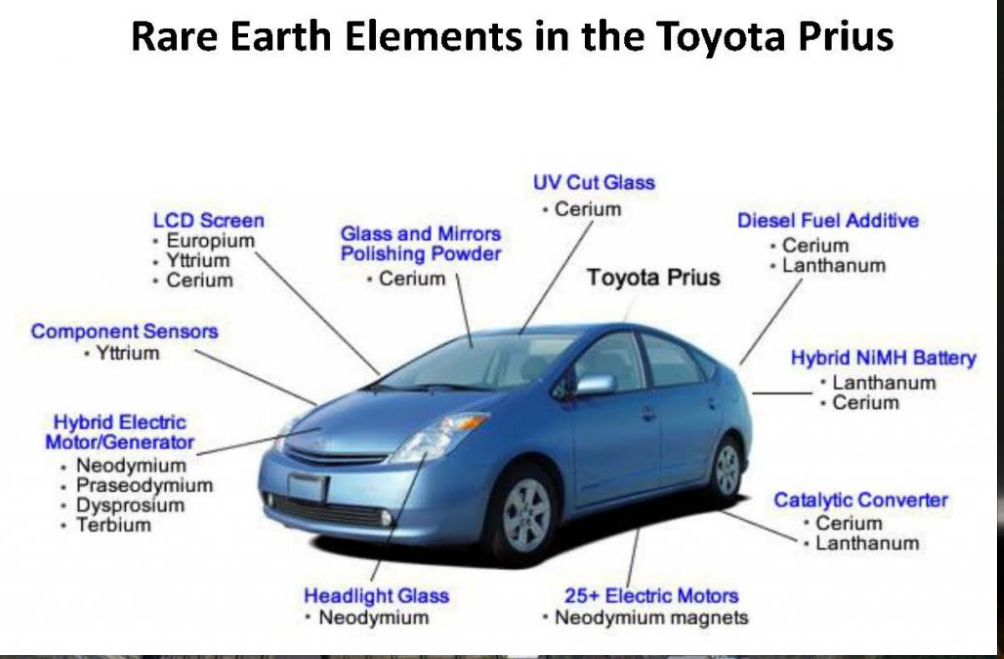
*Technology Metals Also Play a Key Role In Technologies Commonly Referred To as 'Renewables'*

*These Technologies are Promoted as a Solution to the issue of Climate Change*

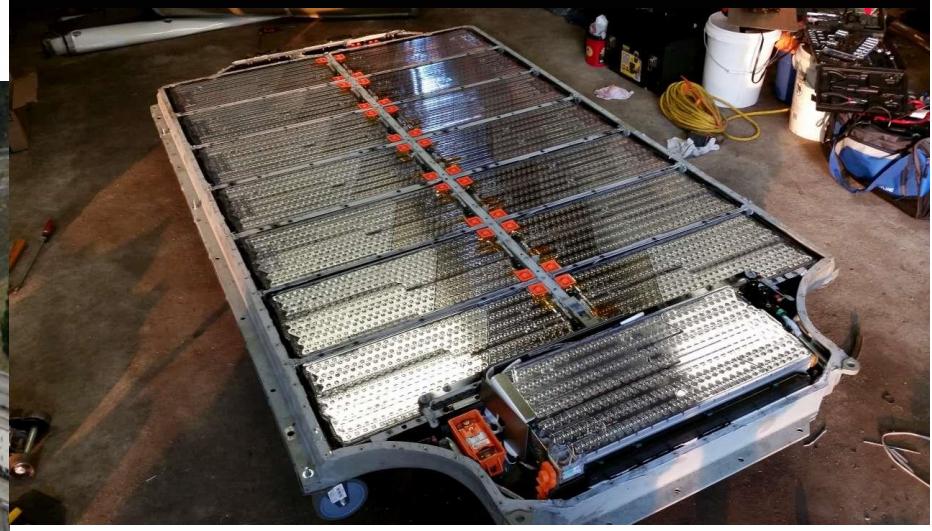
World governments and industry have responded to the climate change issue by promoting the use of ‘renewables’.

