

Energy Economics

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R. Buckminster Fuller was President of the World Society for Ekistics from 1975-77. He is also World Fellow in Residence at the University City Science Center, Philadelphia, as well as University Professor Emeritus at Southern Illinois University. In this paper he describes some of the work resulting from several World Game Seminars, in particular the 1974 Seminar, hosted by the University of Pennsylvania, which was led by Medard Gabel and his Earth Metabolic Design Associates. This resulted in a report entitled "Energy, Earth and Everyone."

The area of the surface of a sphere is exactly four times the area of the sphere's great-circle disk, as produced by a plane cutting through the center of the sphere. The surface of a hemisphere is, then, twice the area of the sphere's great-circle plane. When we look at the "full" moon, we are looking at a hemisphere's surface which is twice the area of the seemingly flat, bright, circular disk in the sky. The total surface of the moon's invisible other side plus the visible hemisphere is exactly four times that of the flat disk area of the full moon as our optical illusion views it.

All of Earth's operational energy comes from the stars, but primarily the star Sun. It comes either as radiation or as inter-astrogravitational pull. One half of Earth's 200 million square mile surface is always sunlit. Twenty-four hours a day the sun radiation is drenching the outside of the aurora and cloud-islanded biosphere's 100-million-square-mile hemispherical surface. The planet Earth's total biospheric mantle, which travels with it through space, has a depth of 400 miles. Forty billion cubic miles of Earth's Sun-radiation-impounding-biosphere is always exposed to Sun, while the other 40 billion cubic miles of Earth's biosphere is always in Earth's night shade.

While its thermosphere mantle is 400 miles deep, its mesosphere 50 miles deep, its stratosphere 30, Earth's propeller-flyable atmosphere is only 10 miles deep. This gives us 1 billion cubic miles of wind turbulent atmosphere on the sunny (day) side, and 1 billion cubic miles on the shadow (night) side. The 1 billion cubic miles of atmospheric molecules in the hemisphere which is constantly saturated by Sun are kinetically accelerated, while simultaneously the 1 billion cubic miles of atmospheric molecules in the shaded night hemisphere are kinetically decelerated.

The shadow side of Earth consists of 1 billion cubic miles of contracting atmosphere, while the 1 billion cubic miles on the sunny side is sum-totally expanding. All around Earth, both yesterday's and today's Sun radiation impoundments countered by gravity pulsatingly perturbate the atmosphere by anti-gravity thermal columns and Sun-evaporated Earth surface water risings, here and there outwardly against gravity, from oceans and lands. The rotation of Earth brings about a series of high-low relative atmospheric pressure differentials and

their world-around semi-vacumized drafts, which altogether produce the "high" and "low" atmospheric pressures and the complex turbulence which we speak of as "the weather."

The combined 2 billion cubic miles of atmospheric kinetics continually and anew convert the solar energy into weather which in turn differentiates into wind power and gravity-accelerated "rain" and highlands-landed water power. A fraction of the wind power again interacts with gravity to produce the great waves, rolling power-laden, onward across the 150 million square miles of surface of the oceans, lakes, rivers, and ponds, to pound thunderingly and grind ceaselessly with fury upon the rocks, producing the gravels, sands, and dusts of Earth's million miles of coast lines. Wind power is Sun power in its most abundant, day and night, anywhere and everywhere, by a relative energy abundance factor of better than 99 to 1 in contradistinction to any of the other known means of terrestrial impoundments of Sun energy.

Three-quarters of Earth's total surface is covered with water. Employing photosynthesis, the water-borne algae convert Sun radiation energy into hydrocarbon molecules which, in a complex succession of swallowings by progressively larger marine organisms, metabolically accomplish a vast impoundment of Sun-emanated energy within Earth's waters.

Since human lungs and other organisms are designed for initial success only on dry land, and since the development of boats capable of mastery of major life support through off-shore fishing means required millions of years of development, we must first look to the dry land for comprehension of humanity's initial life support.

The water-free one quarter of Earth's surface consists of land which is largely covered by deserts, ice and snow fields and rugged mountains. Only about 10 percent of our planet's surface is blessed with a total complex of natural conditions suitable for humans' outdoor cultivation of animal and vegetable food products. This suitability occurs only where the properly watered and temperatured topsoil vegetation can impound Sun's radiation by photosynthesis.

Among the solar-energy-impounding dry land vegetation species, none can now (1977) match sweet corn's performance efficiency. Sweet corn converts and stores as recoverable energy 25 percent of the received ultraviolet radiation, whereas wheat and rice average only 18 to 20 percent. Sustained by the initial botanical impounders of solar energy, animals and other creatures automatically proliferate the production of orderly hydrocarbon molecules in their own DNA-RNA-programmed cell growth.

