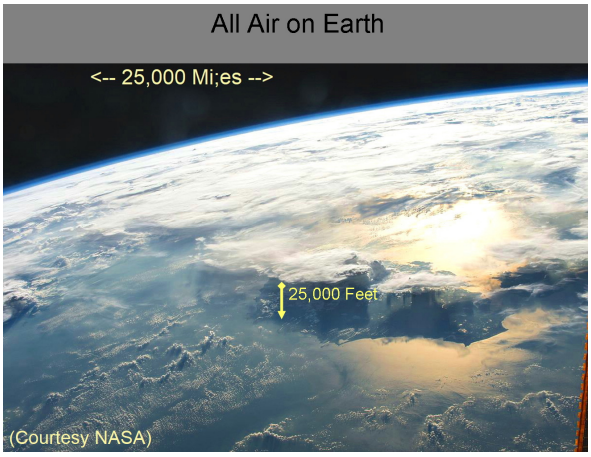
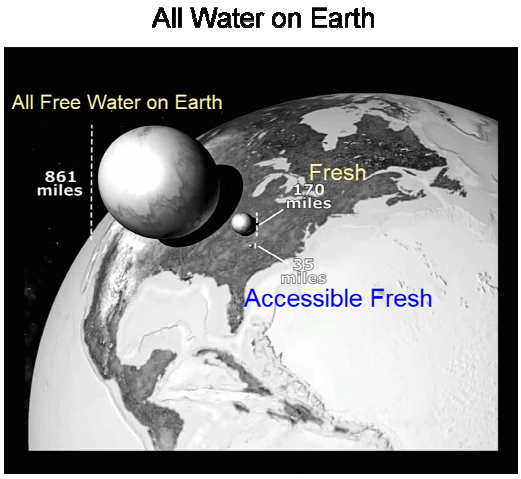
Wakeup Time: Part I

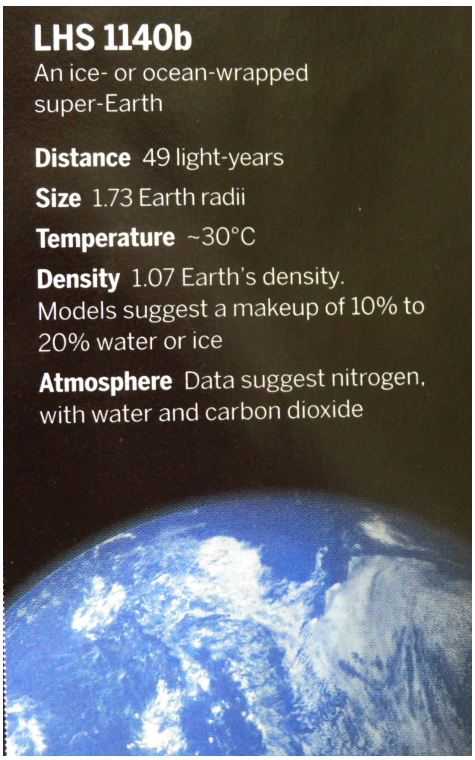
All we have: less than 7 vertical miles of air and seas…





~30% of Earth is land, ~30% of that is arable & sufficiently watered. The Great Lakes is the largest bank of fresh water. **Total fresh water fits in a 170mi diameter sphere**.

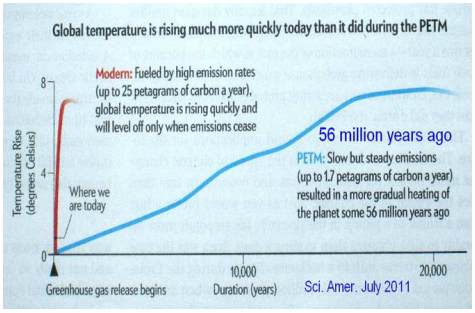
Despite finding bacteria living deep in mines or spiders riding winds at 20,000ft, **life is a planetary surface effect**. And, the closest similar planet + 'sun' are ~50 light-years away. So, retreat to Mars – go ahead & try. Or, try for the nearest earthlike system – fugged- aboud it:

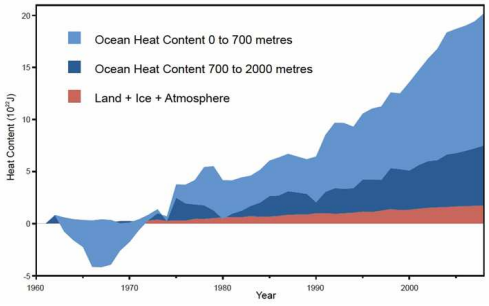


Most anywhere we'd choose to go has no free Oxygen to sustain animated life. New Earth had no free O_2 until photosynthesizing ocean life (plankton…) evolved, a few billion years ago. Even then, it took a billion or so years before enough Oxygen had been split from H_2O by plankton to sate Earth's metals' desire to oxidize. That let our planet's air differ from all others' within light-years – supporting both strong muscles and fire, while leading us into the planetary threats we now face from fire's broad, unstudied use.

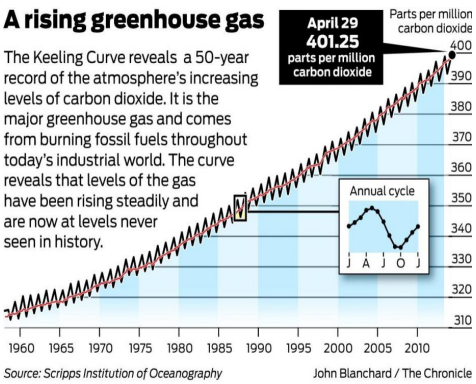
Even steam engineers in the 1800s worried about our mining so much carbonaceous material, like coal, only to turn it all into CO_2 (or oil/gas into that plus H_2O) just to recoup thermal energy from the chemical energy stored in photosynthesizing life forms' own molecules. We surprised ourselves that harvesting and burning billions of tons of coal, oil, methane, biomass etc. and then releasing climate-warming 'greenhouse' gasses (GHGs) like CO_2, methane, even H_2O, would alter Earth's air, ocean chemistry and heat. Oops?

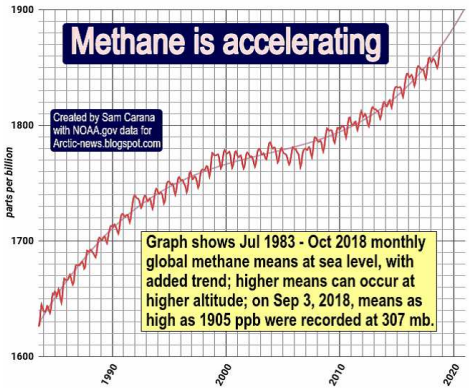
Our GHG emissions, including molecules besides CO_2 (e.g., methane, nitrogen oxides…) **have caused the fastest planetary-wide warming (red spike below left)** since the prior record (blue) in the Permian age >56m years back. The oceans have warmed, sufficient to threaten species like plankton that are both the base of ocean food chains and the largest source of all animals' energy-delivering oxygen.





In 1957, scientists fostered the International Geophysical Year (IGY) to organize studies of Earth and its environments (air, water, near space & crust). The prior work of Keeling showing a continual rising of airborne CO_2 (left below) was just one reason. Ocean heat and chemistry changes were further motivations (https://tinyurl.com/yafgmlmd):





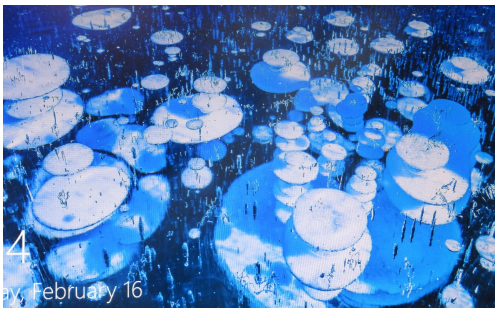
If we'd zeroed our CO_2 emissions in April 2015 (at 400ppm at left above)**, the natural photosynthesis (land & sea) cycles would bring past, air-banked emissions back to 1960's CO_2 levels in about 70 years.** No human-induced C-combustion for 70 years. Very little afterward. Global energy sources must be zero-GHG forever.