These technologies are primarily designed to transform the diffused energy of the sun and wind, a derivative of the sun’s influence on our atmosphere, into electric energy.

The idea is that this ‘renewable’ energy can be used in electric cars & trucks, heat and cool our homes and power the industries that make these products.







# Solar and Wind Renewable Systems Are Intermittent, Incapable Of Storage & Thus Rely On Hydrocarbons

Environmental groups and the natural gas industry promote renewable energy as a ‘clean solution’ but do not measure its true limitations or environmental impact

# The most significant problem with renewables is its intermittent nature, thus it requires massive storage.

*Experts* and other people paid to promote renewable-only energy systems insist that storage is an easy fix. Current battery technology and other resource limitations suggest that strategy is technically improbable or impossible for many reasons. Below are just a few:

1) Wind and solar systems typically operate at 1/5 their design capacity so any system capable of producing 24/7/365 demand would be massive

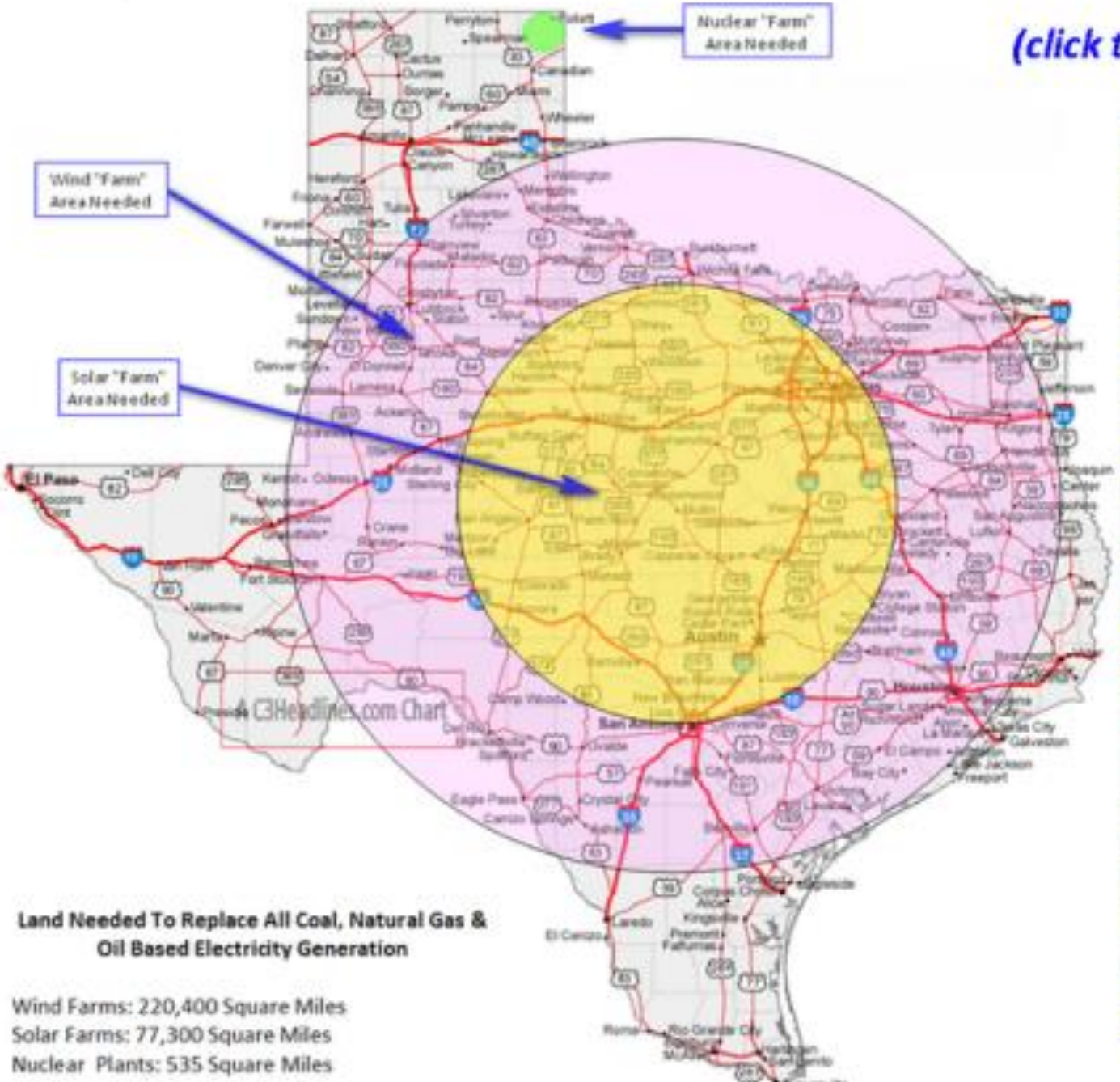
2) A system that size would require more copper, cobalt, rare earths and other technology metals than can be mined from the earths crust, when accounting for their other uses.