Humans in turn consume the energy-rich hydrocarbons proliferated by creature and vegetation cell growth to sustain their own subconsciously (DNA-RNA) accom-

plished corporeal cell multiplication, as well as for sustaining their conscious expenditures of physical work or play effort. Objectively employing the cosmic principles discovered by human mind, human work can design and produce the extra-corporeal tools which in turn produce the commercial alcohol, methane, gas, et al. Or humans can leave untampered with the slow process of nature's energy production of solid and liquid fossil fuels produced through heat and pressure conditions accomplished by nature within Earth's crust.

The requisite pressures and heat that must be maintained continuously and steadily over the multimillenia involved in the natural production of liquid fossil fuels, when accounted at the kilowatt-per-hour prices charged to retail customers by the public utilities for that much energy for that vast span of time, amount to well over a million dollars per each gallon of petroleum. Kilowatts are energy units employed by scientists and engineers which are mathematically convertible into (and predicated upon) humans' prime measure of energy as work, i.e. the amount of energy expended to oppose gravity by lifting a given weight a given vertical distance in a given amount of time, which is expressed as foot-pounds-per-minute, or meter-kilograms-per-minute, or as centimeter-gram-seconds (cgs) etc., ergo, kilowatt-hours. Physicists, astrophysicists, astronomers, chemists, and engineers employ these standards of measurement to discover how the physical Universe in which we live operates. Such methodical measuring has discovered a complete integrity of energy accounting in the Universe.

Newton's discovery of the geometrical rate of inter-attractiveness variance, in respect to arithmetical change of celestial bodies' interdistancing, from which we derive the gravitational constant, plus the measurement of the linear speed of radiation in a vacuum (186,000+ miles per second) is compounded with quantation of photons radiated per second to provide the radiation constants. Non-simultaneous, Scenario Universe's eternally regenerative, 100 percent efficient integrity is predicated upon the ever-energetic intertransformings of gravity vs. radiation — from matter to radiation and vice versa. Einstein's equation of $E = Mc^2$ (as eventually proven by fission) provided humanity with the competence to participate in the integrity of cosmic accounting.

Humans, misconditioned to think of their Earth as the center of the Universe, with the stars and moon occurring only as aesthetic decoration, and of man on Earth as the supreme initiator and authority, account their petroleum exploitation only in terms of their capital risk expenditures in drilling, pumping, refining, and delivery costs, and assume the petroleum itself to be a "free" prize for their effort. Humans, exploiting human needs, find venture capital available only for the greatest and quickest profits: ergo, always first exploit the cream, the high grade ores, etc. It does not require any wisdom at all to realize that it is foolhardy to live entirely on savings capital, or to heat a ship's passengers by burning up the ship. Nor does it take more than common sense to realize that concern for our children, and not just for ourselves, requires that we manage to live entirely within our eternally renewable energy income — which is exactly what we have now learned to be eminently feasible, while providing an eternally sustainable higher standard of living for all humanity.

Since we are in fact in the Universe, and since our planet Earth is but one little planet of a medium-sized star (Sun), which is only one in our galaxy of 100 billion stars, which is, in turn, only one galaxy in a thus-far discovered billion such galaxies; and since the cosmic energy radiationally and gravitationally interacting and intertransforming accounting system is found everywhere and everywhen to be elegantly, incisively, and inexorably operative, which means no loss of energy, we may safely interpret our present Energy Crisis of Earthian humans to be a crisis of ignorant economic accounting, and not a crisis of energy shortage. We may likewise assume that if we are to remain in the Universe as satisfactory members of that interfunctioning integrity, we must immediately convert to cosmic accounting, which will swiftly teach us the imbecility of spending one, two, or three million dollars worth of cosmic energy savings account to "drive to work," to produce no life support wealth whatsoever, and to "earn" thereby 30 to 50 bankers' dollars per day. Anything less than the acceptance of cosmic accounting remains a momentarily palliative measure, and not a cure of our otherwise potentially fatal accounting ignorance.

One-half of the vegetation-producing area of Earth's surface is always in the shadow, or night side, which reduces to 5 percent the relative proportion of Earth's surface always available to vegetation's impoundment of Sun's energy. Though theoretically 5 percent of Earth's surface can impound energy by photosynthesis at any one time, in fact only an average of 1 percent of Sun's dry-Earth-impinging energy is actually being converted into a humanly storable and consumable state, due to local weather conditions as well as to interferences in the infra-red and other energy-radiation frequencies.

The inventions that impound solar energy through Sun-reflecting or lensing devices are fascinating to the imagination, but relatively insignificant in potential. In fact, they work only a few hours daily when Sun is at a favorable angle, or energy must otherwise be expended to continually re-aim them in the everchanging Sun direction.