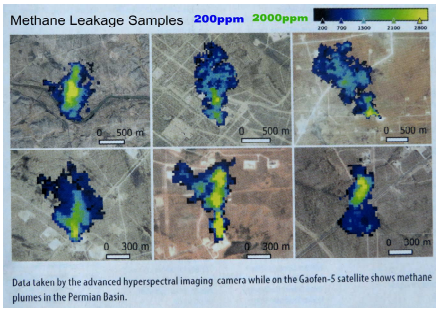
But, our own combustion-induced warming and fuel-well GHG leakage have triggered **methane emissions** from natural sources (tundra, sea floors…) **out of our control**. This is **positive feedback**, making things worse faster and faster (drive backward in a safe parking lot and let go of the steering wheel, or wire the cruise control backward).

Lack of snow/ice cover on Arctic tundra, for instance, allows sunlight to warm/melt it, releasing methane (CH_4) from now unfrozen organisms digesting the newly available organic matter. Methane is more a GHG than CO_2, accelerating tundra warming and further GHG releases (Siberian sinkholes: https://tinyurl.com/yc4etmt7).

Similarly, ocean warming releases methane from solid methane-ice deposits along continental shelves. The 'ices' were formed when bacterial digestion of organic matter from dead sea life released CH_4 into waters cold enough to form ice globs called "clathrates". As oceans warm, more of these will release methane into the air (left below). Overall, human-induced methane releases already add over 200ppm of CO_2 equivalent GHG to Earth's air. The yearly rate is increasing (graph above right) and **out of our contro**l. Even with elimination of human-induced CH_4 sources, only planet-wide cooling can stem methane-driven warming from natural ocean/land CH_4 sinks.

Our petroleum production, as via fracking, releases wellhead & pipeline CH_4 (right below). We can improve this.

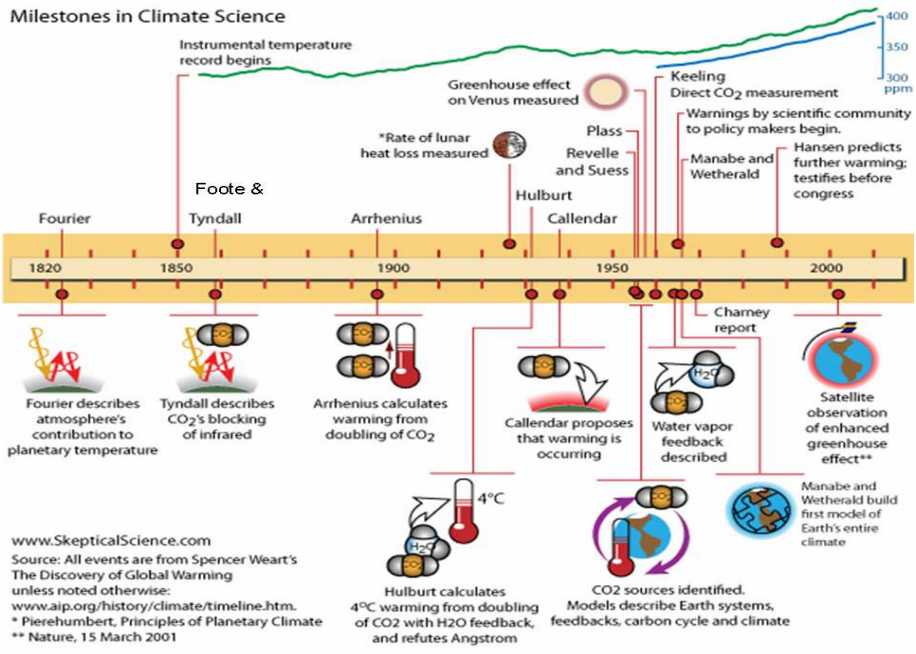




Pressurized CO_2 is often injected into wells to stimulate oil & methane release. Its escape to air must also be prevented.