4) There is no known '*battery technology*' that exists today capable of storing energy at that scale

   a) To put things in perspective, according to Bill Gates '*if you connected and combined every battery in the world it would provide just 10 minutes of the world's energy needs*'

5) In a real world example, Europe spent over $1 trillion euros on a renewable platform that remained 82% dependent on other forms of energy for base-load. They found it to be disruptive and that it undermined all other forms of base-load energy
6) In the U.S. the entire deficiency in "base-load" would be exclusively produced by natural gas (due to ramp-up demand requirements), so we are back to hydrocarbons again (Germany and other nations have switched back to coal).
7) Developing systems that ultimately depend on natural gas will result in the rapid depletion of these resources while continuing to load the atmosphere with CO2 and methane emissions (80 times worse that CO2).

# The Gigantic Land Footprints of Solar & Wind Power - Impractical Solutions




***(click to enlarge)***

**Land Needed To Replace All Coal, Natural Gas & Oil Based Electricity Generation**

Wind Farms: 220,400 Square Miles
Solar Farms: 77,300 Square Miles
Nuclear Plants: 535 Square Miles

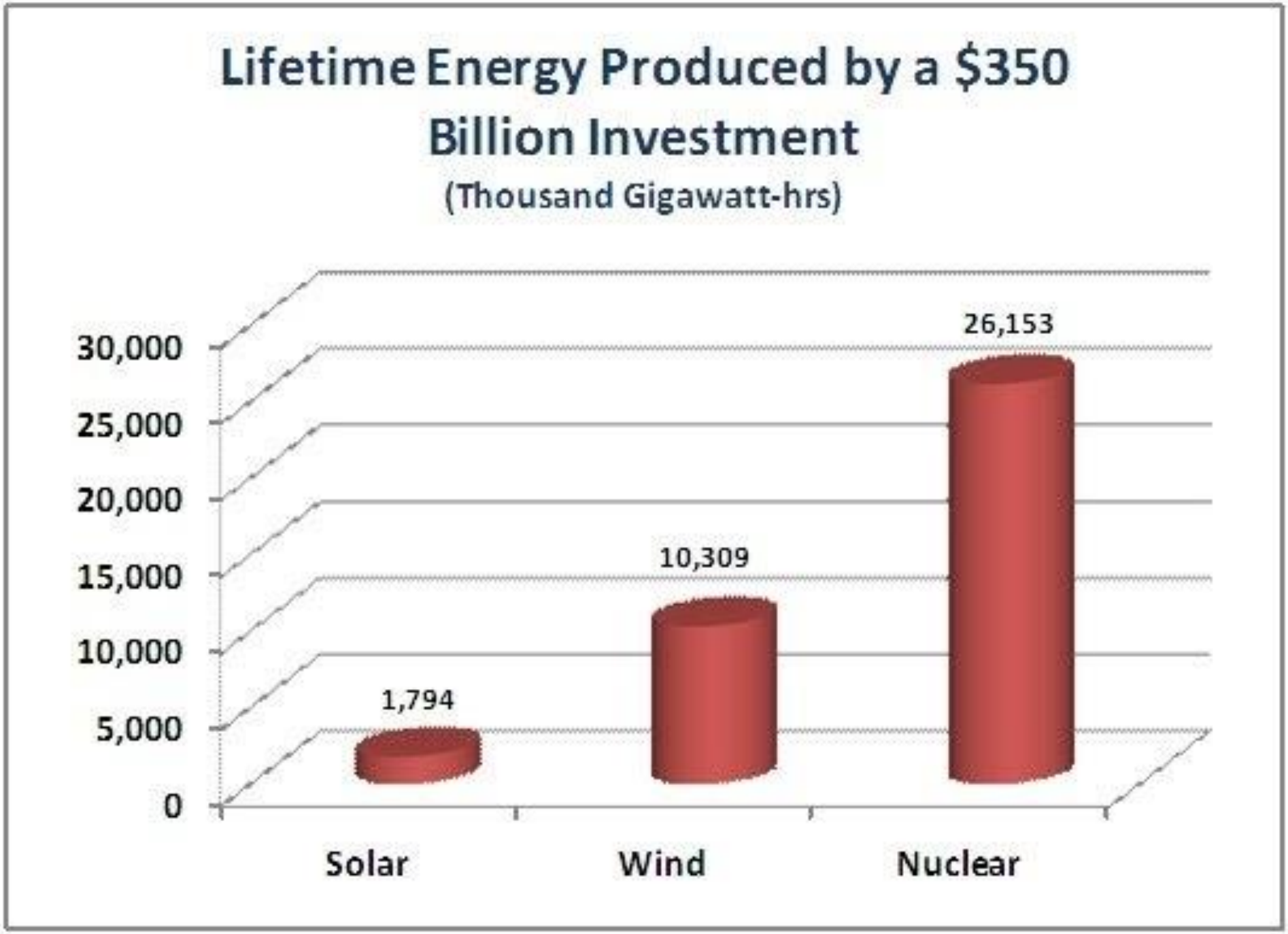
A goal of the radical environmentalists and naïve idealists is to replace all fossil fuel electrical generation with solar and wind renewables. This type of anti-CO2 mania solution would cause even greater environmental harm due to the less efficient solutions of solar and wind.