Even if half of preponderantly cloud-free Arizona were turned into a direct-sunlight-energy-converting mechanism, the total quantity of energy thereby to be produced would be negligible in comparison with averagely-available windpower sources.

Wind power is in a class by itself. It presents the potentially greatest terrestrial medium for harvesting, harnessing, and conserving solar energy. The water and air waves circulating around our planet are unsurpassed energy accumulators whose captured energy may be used at any time to generate electrical, pneumatic, and hydraulic power systems.

Windmills produce power from Sun-generated differentials of heat, which are the source of all wind, with far greater efficiency than do devices which focus and store direct solar radiation. But the most comprehensive consideration regarding wind power is not technological. Rather it is the problem of developing human appreciation that wind power is indeed by far the most efficient way to recapture and use solar power. Another problem is that those who profit by speculative investment mistakenly find the wind-exploiting prospects unattractive, due to the fact that anybody anywhere has direct access to the wind power and can circumvent the exploiter for

monetary profit, as the fisherman can raise the sail of his craft to participate in nature's solarized energy resource.

All biological life on planet Earth is regenerated by star energy, and overwhelmingly by Sun's radiation. Sun radiates omnidirectionally at a distance of 92 million miles away from Earth, wherefore only two billionths of its total radiation impinges upon Earth, at a rate of two calories of energy per each square centimeter (13 calories per square inch) of Earth's sunny-side hemispherical surface per each minute of time. About half of that received energy is reflected back omnidirectionally to the Universe. Half of all the Sun's energy impinging directly on Earth, which is impounded within the biosphere, amounts to one calorie per minute per square centimeter ($6\frac{1}{2}$ calories per square inch). This net amount of energy is impounded by our planet's biosphere in various ways, all of which energy is available for human use. To avail itself of this energy bounty, humanity must successfully use its cosmically permitted, comprehensive, ecologically considerate, inventive capabilities and its spontaneously cooperative social proclivities.

No matter how dubious one may be that any such logical realizations of our bounteous human potentials may be realized, the fact remains that our net hourly cosmic energy receipts and their natural biospheric impoundment amounts to 120 trillion horsepower, which can also be stated as 90 trillion kilowatts per hour; which, with 8,760 hours a year, amounts to 786 quadrillion kilowatt-hours a year. This 786×10^{15} kilowatt-hours is almost 2 hundred thousandfold the world's present 5×10^{12} kilowatt-hour rate of fossil fuel or water power conversion and consumption of electric energy.

If all humanity enjoyed 1973's "highest" living standard — that of the United States — each human on Earth would consume 200,000 (2×10^5) kilocalories a day.

Assuming 5 billion (5×10^9) humans by AD 2000, each consuming 2×10^5 kilocalories daily, we would need only 1×10^{15} kilocalories a day, while our actual daily terrestrial income of cosmic energy is 2×10^{18} kilocalories; our planet's usable daily cosmic energy income is therefore 2×10^3 or 2 thousandfold that of our daily requirements in AD 2000.

I have been pursuing the twin subjects of wind power and wave power in varying degrees of intensity since 1927, when I initially included windmills, air compressors and liquid oxygen liquefaction equipment for the wind power impoundment and storage, as well as pre-expansion chambers and air turbines, in the 1927 design of the first Dymaxion house.

Concurrent with the advent of rural electrification — more than a third of a century ago — I saw that windmills were going out of use on the farms just as modern aerodynamic research was coming in. To take advantage of the subsequent third of a century harvest of aerodynamic knowledge, I have for the past four years been pursuing the development of windmill-generated electricity.

One of our strategies for storing the wind-harvested energy has been to convert electrolytically pure Sun-distilled water directly into hydrogen for either immediate or delayed power purposes. The hydrogen and oxygen can be reassociated to produce electric current at an overall 85 percent efficiency. A complementary strategy is the combination of improved, variable pitch, windmill propeller blades with the aerodynamics of jet

technology, in which the windflow patterns embracing whole buildings are focused and funneled through Bernoulli cowlings at high speed rates, to propel turbines and to process large increments of electrical energy.

"Windworks," our experimental organization at Mukwanago, Wisconsin, has developed a new octahedrally structured, low weight windmill mast which is transportable, powerful, economical, and swiftly erectable. Windworks has also developed a new low-cost mechanical linkage from the windmill to the generator.

Present experiments show that flywheels — as energy accumulators — can be employed efficiently to harvest unpredictably intervalled and variable force winds to drive electric generators.

All the winds around Earth, whose energies produce the 150 million square miles of ocean waves, travel inland to bend, swirl, and twist, often uprooting the world's trees, bushes, and grasses and stirring up dust storms. They also form 2 billion cubic miles of clouds and raise hourly billions of tons of water into the sky to be rained back upon Earth to maintain its vegetation. The winds and their many side-effect tasks altogether constitute a 10-mile thick, 2 billion-cubic-mile spherical mantle, which is indeed an ever renewable, daily "income," wealth producing, Sun-accumulator or Sun energy storage battery, whose stored power capacity is adequate to accommodate and eternally regenerate all of humanity's terrestrial needs and pleasures. It is a terrestrial energy accumulator, or "storage" battery adequate for all human life support for all time to come: a safety-factor with an adequacy coefficient of 10,000 to 1.

