The Yoke... then the Birds

Tom Ransom

Insofar as humankind is concerned, no question about it, the 'yoke' was here first long before we were – waiting reservoirs of oil so abundant they were under pressure; just tap in and out gassed petroleum, barrels full for the filling, so much fuel that it provided for the cityscaping of earth and globalization of commerce. Many believe the petroleum age has run amuck, fouled our planet, and now presents humanity with a potential crisis that places our future in jeopardy. Perhaps, but that seems unlikely... as unlikely as an embryo laying waste to itself consuming its yoke.

Afterall, the earth does look a lot like an 'incubator' – fertile lands awash in water, slowly rotating in the warmth of a hydrogen fusion lamp, the most damaging radiation deflected by an invisible magnetic shield. This "biosphere" proved so favorable for life that over the course of hundreds of millions of solar orbits the sun's energy was duly appropriated to synthesize layer upon layer of plant "carbohydrates". These carbon-hydrogen-bonded sugars and fats fueled the subsequent coevolution of complex animals, and under the compounding pressure of each passing generation, and geologic churning, life's remains were slowly processed into coal, oil and methane gas. Such "fossil fuels" ignite because when heated to their combustion temperature they become so kinetic their hydrogen-carbon bonds break, and as oxygen rushes in to "oxidize" the free carbon, a bit of solar energy leftover from the original H-C bond is released. That's the heat of the sun we feel whenever something burns – stored sunlight from millions of years ago if we're burning fossil fuels.

It now seems a gathering consensus believes that critical consequences require us to reduce our consumption of these fossil fuel reserves. Clearly, it's not like letting sunlight out of a jar; when light and heat are released from combusting carbohydrates, carbon is discarded in the process, and carbon compounds get heavy and messy. Burning hydrocarbons pollute the atmosphere with particulates and gases increasing its density. The prevailing ecological equilibrium is an emergent adaptation tuned to the thermal mean of its habitable range; rapid range change can overwhelm its adaptive capacity and undermine the viability of the most complex organisms. In fact, fossil records indicate that life on earth has retreated numerous times in the past due to catastrophic volcanic and meteoric events(1).

Global warming alarmists present field data and computer models portending extreme environmental stress as fossil fuel consumption is increased. Informed skeptics caution that the ecosystem is likely too complex and convoluted to be successfully compressed into algorithms predicting real-world outcomes. They note that one of the most complicated and influential model components – the water vapor cycle, is also the least understood(2). And they question the purported "anthropogenic" climate change claims. There are, afterall, causations far greater than human activity influencing the global climate, such as cyclic variations in solar radiance and periodic perturbations of earth's orbit and rotation. And unlike major cataclysmic events, the burning of our hydrocarbon reserves will likely evidence the thermal effects of a slow extended impact trending on a centuries scale – not decades.

Though the issues raised by the anthropogenic skeptics are legitimate, a preeminent countervalent fact remains: in a few hundred years we will have reintroduced hundreds of *millions* of years(3) of hydrocarbon-sequestered solar energy onto the surface of our planet. Additive "greenhouse gas effects" aren't even required: because every fossil fueled activity ends up as heat, and compensatory radiative forcing(4) is a *retarded* process, the certain consequence of consuming our petroleum yoke *will* be a warmer world. Take a look at our high resistance electrical grid from outer space(5) and consider that in the comparative space of an apple skin, this round-the-clock, multi-terawatt 'electric heater', is less than half the heat we're actually producing:

Until recently the earth was generally integrating two primary thermal inputs: one internal – radioactive and residual heat escaping from its interior, and the other external – radiant energy from the sun(6). Ever since human beings began burning its fossil fuel reserves, however, and learned to fission uranium, the bio-sphere has had to adapt to an ever increasing thermal input of terrestrial origin.

Though this may account for a relatively small percentage of the earth's daily thermal exchange, our environment is a complex, feedback intensive system, small influences can have profound effects, and the thermal input of human civilization is both non-trivial and unprecedented. While we can't predict to what degree, we can reasonably expect, and accept, that *all* energy released from mineral energy resources contributes to global warming. Accepting the prevailing predilection toward our subsequent demise, however, doesn't necessarily follow. We could be right on time, doing just fine... Buckminster Fuller:

> "Humanity's survival and growth up to now was apparently provided just as a bird inside of the egg is provided with liquid nutriment to develop it to a certain point. But then by design the nutriment is exhausted at just the time when the chick is large enough to be able to locomote... stepping forth from its [shell] the young bird must now forage on its own legs and wings to discover the next phase of its active regenerative sustenance. My own picture of humanity today finds us just about to step out from the pieces of our broken eggshell... we are faced with an entirely new relationship to the universe. We are going to have to spread our wings of intellect and fly or perish." (7a)

> "The fossil fuel deposits of our Spaceship Earth correspond to an automobile's storage battery which must be conserved to turn over our main engine's self starter. Thereafter, our 'main engine', the life regenerating processes, must operate exclusively on our vast daily energy income from the powers of wind, tide, water, and the direct Sun radiation energy." (7b)

The degree to which the ecosystem may be influenced by our thermal load will be proportional to the total energy human beings *introduce* into the environment, not the amount they necessarily consume. There would be no pending "energy crises" were we to unburden ourselves of having to find, extract, refine, carry, burn and clean up, heavy, contaminating, hydrocarbon and radioactive mineral fuels. In fact, relief is already being provided: a clean, weightless, inexhaustible, incoming daily solar and geothermal energy allowance is ours to use freely, and it's not just adequate – it's plenty(8). The technologies to capture it are readily advancing. It's just a matter of time before the scarcity and externalities of fossil and fissionable fuel acquisition and consumption drive up their true costs to where these alternative energy sources favorably compete and humanity moves as a matter of course from its petroleum yoke dependency on the past to a renewable 'real-time' energy future.