Sea rise and glacier melting/retreat add to both coastal flooding and overall warming. Just Greenland's yearly ice loss is over 51 cubic miles and increasing. This is another warming-induced problem that **can only be stopped by planet-wide cooling**. Suppose humanity chose to begin refreezing sea ice to deliver back atop Greenland as, say, snow. All humanity's energy-production systems driving refrigerators for ~3 years would return just ~1 cubic mile of ice to Greenland. No energy available for humanity. Surprise?

Some scientific GHG history & names…



Eunice Newton Foote observed in 1856 that an atmosphere of CO_2 would heat the planet.

PICTORIAL PRESS LTD/ALAMY STOCK PHOTO

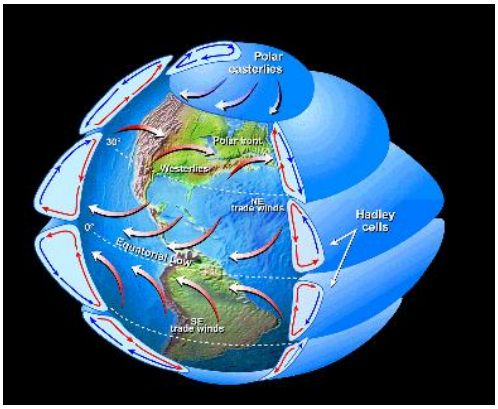
Svante Arrhenius, 1859-1927

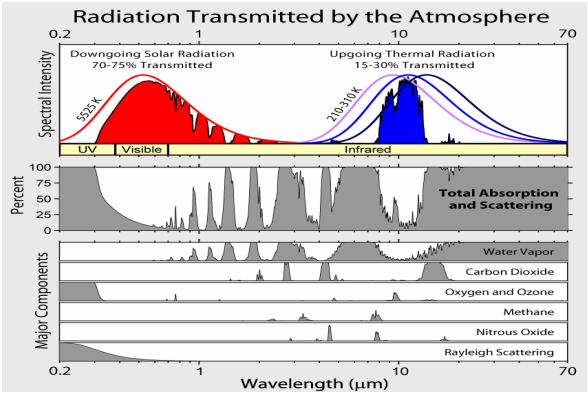
"Any doubling of the percentage of carbon dioxide in the air would raise the temperature of the earth's surface by 4°; and if the carbon dioxide were increased fourfold, the temperature would rise by 8°." – *Världarnas utveckling* (Worlds in the Making), 1906

We've known since at least 1850 (Tyndall, Foote…) what our combustion-energy infatuation might do to change environments we've depended on for comfort, food, security, even evolution. Did humanity respect scientific advice or comfort + $?

Earth has some effective cooling mechanisms. One is surface-water evaporation (heat absorption), then upwelling to reach cool altitudes away from the Equator, where water vapor can radiatively dump heat into the depths of space, then condense into raindrops that fall at higher latitudes. Several such atmospheric structures (Hadley Cells below left) are at work daily, moving equatorial waters' heat of evaporation away from the Equator. Earth's rotation aids the process via the imaginary Coriolis Force that affects particles confined to the surface of a rotating sphere (that's us).

Hadley Cells and atmospheric solar heating/transparency…





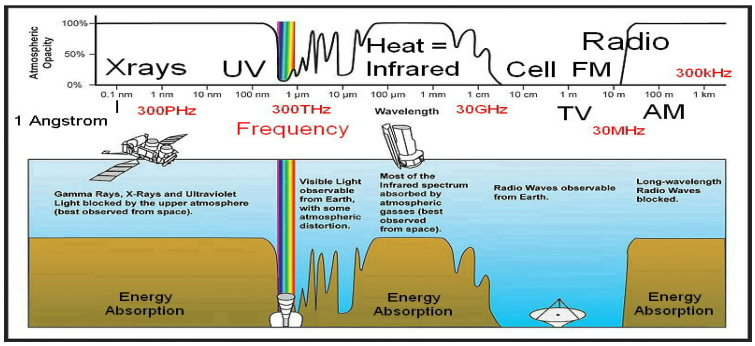
And, every daylight second, the sun delivers about 1kW of visible, infrared and ultraviolet radiation to each illuminated square meter of Earth (red curve above). GHGs absorb certain frequencies (colors) of that solar energy (red curve's dips). The dips are brought about by GHG molecules absorbing (dancing to) those colors that vibrate them uniquely because of how their atoms are linked together into molecules. A microwave oven works because it generates frequencies that water molecules in food absorb.