As the US Navy reckons it, one minute of one hurricane releases more energy than that of the combined atomic bomb arsenals of the United States and Russia. From the viewpoint of design science, it is simply a matter of coping technically and efficiently with the variabilities of wind power: calm, zephyr, gale, or hurricane.

Great corporations have not as yet ventured into this field because wind energy has not seemed to be readily monopolizable for delivery to humans, exclusively flow-metered via pipes and wires. Enterprise can be rewarded, however, and in magnitudes greater than ever before, by producing, delivering, and renting — on a world-around service basis — the appropriate wind-harnessing apparatus for large, medium and small consumer needs: this incidental equipment rental service to follow the business methods of the computer, telephone, car rental, and hotelling-service industries.

Hydrogen, harvested in the fuel cell manner, can be used immediately to operate all the world's piston- or turbine-driven engines now driven by gasified petroleum products. Recent studies by the National Science Foundation afford statistical confirmation of my statement that wind power can take care of all our energy needs, and that this can be accomplished in short order. The National Science Foundation's development strategy is, however, directed exclusively toward producing large offshore ship- or tower-mounted windmill batteries to supply large public utility companies, who in turn may supply the public. In contradistinction to this strategy, the design science program of our World Game is aimed at supplying individual windmills to individual consumers and their families.

Wind power permits humanity to participate in cosmic economics and evolutionary accommodation without in any way depleting or pollutionally offending the great ecological regeneration of life on Earth.

Windworks has been successful in inducing cooperation between individual windmill owners and large private enterprise electrical power generation and distribution industries by coping with several fundamental facts:

1. Peak wind loads rarely co-occur with peak energy consumption periods.
2. The storage of wind-harvested energy in batteries, and later withdrawal from them, involves a 50 percent storage and withdrawal energy expenditure loss of initially harvested energy.
3. The only one-way revolving electric generator-coupled windmills inherently produce direct current (DC).
4. The electricity generating industry produces and distributes alternating current (AC) and the electrical equipment industry produces and sells alternating current devices.
5. The electricity industry's meters needed great improvement in sensitivity, accuracy and efficiency.
6. Present day direct to alternating current transforming equipment is larger, heavier and more inefficient than that which has become feasible and desirable.

To meet the foregoing challenges, Windworks:

1. Developed a new, vastly improved, highly efficient miniaturized electromagnetic circuitry for low cost conversion from DC to AC.
2. Developed greatly improved, far more sensitive and reliable meters of electrical input and output recording.
3. Connected the windmill's electric generator through their low cost DC to AC transformer, thus feeding AC electric power immediately into the private enterprise enterprise public utility lines. This means that whenever wind is blowing locally, energy is being fed into the public energy network system, thus avoiding the in-and-out 50 percent loss in storing energy income.
4. Integrated the DC to AC transforming circuitry with energy flow meters, so that all apparatus is in one neat container no larger than a brief-case.

First the Wisconsin public enterprise utilities, and subsequently the utilities of 22 other states of the United States, have accepted this hook-up. The individual windmill owner does not connect his windmill to his own household equipment, but feeds all wind-harvested power directly into the public utility's power lines, and in turn takes his own only from the power company. In months when the wind harvest is high, the individual windmill home owner finds that, in addition to satisfying his own needs, he has profited with a credit balance shown on his monthly utility bill. The individual windmill owner is paid at wholesale rates for feeding into the system, and charged at retail rates for what he takes out of the energy system. This makes it a profitable matter not only for the privately-owned utilities, but also for the individual who frequently finds that the public utilities owe him money.



Windmill in central Australia (photo: Heather George, Melbourne).

Most importantly of all, the whole human economy is benefited.

It has been discovered that somewhere within a radius of 100 miles of any given point, the wind is always blowing. With wide distribution of individual home windmills feeding into the integrated electrical power networks — which as described later will soon be integrated into a world network — the world-around windmills, working both day and night and throughout cloud-covered days, hold the greatest energy promise for humanity.

Wind power also can be harnessed and tank-stored by air compressors directly coupled with windmills. Air (pneumatically)-driven tools weigh less and bulk less than their equivalent electric tools. High heat is a by-product of air compressing. The high heats produced by wind-driven air compressors can be used for water heating and storing and by sea shore-mounted windmills to desalinize salt water. At the same time or at other times, the windmill may be directly or indirectly coupled with hydraulic pumps to elevate the desalinized or heated water to any heights, to be stored insulatingly and distributed gravitationally through present water-course systems.