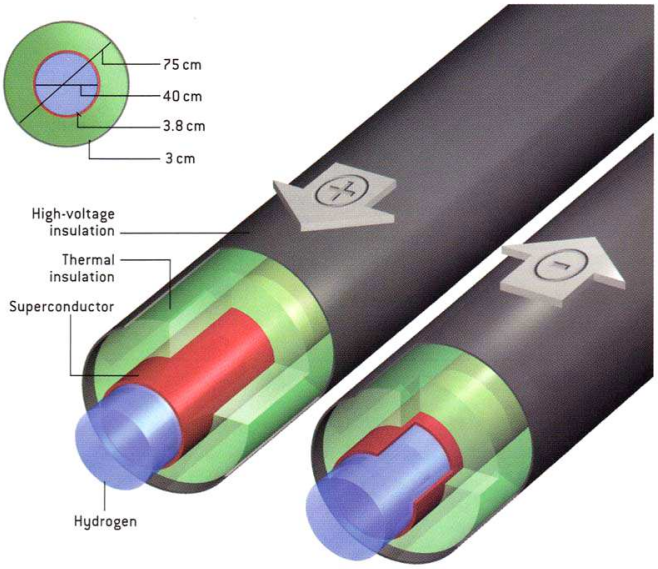
We could expedite this eventuality by anticipating the energy end-game: hydrogen and electricity. These two 'fuels' aren't energy resources themselves because it takes energy to produce them, rather, they are readily transportable fluid carriers. Free electrons and atomic hydrogen are the ultimate energy

currency. Not only is each immutably basic, together they form a single, complementary, electro-chemical utility because each can regenerate the other. Hydrogen can be oxidized (leaving only water behind!) to drive the magnetic turbines that force electrons in a copper coil to surge through a conductor. Hydrogen can produce electricity directly if processed in a fuel cell. And an electrical differential is an excellent way to separate a water molecule into its constituent gases – oxygen and hydrogen. Hydrogen can be pumped into storage and called upon to produce electricity whenever sun, wind and water resources directly provide less than demand requires. And remarkably, the carrying capacity of these energy carriers is complementary as well: at the temperature of liquid hydrogen electrical conductors are nearly "super-conducting" meaning that electron conveyance via hydrogen cooled cable is as efficient as it gets. In fact, so integrated are these complementary carrier coefficients, that without hydrogen, solar-electric won't solve the sustainable energy equation.

Government and corporate leadership could promote the transition from the petroleum to the hydrogen age by committing to the capitalization and construction of a "SuperGrid"(9). Following the existing power tower corridors meter-wide "supercables" would pipe hydrogen and electricity ("hydricity") into every metropolitan area. A "smart"(10) decentralized SuperGrid could be locally energized along its way by whatever means and from any source that pressurizes hydrogen or produces a positive voltage potential. It would literally be a pipe dream – a 'build it and they will come' proposition. Small scale energy producers would proliferate, technological innovation would flourish, efficiencies and synergies would be forthcoming. A strategic plan to develop a distributed-supply, interstate Super-Grid would reaffirm our nation's technological leadership, stimulate investment, create jobs, and trend the economy away from its dependency on fossil and fissile fuels before they become too costly to burn. Anyway, at what ever price, these finite resources will likely be even more valuable to future generations for purposes other than terminal combustion.

SUPERCABLES

SuperCables could transport energy in both electrical and chemical form. Electricity would travel nearly resistance-free through pipes (*red*) made of a superconducting material. Chilled hydrogen flowing as a liquid (*blue*) inside the conductors would keep their temperature near absolute zero. A SuperCable with two conduits, each about a meter in diameter, could simultaneously transmit five gigawatts of electricity and 10 gigawatts of thermal power (*table*).



	Voltage/Temperature	Flow rate	Power delivered
DC circuit	+50,000 volts and −50,000 volts	50,000 amperes	5,000 megawatts electric
Liquid hydrogen	20 kelvins	0.6 cubic meter/second in each pipe	10,000 megawatts thermal

An advancing marketplace of products and technologies is primed and ready to begin moving us toward a sustainable, non-polluting, hydrogen-solar economy. Hydrogen turbines, hydrolytic and hydrogen fuel cells, waste biofuels, photo-voltaics, solar-thermal arrays, hydro-electric, oceanic and wind driven turbines are all producing energy today. Add to these the geothermal potential that exists to some degree most everywhere just below the earth's surface and we have more energy available than we require. These energy sources won't contribute to net global warming nor are they likely to stress the prevailing balance of the biosphere because they've always been integral components of the global ecology. We should diligently invest our fossil fuel endowment in the development of a smart, secure, SuperGrid energized in real-time by the radiant heat of the earth and its parent star – the Sun: that life sustaining, exemplary fusion of hydrogen and electromagnetic transmission. It's time we gratefully turn away from our petroleum yoke, tap our way out of Fuller's metaphorical eggshell, tap into the solar wind, and "spread our wings of intellect and fly".

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