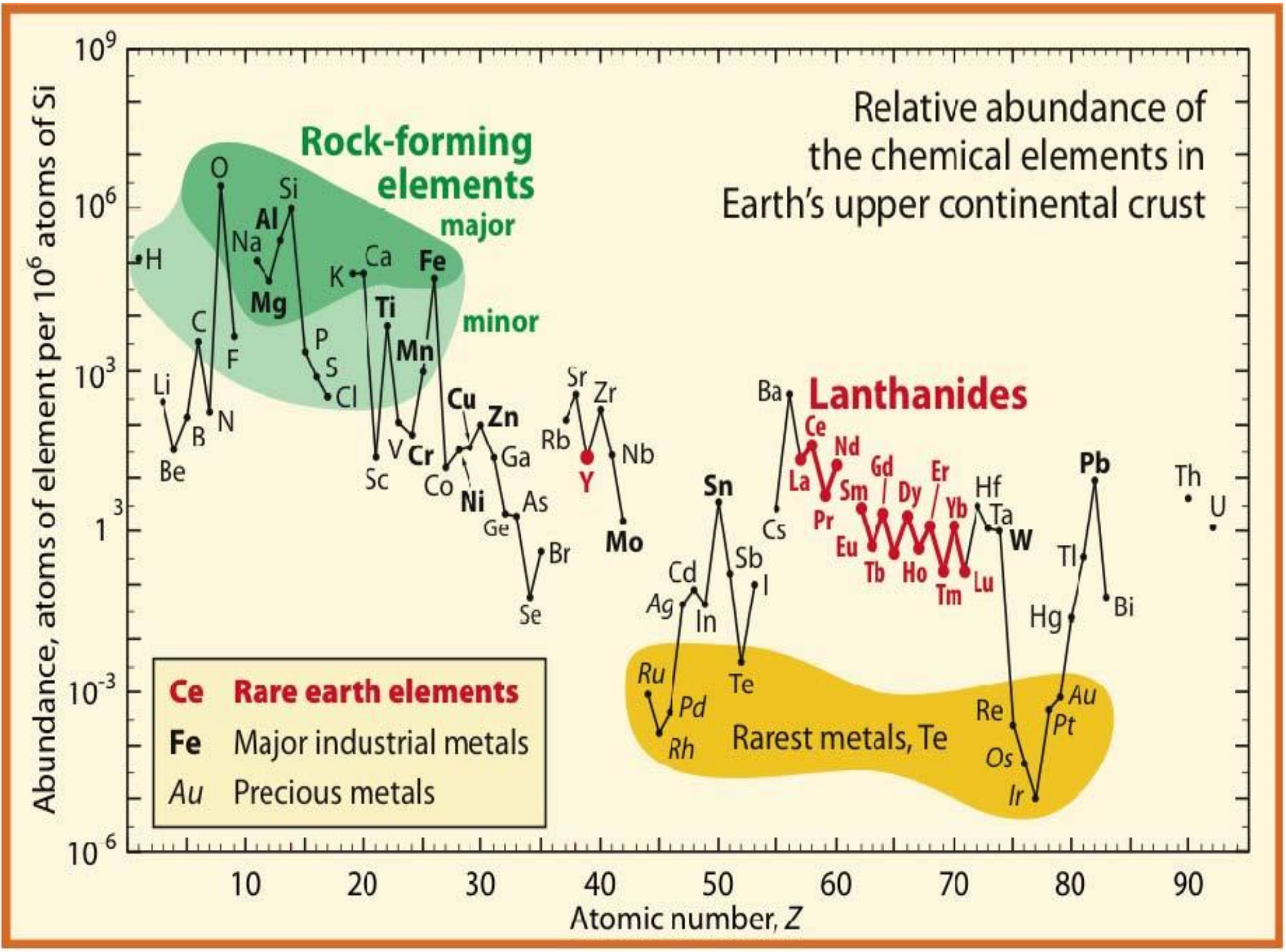
If all U.S. fossil fuel electric plants were replaced, the actual dedicated land needed to do so is depicted to the left. The light yellow circle is land needed for solar; the light pink is land needed for wind. For comparison, the land needed for the same nuclear generation capacity is represented by the small green circle in the upper right corner of the Texas panhandle.

Of course, if the wind isn't blowing or the it's night with no sun energy, the huge dedicated land dead-zones are worthless. This requires that there still be nuclear and/or fossil fuel generation backup for reliable 24/7 generation.

The cost in dollars and effort to build all the structures and devices needed in the solar and wind areas is mind-boggling, let alone the cost of acquiring the land and right-of-ways.