"Fog guns" using a minimum of atomized water (1 pint per bath) and high pressure (200 p.s.i.) air will both clean and massage human skin in a clinically healthy manner without losing any of the skin's essential chemistries commonly removed by soap and water.

The scientist Boltzmann posited, and Einstein later concurred, that in order for all the stars of the Universe to be broadcasting their energies entropically, star embryos must elsewhere and elsewhen be importing those seemingly annihilated energies. Boltzmann also explained that it is the exporting broadcast energies that make those stars visible and that the importing embryo would be invisible to us until it had reached a firing-off critical mass. For this reason, neither he nor other scientists could identify any such importing embryos. Einstein and Weiner, as well as this writer, have shown that this Earth planet is just such a syntropic photosynthetic-vegetation equipped energy importing and orderly hydro-carbon forming and storing cosmic center, at which importing center we humans, by cosmic design, happen to be present, and are thus capable of making direct observation of such energy importing functioning. In the 100 percent efficient cosmic scheme of eternal regeneration, the fossil fuels constitute the Universe's energy wealth savings account. This cumulative capital it ultimately invests in producing a new star.

In its infallible designing integrity, we must assume that nature deliberately designed humans to be born naked, helpless, ignorant; and at the same time hungry, thirsty, and curious; ergo, driven to learn only by trial and error: that our muscles are of only negligible account and our generalized cosmic-principles-discovering minds are of infinite account.

We may therefore assume that we had to learn of our mistakes only through lethal crisis and that mistakes are permissible until humanity has learned of its common error, at which critical points we must abruptly alter the course of action of our human affairs. Quite clearly, we have now arrived at our most critical-in-all-history point and are fortunately most recently endowed with vast computer accounting capability, lacking which a complete new omni-world energy economics accounting system compatible with our Universe's generalized energy economics accounting would be unthinkable.

It is now feasible to harvest enough of our daily income of extra-terrestrially generated energy at a nature-sustainable rate to provide all humanity and all their generations to come, with a higher standard of living and greater freedoms than ever have been experienced by any humans, and to do so by 1985, while completely phasing out all further use of fossil fuels, atomic and fusion energy.

This means it is now possible for Earthian humanity to live on its daily energy income as generated by star radiation and cosmic gravity — primarily that of the star Sun — rather than:

1. by exhaustion of the millions of years of celestial energy, photosynthetically impounded by the terrestrial vegetation and deposited into Earth's crust as a cosmic savings account to be used many billions of years hence to convert planet Earth into a star.
2. by burning up the atoms of which spaceship Earth is structured.
3. by fusion's disruption of the biosphere's delicate hydro-and thermal balancing whose incisive integration governs the comprehensive metabolic chemistries of terrestrially regenerative ecology.

Three-quarters of our planet Earth's surface is covered by water. Water constitutes about 60 percent of the physical structuring substances of planet Earth's biological organisms. Sixty-five percent of the female and 70 percent of the male human body consists of multi-ways functioning water. The Earth's oceans contain 97 percent of all our planet's water. The surface of the Earth's waters is being continually vaporized into clouds to be redistributed around Earth as rain or snow. Sum-totally, Earth's waters are being continually recirculated throughout its combined ecological and geological biospheric system. Water is both the "Blood" and omni-load distributing compressional structuring means of Earthian life. The average depth of its oceans is less than one four-thousandths of the Earth sphere's diameter. It is a gossamer film so thin that it is proportionately less than the depth of the oceans on a 24 inch Earth globe. This almost aetherial film is kept from instant evaporation by the Sun only through the energy reshunting properties of the plurality of additional corcentrically enshrouding chemical and electromagnetic spherical mantles of Earth's biosphere.

The entropic energy losses to Universe occasioned by our emergency-urged fortuitous exploitation of Spaceship Earth's inventory of integral atoms, either by fission or fusion, will probably violate the integrity of the complex cosmic design for successful maintenance of human life aboard Earth until its billions of years' later firing-off as a new star has occasioned humanity's astro-migration to newer planets.

If you were a poor farmer and an oil gusher spurted on your land and further geological investigation showed that you could realize a million dollars a day for the rest of your life, it would be difficult for you to convince yourself that you ought to forego such monetary advantage. Human reasoning is designedly compromised by such circumstances. Most individuals would probably rationalize, "I can do more good for humanity with that wealth than I can as a farmer..." Having persuaded themselves to accept such fortune, the oil-rich soon discover many complexities of tax accounting requiring a host of professional lawyers and wealth managers who recommend various foreign residences, etc. There are now millions of such supra-millionaires, each directly or indirectly supporting beavies of lawyers. Through many such spontaneous human rationalizations and their vast bureaucracies of dependents, the multi-aeons of cosmic energy wealth deposited by the Universe as a future evolution accomodating savings account on this little planet is being depleted in one spendthrift century.