Our nanotech abilities can now even shift light to frequencies that GHGs largely ignore (blue band above). So, with enough $ and regulatory laws, we could even make PV itself not heat up the environment so much (sunlit commercial PV adds ~800 Watts per square meter of waste heat to the environment)...

Note that water vapor (H_2O) has the most absorption (gray) peaks and they occur mostly in the infrared ('redder' than the "red" we can see). This makes sense, since we see red through air. Likewise, we don't get much damaging UV (ultraviolet) into our eyes because Ozone high in the atmosphere absorbs UV, protecting our eyes and most life forms exposed to sunlight. Remember the "Ozone hole"? UV is a strong disinfectant.

If air absorbs some colors of sunlight, heating it up, and if it heats up even more from GHG light absorption, why doesn't air just 'boil' away daily? A little does, especially from the solar proton 'wind', but the blue blob shows how Earth radiates heat energy away into space through a range of infrared light frequencies that air & GHGs don't much absorb.

The next worry is that a warmer Earth means its blackbody (blue) radiation shifts left into more absorption (gray above; brown ~30GHz below)…



Waste heat is the end product of our century or so of ignoring energy reality on a rare planet that is and always will be (sorry Mars enthusiasts) our home. Sure, lots of us wrote/read about Mars colonies in the '50s. Our landers even tell us Mars used to have water, perhaps life, but they also winess the stark reality when a warmish planet loses its magnetic field and cosmic radiation just streams in. Any atmospheric molecule has a good chance to be whacked into space.

<u>What can we do?</u>

Demand efficient, environmental, non-GHG-emitting power: hydro, nuclear, geothermal.

Lobby federal, state and local politicos for such.

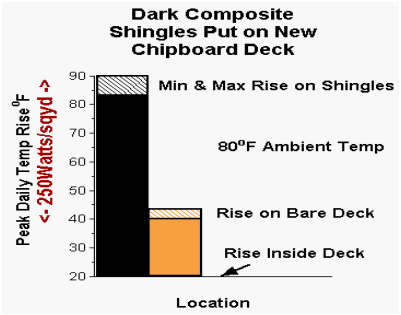
Support restoration of idled clean power stations.

Express the realities above to news media.

Study what can be done by each of us in our towns and cities.

a) For instance, CEC, LBL* and other researchers long ago determined that a dark roof adds as much warming as operating another combustion vehicle in a home…

	Solar Reflectivity Increase	CO_2 Offset by 100 m^2 (~120 sq yards)	CO_2 Offset Globally
White Roof	0.40	10 tons (~2 cars)	
Average Roof	0.25	6.3 tons	24 Gt
Cool Pavement	0.15	4 tons	20 Gt
Total Potential	–	–	44 Gt
Value of 44 Gt CO_2 at $25/t ~ $1 Trillion 100 gallons Gasoline/year => ~1 ton CO_2 **Global CO_2 emissions in 2009 ~24Gt** (Akbari, Menon, Rosenfeld. *Climatic Change*, 2008)			



* Lawrence-Berkeley Labs, California Energy Commission.

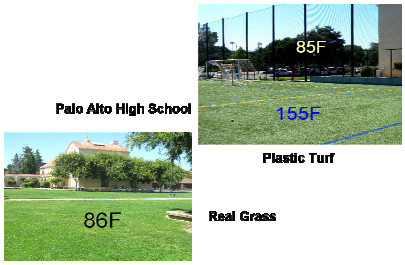
b) Present ~20%-efficient PV on a home is as bad as a black/dark roof, despite the modest electrical output (~80% of solar energy wasted as heat).