Source for land footprints:
www.cleanenergyinsight.org/energy-insights/what-does-renewable-energy-look-like/


Lifetime Energy Produced by a $350 Billion Investment
(Thousand Gigawatt-hrs)
30,000
25,000
20,000
15,000
10,000
5,000
0
1,794
10,309
26,153
Solar
Wind
Nuclear


Relative abundance of
the chemical elements in
Earth's upper continental crust
Rock-forming elements
major
minor
Lanthanides
Rarest metals, Te
Ce Rare earth elements
Fe Major industrial metals
Au Precious metals
Abundance, atoms of element per 10^6 atoms of Si
Atomic number, Z
10^9
10^6
10^3
1
10^-3
10^-6
10
20
30
40
50
60
70
80
90
H
Li
Be
B
C
N
O
F
Na
Mg
Al
Si
P
S
Cl
K
Ca
Sc
Ti
V
Cr
Mn
Fe
Co
Ni
Cu
Zn
Ga
Ge
As
Se
Br
Rb
Sr
Y
Zr
Nb
Mo
Ru
Rh
Pd
Ag
Cd
In
Sn
Sb
Te
I
Cs
Ba
La
Ce
Pr
Nd
Sm
Eu
Gd
Tb
Dy
Ho
Er
Tm
Yb
Lu
Hf
Ta
W
Re
Os
Ir
Au
Pt
Hg
Tl
Pb
Bi
Th
U