Ownership of the as-yet-remaining fossil energy wealth of our planet Earth has now become concentrated in the control of a very few individuals. Arabia embraces by far the largest remaining petroleum reserves. The majority of Arabian oil land-owning monarchs are beset by the world's most powerful, quick, but short-sighted profit exploiters of human needs, and the latter's terrestrial resource gratifications whose world-around bank owning and specialized professional expertise accreditation to the oil well owners is the exploiters' world distribution system of tanker fleets, pipe lines, storage tanks, refineries and metered retail filling stations, as well as their proven administrative know-how to take oil out of the ground and convert it into money.

The grand strategy of the world's free enterprise cartels is determinedly set to establish comprehensive installation and monopoly of atomic energy power before their exhaustion of the world's petroleum. The atomic energy know-how which they exploit was developed by the US Government at a 200 billion dollar cost to its citizen taxpayers. A third of a century's skillful manipulation of governmental evolution has shifted proprietorship of atomic power in the non-communist economies from the general citizenry's ownership prerogative to that of supranational private enterprise corporations. The grand strategy of the free enterprise cartels is predicated on their conviction that humanity cannot conceive of any possible alternative to their atomic energy development plans.

But the omni-humanity advantaging alternative options do exist. That fact is "the" epochal news.

Discovery and proof of the existence of eminently feasible cosmic energy income alternatives required exhaustive research. It required full inventorying of all the known and physically proven daily income of inexorably operative cosmic energy behaviors, such as the omni-energy conserving terminal turnaround intertransformability of entropic radiation and syntropic gravity, as complexedly and complementarily manifest, for instance, in the Sun and Moon's pulsatively rhythmic, gravitationally-pulled and precessionally-elevated tidal waters of Earth; or in Sun-generated winds; or in the syntropic intertransforming of world resources by cosmic receipts whose chemical processes produce methane, hydrogen, alcohol, etc.; or by inexorably operative thermal steam generation by natural subterranean inferno sources available around our planet.

Proof of the existence of an omni-humanity supporting cosmic energy income and its technical feasibility of accomplished production required a fully documented inventorying of the prime annual energy income sources as well as the known rates of toolability of the proven technical processes of employment of those proven natural daily energy income resources of our Earth.

What are all the "first things first" that must be done? How long does each one take? How do they overlap without delaying interferences? At what stage of each of the "first things first" can each of the second things be inaugurated? The critical path and the countdown of its accomplishments for getting humans safely to the Moon and back aboard planet Earth was in the magnitude of 2 million items that had to be realistically accomplished. The Cape Kennedy "countdown" was not from 10 to 1, but from 2,000,000 to 1.

The 1974 World Games Seminar, led by Medard Gabel and his Earth Metabolic Design Associates, hosted by the University of Pennsylvania, undertook the exhaustive inventorying of proven daily income energy resources, proven know-how technologies and proven rates of realization of the full complex of developments. Their work was governed by all the technological realities of sustainably energizing all humanity's highest known standards of living and accomodating not only all its further exploratory needs but also accomodating adequately all generations of humans to come.

Their report "Energy, Earth, and Everyone," shows how all this can be accomplished by 1985. We are confident

that it will bear the most rigorous examination by the world's scientists, engineers, and operating managers — Russian, Chinese, and Western World — because it clearly evidences a previously unknown, but workable, alternative option in the provision of adequate energy for all foreseeable human needs and desirable development. It invalidates the general systems assumptions underlying the grand strategies of the present world power masters of free enterprise.

Humanity is now deeply but silently apprehensive about exhaustion of its petro-energy resources. Humanity is also intuitively apprehensive about burning up the irreplaceable atoms of which its spaceship Earth is comprised, but 99 percent of humanity knows of no alternatives and can only protest that the petro-atomic exploitation seems unwise.

It is quite another matter for humanity to learn that it has indeed a clearly cut, feasible and omni-desirable alternative. With proven alternatives, youth's spontaneous strategems become wholistically constructive. Negative begets negatives. Positive begets positives. Instead of using their heads for battering rams in bloody revolutions, humans can use them to carry forward the design science revolution which alone leads to the comprehensively competent success of all humanity for all time.

The frequently negative and oftentimes lethal experiences of humanity, reoccurring throughout all history, persuaded the political and economic leaders that there is a fundamental inadequacy of life support on our planet. Assuming fundamental inadequacy also hypothesizes:

1. that many humans are to perish short of their potential life span;
2. that vast numbers are destined to poverty and all the physical deprivations that go with it;
3. that many are destined to die in trial of arms in evolution's process of selecting those fittest to survive.