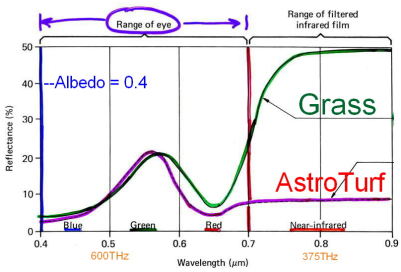
…LA has even considered painting streets white.

c) Avoid home air-conditioner use, unless via verified heat pump.

d) Avoid car A/C use – open windows, enjoy the breeze. Choose a light (or white) car color.

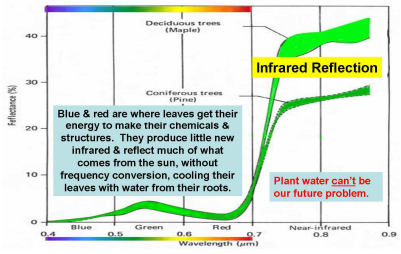
e) Do not use fake turf, especially for playing fields.





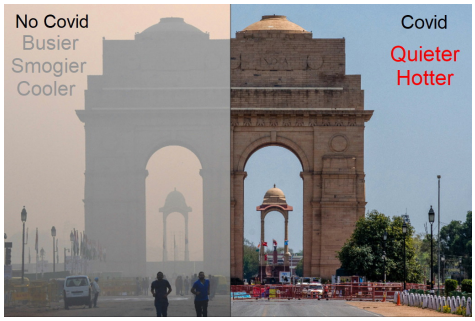
f) Unify commercial & residential roof/paving reflectance standards…

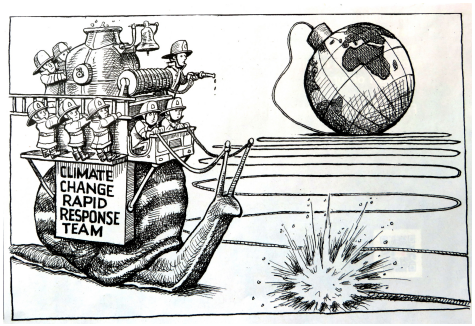
g) Note that a mature, broadleaf tree is a ~60kW cooling system (conifers a bit less): use trees around homes/offices (get a C-credit ;).



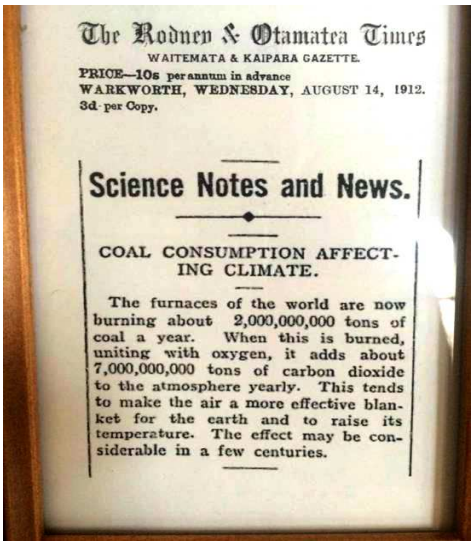
h) At 95°F wet bulb (accounts for humidity) people die…

i) Unfortunately, smog actually cools us and fools us…





j) Our problem remains our history of ignoring reality…

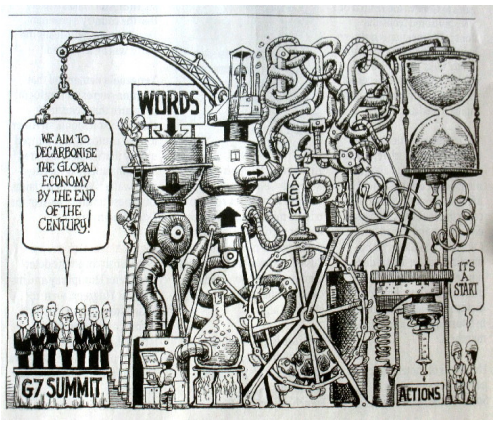


The Rodney & Otamatea Times
WAITEMATA & KAIPARA GAZETTE.
PRICE—10s per annum in advance
WARKWORTH, WEDNESDAY, AUGUST 14, 1912.
3d per Copy.