It is only because of the universal assumption of the lethal inadequacy of life support that Earthians have politicians.

Because seemingly only a fortunate few are eligible for survival, politicians are inherently biased. Each political ideology assumes that it has the most logical and fair method of coping with fundamental inadequacy of life support resources.

All politics assume ultimate trial by armed might to determine which political group is to survive. Hence 200 billion dollars for arms have been jointly spent each year for the last two decades by the world's leading political powers.

Not only have the design science explorations of the World Games Seminars proven the complete adequacy of natural energy income to support all of humanity, but they have also found that all the livingry in general, the housing, clothing, and all environment controlling needs and desirables, can now be provided through known technology and provenly available resources in such a manner as to take care of not only all the fundamental needs, but also of an ever increasing number of the "desirings" of humanity, and do so unpollutingly by 1985, while greatly reducing the restraints upon individuals.

We can state informedly and unequivocally that we now know how to take care of all humanity at a higher standard of living than any humans have heretofore ever known, and can do so by 1985. We now know there is no fundamental inadequacy of life support. There is only inadequacy of human knowledge and experience. Knowledge and experience now make it clear that humanity was potentially designed to be a success and not a failure. We now know that all "you or me" political theories are obsolete. We now know that all warring is obsolete. We now know that all weaponry is obsolete. Universe is trying to make humanity an important success aboard our spaceship Earth. We can therefore assume that Universe has important need for the successful functioning of humanity's highest capabilities which are its mental abilities.

Because of the powerfully conditioned reflexes of humanity; because of fearborn inertias of bureaucracies; because of the lack of common knowledge that humanity has the option of sustainable physical and economic success; because evolution is moving inexorably to make humans successful despite the opposing factors; humans on Earth are now entering a period of total revolution. If it is bloody, because humans resign themselves to solution of survival problems only by physical power, humanity will disqualify itself for functional continuance aboard our planet.

What is unique about humans, in contradistinction to other living creatures aboard our planet, is our human mind's access to scientific knowledge of the operating principles governing eternally regenerative Universe itself.

Infinitesimally small humans on tiny planet Earth of medium-sized star Sun of our 100 billion star galaxy have been able to discover cosmic principles and have been able to employ those generalized principles to develop astro-photography. Infinitesimally minute humans, employing generalized principles of optics, have telescopically discovered and photographed a billion other celestial galaxies in our thus far 11½ billion light year radius sphere of local Universe observation. These little humans on planet Earth, through their gift of mind, have been able to discover the unique electromagnetic frequencies of each of the 92 self-regenerative chemical elements. Little human beings on planet Earth have been able to take inventory of the relative abundance of all those chemical elements present within the 22 billion light year-diametered sphere of Universe thus far humanly observed, 99.9 percent of which phenomena are utterly invisible to the naked eye of humans.

Up to the 20th century, reality was everything humanity could see, smell, touch and hear. Humans knew nothing of the electromagnetic spectrum, of X-rays or radio. Now 99.9 percent of all the evolutionary endeavors of humans are being conducted within the electromagnetic realm of the Universe, directly unapprehendable by humanity's naked senses. The 99.9 percent sensorially undetectable realities have been reached, and are being explored and employed by humans, only through their faculty of mind and the mind's capability to understand eternal, utterly incorruptible, principles.

Their physical prowess being greatly inferior to donkeys, humans are clearly present in the Universe for their mind functioning. If humans are to pass their final

examination for continuance on board our planet, it will be because weightless metaphysical mind and all the synergetic truths that minds discover have come into sustainable command of brain and muscle in the comprehensive resolution of all humanity's affairs.

If the design science revolution is conducted by mind, not for the advantage of the few but only for the advantage of all humanity, humanity will pass its final examination and thereby earn cosmic accreditation to its further local universe functioning within the great scheme of maintaining the integrity of eternal cosmic regeneration.

The 1969 World Game Seminar confirmed the feasibility of this writer's 1955 Design Science-evolved entire world-interlinking ultra-high-voltage (UHV) electrical energy network which interlinked the Americas with Asia, Europe, and Africa by an underwater Bering Straits cable connecting Alaska's networks with Russia's Kamchatka and Eastern Siberia's network whose energies are supplied by Russia's recent successful installation of water-power-driven generators employing Siberia's mainly northward flowing rivers.

The recent decade's ultra-high voltage electrical energy distribution reach is 1500 miles, about four times the 350 mile limit reach of the last half century's network technology.

Electric energy generating stations have a bank of individual generators. As demand increases, additional generators are set into operation. The world's local electric energy generators are used in full only during the short-time peak-load periods of the day when the lights go on before the industrial load has diminished. As a consequence, for more than half of our 24 hour-day, 50 percent of the electrical generating and distributing capacity of the world is unemployed.

Design Science disclosed that by taking comprehensive advantage of the UHV's 1,500 mile reach and interlinking all the progressively occurring night and day areas of our planet with one integrated world energy pool network, all the world's total energy generating capacity would become operative on a 24 hour basis, thus immediately doubling the kilowatt-hour output of the already installed world's generators. Thus, integrating only the high voltage conducting lines of the world would mean doubling the numbers of humans to be advantaged by the world's electrical energy system.

Fuel-combustion-heated, steam-turbine-rotated, electric generators can be arbitrarily shut down when not in demand, but the gravitational pull actuating water falls and water power cannot be shut off. Water power varies between abundance and scarcity on a seasonal basis, whose peaks and valleys do not coincide with the peak-valley pattern of humanity's articulated need patterns. The same non-congruence of peak-valley patterns is true of wind power, ocean tidal and wave power, and intermittently-eruptive, Earth-inferno heated, steam geysers. Only a world energy pooling and united distribution network, combined with a world-around system of high altitude lakes or hilltop reservoirs (that are pumpingly filled by all non-demand hour natural energy income) can effectively integrate the irregular inputs to sum totally service the world around rotative peak loads, while synergetically rendering the total system twice as effective as the sum of the separately operative systems. No single event could be more conducive to

realizing total cessation of all the world's 150 sovereignly independent and inherently competitive socio-economic systems than could be the closing of the gaps between all of the world's electrical energy grids.

Birthrates in the various political economies around our planet are in exact inverse proportion to the rate at which the average number of kilowatt-hours of electric energy per year are delivered to each human individual in that economy. As the number of kwh-per-capita increase, the new babies' birth rates decrease, in exact one-to-one correspondence. These correlated kwh-birth rate curves characterize all the separate nations of our planet. The highest kwh-per-capita economies have all reached zero population growth, i.e. number of births vs. number of deaths per year. A zero population growth for all humanity can be swiftly realized by doubling the World electrical energy generating and delivering capability through now feasible World network integration, as well as the feasibility of attaining World-around omni-humanity's high standard of living, to be realized entirely from our daily energy income as now opened to World people's view by Design Science prospecting and World Game certification.

The foregoing 1969 world Game-developed knowledge of the proven feasibility of doubling humanity's World-around electrical advantage, and thereby stabilizing the planet's population, may be compounded with the 1974 World Game-developed knowledge that all of the energy needs of humanity can be supplied entirely from inexorably operative energy events that become available as daily income around our planet. These income energies may be fed into the integrated World energy network.

These two World Game proven assurances may also be compounded with the pre-1967 World Game developed proven capability to adequately house, implement, and service all humanity as proven by the last quarter century's spontaneous acquisition and use by humanity of over 100,000 geodesic domes installed literally from North to South Poles, under the most formidable of environmental conditions occurring around our planet; with an average of only one thirtieth of the physical resources required by any other known engineering strategy for providing an equal amount of enclosed, safe, human environment habitat under the same environmental chal-

lenges of earthquake, tornados, hurricane, floods, fires, and pestilence, and the same general economic and social conditions, as measured scientifically in pounds of material, minutes of time and kilowatts of energy invested per each enclosed cubic unit of satisfactorily controlled environment.

Lest humanity be skeptical of its ability to realize such potential, omni-advantaging under any as-yet-known-organized human affairs management, we take note of the following unpublished but significant event.

A year before I had confronted the 1969 World Game Seminar with the challenge to prove the technical feasibility of integrating the World-around energy grid, I met privately with the Prime Minister of Canada, Pierre Trudeau, who was soon thereafter to make his first official visit to Moscow to meet with the USSR's Brezhnev. I gave Mr. Trudeau a copy of my "Sky-Ocean World Map" showing the north-south unification of all the World's continents as one unbroken perimetered "World Island" in one World ocean upon whose visibly undistorted one-World Island I had drawn the 1,500 mile (and less) interlinking of the World's electrical energy network grid. The grid showed the already developed and then known-to-be-developing generated energy input points as well as all the newly proposed input points now opened to consideration by the extension of UHV delivery reach from 350 to 1500 miles.

Mr. Trudeau was favorably impressed and took with him to Moscow an additional copy of my map and its super-imposed world network concept to present to Mr. Brezhnev, who, as later reported to me by Mr. Trudeau, was very favorably impressed with the concept which both Trudeau and Brezhnev had given to their respectively concerned authorities for feasibility checks.

We now also propose an over-the-Bering-Strait World "backbone" water supply system in which all the integrated electrical network's constant wind, wave, tidal, waterfall, etc. input overage will be constantly invested in world-around desalinization and elevated pumping of the pure waters to the world-backbone reservoir lakes. The "World Backbone" will follow the continental highlands employing the same north-south Dymaxion World's map of the One-World-Island in One-World-Ocean (see cover).