Science Notes and News.

COAL CONSUMPTION AFFECTING CLIMATE.

The furnaces of the world are now burning about 2,000,000,000 tons of coal a year. When this is burned, uniting with oxygen, it adds about 7,000,000,000 tons of carbon dioxide to the atmosphere yearly. This tends to make the air a more effective blanket for the earth and to raise its temperature. The effect may be considerable in a few centuries.



k) Your suggestions – home, work, business, community, governmental…?

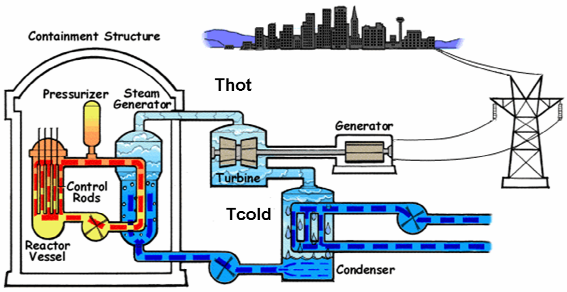
So, we're over a century late in dealing with combustion emissions and their real effects on everything around us that Ma Nature created, or that we built by learning her facts and applying them without great thought – the steam engine comes to mind...

Up to the 20th Century, we only knew how to produce industrial amounts of energy via water plus gravity and combustibles plus air. Colonial cities in US Eastern states were specifically settled at the first useful elevation change for water power. Natural falls (e.g., Niagara) provided excellent water-power sites. More recent hydropower sites have exposed output to environmental realities, such as the construction of Glen Canyon Dam on the Colorado River being done despite overestimates of future precipitation in the Colorado River basin. Similar hydropower projects around the world, from Hydro Quebec to the world's largest project in China, demonstrated the vagaries of climate-sensitive power generation.

We've also seen the low energy yield of wind/solar power, given the daily vagaries of sunlight and wind, whose energy yields barely reach several (wind) to a few (solar) percentage points of naturally incident energy. Unlike hydro, geothermal, nuclear and combustion, wind/solar are evanescent, not utility grade, present unpredictably and of low energy density.

Since unnatural heating plus GHG production are leaders in environmental threats, our long-term, survivable power choices must maximize clean energy output per unit of materiel investment. DOE's Quadrenniel Review makes clear that hydro, geothermal and nuclear power give us the cleanest utility-grade, reliable power. And, of those, we should choose plant designs that waste the least energy.

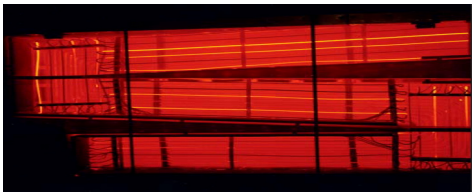
Hydro plants are at least 75% efficient, as long as they've impounded enough seasonal water. For thermal plants (including geothermal), operating temperature is the first key parameter...



Carnot Efficiency = (1 – Tcold / Thot)

Water/Steam => ~33% efficiency
Gas/Molten-Salt/Metal => ~45%

The plant above (combustion, geothermal or nuclear) yields ~33% efficiency, rising to ~45% if operating at maximum temperature and/or with energy fed back from condenser to boiler input (combined-cycle), or simply operating at high working-fluid (gas, molten salt…) temperatures (Thot) – yes, we want red-hot, efficient power...



The key point from all the above is that since we've opened ourselves to a warming world, we must minimize waste heat and power. This means environmentally safe hydro and geothermal, plus efficient nuclear power (plus reining in questionable power diversions like crypto, datacenters, etc.) – a modest example…

Diablo Canyon (DCISC.ORG, CGNP.ORG)

10% of CA Power

30% of CA Clean "

< $0.04/kWHr

90% Uptime

$1 Billion to County

Desalination "

Salary Avg. $147,000

Flexible Storage...

CAISO: "*Planned Maintenance at Diablo Canyon Unit 2 Delayed to Meet State Energy Needs During Heat Wave*" 9 Sep. 2015, CAISO: "***Requests Both Units Operate at Full Power***". **http://tinyurl.com/zha8dba**